

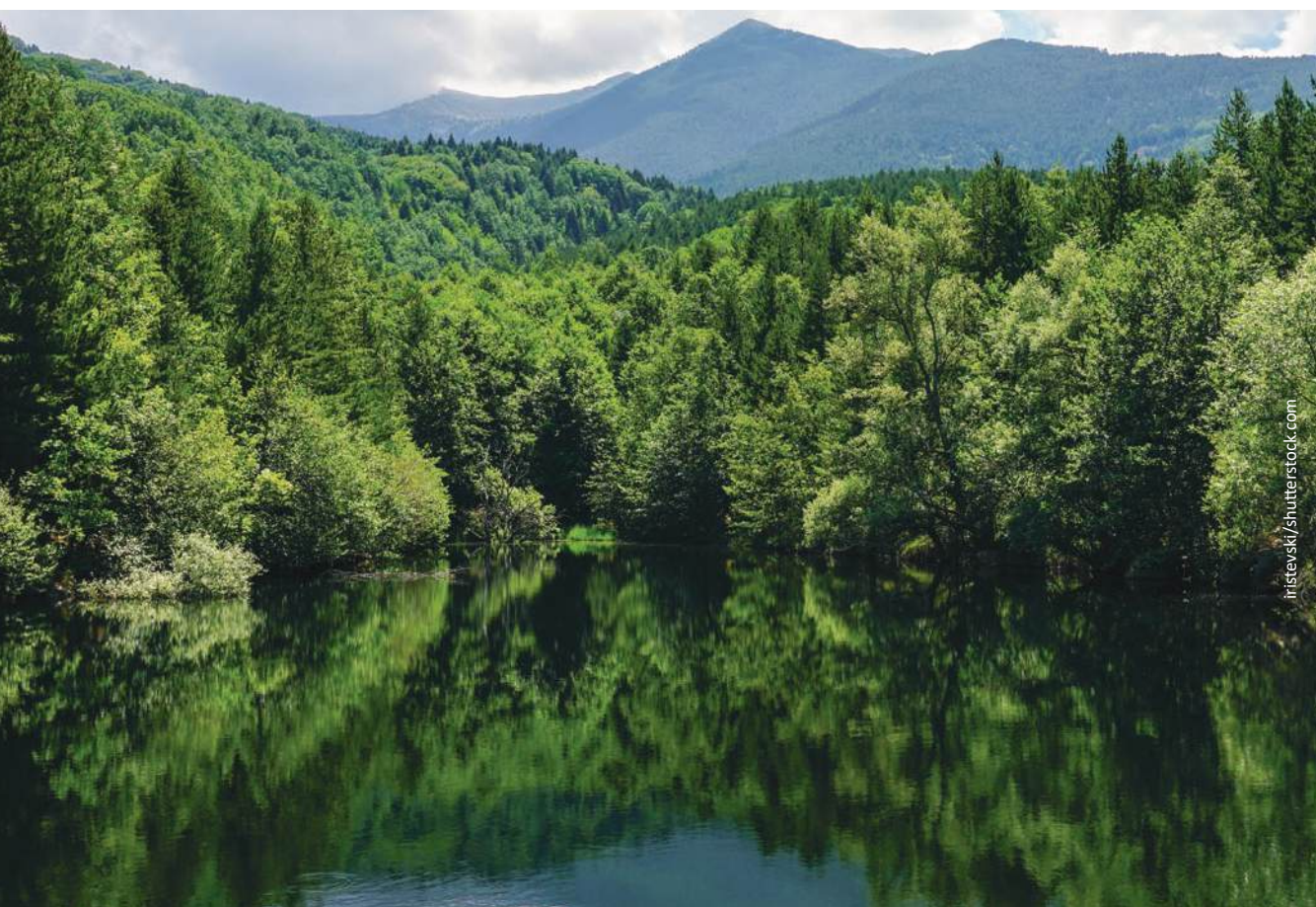
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Sustainable Forest Management: Close to Nature Forest Management as respond to the Climate Change in the Western Balkans

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the Climate Change in the
Western Balkans**

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**This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo Declaration of Independence.*

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Management guidelines in WB countries/territories

Prof. Nenad Petrovic

Management guidelines can be used in state and private forests. Management guidelines provide instructions for the management of individual tree species according to developmental phases/silvicultural groups. For each silvicultural group, clear indicators are given, the recognition of the silvicultural group through the upper heights, which is the most reliable indicator of productivity of the given habitat. The planning of management interventions by silvicultural groups given in the management guidelines provide frameworks for use by silvicultural groups in relative amounts (% of the volume increment or the number of competitors for each silvicultural group) and can be used at different site index classes.

Guidelines for types/tree species management represent the basic instrument for the operationalisation of the concept of closer-to-nature forest management into forest management practice. Guidelines for each management type/tree species provide recommendations that aim to implement the concept of closer-to-nature management into forestry practice with special reference to the following aspects:

- Preference is given to autochthonous tree species, and only the most adapted non-autochthonous tree species are proposed in a limited percentage, mostly as small groups in places where natural regeneration of autochthonous tree species in the stand has failed.
- The impact of climate change on each management type is taken into account during long-term planning at the level of each management type and its development phase/silvicultural group.
- All management goals should be achieved in a cost-effective manner, taking into account environmental goals at the same time.
- During regeneration, or ending the production process, it is suggested to regenerate smaller areas several times. Regeneration in smaller groups promotes natural regeneration to a greater extent than regeneration in large areas at the end of the production process, where significant financial resources are required for artificially assisted regeneration of the main tree species, from seed facilities or surrounding nurseries.
- Forcing natural regeneration aims at more vital stands that are developed from the best trees **in situ** and do not have the problem of adapting seedlings or seeds from artificial facilities (nurseries).
- Management guidelines promote the establishment and maintenance of mixed stands in all management types through artificial additional planting in small groups, in places where natural regeneration of the main tree species has failed, as well as later support of the desired tree species through adequate tending measures.
- In conifer monocultures, it is recommended to force mixed stands, preferably unevenly, in order to minimise the risks of windbreaks, snow breaks and secondary pathogens.
- It is necessary to minimise the use of chemical agents, and to the extent possible rely on supporting the natural laws of growth and development of forest ecosystems.

- Independent differentiation of potential crop trees must be ensured by creating conditions for intense natural competition between trees in the phases of regeneration, early and late saplings (especially among conifer species) in order to obtain a sufficient number of the best-quality potential crop trees in the coming period and reduce the costs of tending to the stands.
- As a result of the implementation of these guidelines, mixed stands and unevenly aged structural forms will be formed to a greater extent.
- Guidelines for the management of management types rely on natural processes that prevail in forest ecosystems, as well as interventions in the forest that are reduced to supporting existing ecological processes in forest ecosystems.
- Guidelines define the production goal for each management type, which is reflected in the desired/target diameter that we want to achieve at the end of the production process, taking into account productivity of the habitat (larger target diameters can be achieved during the same time compared to the same target diameters in worse habitats).
- All attention during management is shifted from the stand as a whole (volume of the stand) to the certain number of potential crop trees (PCT) with a defined target diameter of these trees, which are carriers of economic productivity throughout the entire production process.
- Potential crop trees can be permanently marked on the field.
- Tending measures are concentrated on a smaller number of potential crop trees during the entire production process, which facilitates continuity in monitoring the development of those trees, regardless of changes in the generation of professional staff or changes in jurisdiction during the working life of individual forestry engineers.
- Guidelines for types/tree species management are an instrument of communication between planners and district engineers who implement plans according to the same working principle (target diameters, potential crop trees and their selection and spatial distribution) using the guidelines as a common communication instrument for a better understanding of management goals and specific measures for their implementation.
- Clear cuts as part of management (regeneration on large areas) should be avoided.
- The implementation of these guidelines and the concept of closer-to-nature forest management should be carried out through a systematic approach to education and continuous training of professional staff using experimental and demonstration plots in the field for each management type and all development phases/silvicultural groups.

Climate change

Guidelines for types/tree species management present long-term goals that, in possible climate scenarios, should present the basic directions of development of stands and main tree species, i.e. which tree species should be promoted so that future generations have the opportunity to meet their needs from the forest and have a healthy environment. Management guidelines also take into account long-term goals regarding the main tree species that should be promoted in relation to existing species. Guidelines should take into account the border habitats of certain tree species, that due to the increase in temperature and precipitation oscillations, especially during the vegetation period, will not have the same production results, and long-term goals should be directed to the habitat of the most

suitable domestic tree species or the habitat of adapted foreign tree species. By taking into account climate change in these guidelines, negative effects on the growth and development of existing tree species are reduced and the negative risk of certain tree species drying up and disappearing in some localities is increased. Guidelines for management types/tree species management focuses on the stability and vitality of existing forest ecosystems by promoting mixed stands with smaller groups, concentrating tending measures on the most vital and highest quality trees in the stand, thus creating genotypic assumptions (in addition to phenotypic ones) that the best mother trees are ensured for forest regeneration, which are of the highest quality in terms of their characteristics and which, by implementing timely silvicultural treatments, have reached the end of the production process as the most vital and highest quality trees and have thus provided the most vital young trees for the next generations.

Forestry policy

From the point of view of forestry policy, management guidelines represent an important instrument for the implementation of the concept of closer-to-nature forest management, contribution of the forestry sector to climate change adaptation and mitigation at an operational level. At the same time, they present a clear operational instruction for practice, explaining the mechanisms of implementation of sectoral policies in the forest management practice. Management guidelines serve as an instrument for monitoring and controlling the implementation of the closer-to-nature concept of forest management and as well as climate change adaptation and mitigation at the local, regional and national levels. Management guidelines and their use and implementation are an instrument of communication and better understanding between sectors and a place for the integration of various goals and measures that contribute to sustainable, multifunctional and closer-to-nature forest management.

The implementation of closer-to-nature forest management has been selected among Western Balkan countries/territories as an important concept for future sustainable forest management in the region under climate change. As operationalisation of this implementation, a Closer-to-Nature Forest Management Expert Group has been created with representatives from all WB countries/territories. All forest management guidelines used during national training activities are provided in this report, including the main findings at the regional level. Closer-to-Nature Forest Management Guidelines (CNFMG) have been selected as an instrument for implementation. An outline was prepared in advance, including several examples from Germany and Serbia and provided to the national experts. A draft version of CNFMG was created during September and final discussion were held online. Practical training for the implementation of management guidelines at demonstration plots was prepared and implemented within the training centre on the Goč Mountain in Serbia. Participants had a chance to work practically on the established demonstration plots in beech and Austrian pine forests. Representatives from each country/territory were trained on these plots, which was followed by a discussion to receive participants' feedback regarding the concept itself, as well as the fieldwork. Findings from these discussions, including conclusions and recommendations, will be used later during the preparation of national demo plots and national training activities.

1.1. Comments and recommendations regarding the established demonstration plots in WB countries

After the establishment of demonstration plots in all Western Balkan countries, training with stakeholders was done in each country, including Serbia, where the demonstration plot concept has existed for several years and where training has been conducted for all licensed forestry engineers and different stakeholders, including national experts engaged within this project. At the end of the training sessions in each country, participants discussed different aspects of the implemented training concept, and a summary of their thoughts is presented below.

Conclusions by countries:

- Forest management guidelines that treat beech forests are applicable in Montenegro and their wider practise would improve the condition of beech forests in Montenegro.
- Newly developed Guidelines for the Management of Beech Coppice Forests and Marteloscope will significantly enhance their forest management knowledge and practice in the Federation of Bosnia and Herzegovina (FB&H).
- In the Republic of Srpska, the conclusion is that the approach is good and it facilitates fieldwork, but must be adapted to local conditions.
- Participants in the Republic of Srpska expressed that the Marteloscope, in conjunction with the use of tablets and I+ software, is a valuable educational and training tool for forest experts and stakeholders.
- Management guidelines on new trends in forestry are an important part of professional training and professional development of engineers, as stated in North Macedonia.
- The public forest management company Forests of the Republic of Srpska expressed an interest in establishing a similar demonstration plot in high beech forests. They found the experiences shared during the establishment of the first Marteloscope in Kupres to be valuable for their future endeavours.
- The training session served as an important step in advancing sustainable management practices for beech coppice forests in Bosnia and Herzegovina.
- Management guidelines on new trends in forestry are an important part of professional training and professional development of engineers. The situation in North Macedonia is not satisfactory taking in consideration lack of literature for professional training.
- The frequency of professional training is unsatisfactory. Professional training should be a regular activity of forestry professionals in North Macedonia. For this purpose, specific locations where on-field training will be realised should be established.
- In the Republic of Srpska, it was emphasised that previous management practices predominantly involved direct and indirect conversion, without a concerted effort to maximise forest value or extract more technical wood from coppice forests. In addition, the necessity of revising tree marking regulations to expedite and streamline the management of coppice forests was further highlighted.

General conclusions:

- Many aspects of the treatment of forests according to this concept are already present in the current practice of forest management in the Western Balkans.
- The participants think that it is completely possible to apply this concept in Albania, emphasizing the need to adapt forest management guidelines according to this concept.
- There is great need for the development of human capacities in the forestry sector to make the implementation of the closer-to-nature concept of forestry possible in practice.
- The enthusiasm and commitment of participants, coupled with the introduction of the Marteloscope tool and guidelines, promise a better management of vital forest ecosystems.
- Participants expressed that the Marteloscope, in conjunction with the use of tablets and I+ software, was a valuable educational and training tool for forest experts and stakeholders.
- It was noted that this combination of practical training promotes discussion and exchange of experiences and knowledge among participants.
- The concept of target diameter, despite being known by forestry professionals, has not been implemented so far in forest management practice.

Recommendations by countries/territories:

- It is certainly necessary to train forestry experts from Montenegro in order to acquire broader knowledge and apply forest management guidelines.
- Professional training should be a regular activity of the professional staff in forestry in North Macedonia. For this purpose, specific locations where on-field training will be realised should be established.
- Implementation of this concept in Albania makes it necessary to undertake intensive studies on the impact of silvicultural interventions on the development of forest stands in different stationary conditions and treated under different silvicultural regimes.
- In the near future, intensive and continuous practical training of all forestry professionals will be necessary, and the National Forestry Agency in Albania must be able to respond to this challenge.
- In FB&H, the establishment of a second demonstration plot in high beech forests should be considered, in collaboration with Hercegbosanske šume doo Kupres.

General recommendations:

- Continue to promote the use of the Marteloscope tool and tablet software for training and education within forest management companies.
- Consider the establishment of additional demonstration plots in coppice and high beech forests, but also in coniferous forests.
- Explore regulatory changes related to tree marking to streamline and improve the management of high and other forests.
- The concept of demonstration plots together with Marteloscope, as well as experiences and knowledge gained during the training should be shared among forestry sectors in all countries.
- Reduce information that INTEGRATE+ software is offering and consider only data needed for the training request.

1.2. Concept of guidelines for forest management on the example of one forest management type/ tree species – Albania: High Beech Forests

Prof. Leonidha Peri

GUIDELINES FOR THE MANAGEMENT OF HIGH MIXED BEECH FORESTS

Management Type (MT): High Mixed Beech Forests

Area: 188,000 ha

1. General characteristics



2. Actual distribution

2.1. Distribution in the country

Regional Distribution

Beech represents the most important forest species in Albania in terms of its contribution to the area and volume of the national forest fund. Beech forests are the most widespread formations with deciduous species in Albania, forming large forests from Vermoshi (Northern Albania) to Nemerçka (Southern Albania), which is the southern limit of its distribution. The districts with the largest area and volume of beech forests in Albania are Librazhdi, Tropoja, Malësia e Madhe, Bulqiza, Tirana, Shkodra, Puka, Pogradeci and Mati.

Beech forests in Albania, for the most part, are pure and rarely mixed with fir and mountain maple, and even more rarely with *Pinus nigra*, alder, *Pinus peuce*, *Bosnian pine*, etc. Among the few shrubs, there are yew (*Taxus baccata*), ashja, ajdesi (*Laburnum alpinum*), mezereon (*Daphne mezereum*), blackberry (*Rubus idaeus*), buckthorn (*Rhamnus fallax*), and European blueberry (*Vaccinium myrtillus*). The herbaceous cover consists of species with a root system with rhizomes and bulbs, which find optimal conditions for development in the soil of beech forests. These include *Dentaria bulbifera*, *Fragaria vesca*, *Galium odoratum*, *Anemone nemorosa*, *Atropa belladonna*, *Lactus muralis*, *Oxalis acetosella*, etc.



Photo by A. Diku

Elevation: They are found between 800 and 1,800 (2,000) m above sea level.

Climate conditions: The climate of the distribution regions is characteristic of the mountainous mediterranean climate zone, but it descends in the coldest exposures in the Castanetum phytoclimatic zone and ascends in the warmer exposures in the Picetum phytoclimatic zone. It prefers places with heavy rainfall and high atmospheric humidity. Late frosts and droughts limit its spread. Characterised by annual temperature ranges from -10 to + 25°C, mean annual temperature 7-13°C, precipitation 1,300-2,500 mm.

Soil: Beech grows in brown forest-type soils, rich, loamy, and fresh, preferably those created on flysch and limestone formations, but it also grows in poor ones on serpentine and does not adapt to moist, heavy soils or those that are dry and very poor.

Area:

Forest type	Area	Standing volume		
	000 ha	% of the total forest area	Mill. m ³	% of the total standing volume
Fagus Sylvatica beech forests	124.7	10.4	16.6	28.7
Fagus Moisiaca beech forest	63.7	5.3	6.1	10.6
Total Area	188.4	15,7	22.7	39.3

3. History of forest management planning

An even-aged silvicultural system is applied in pure beech forest stands. It involves release treatment (cleanings and liberations), one to two pre-commercial thinnings, commercial thinnings and uniform shelterwood systems to remove the old stand. The old stand is removed in a series of cuttings (usually three cuts) to promote the establishment of an essentially even-aged new stand under the shelter of the old one. The primary intent of this system is to protect and shelter the developing regeneration.

4. Environmental and production characteristics

Beech tends to form pure stands due to its pronounced competitive ability in relation to basic growth factors (growth space, light, nutrients, water, growth in the region of the root system) compared to other mixed tree species, except to a lesser extent compared to white fir. Small groups of other tree species can be found primarily in habitats more suited to companion species than to beech. Beech mixed forests are extremely stable ecosystems, but rare in Albania. Within mixed beech stands, it is necessary to preserve and, above all, actively protect the species in the mix, if one wants to improve the diversity of the species, dimensions and spatial mixing, and enable the realisation of some of the most important principles of sustainable management. Mixed forests of beech and white fir, Bosnian and Macedonian pine, maple, and spruce are of great production and ecological importance. Also, from the production and ecological point of view, beech and oak forests are very valuable for the climate.

5. Forest functions

Pure beech forests and mixed forests with beech and other tree species on steep slopes (especially in mountainous areas) play a significant role in the function of soil protection and water retention through interception, transpiration and infiltration. In addition to production, the following functions are particularly important: (1) soil protection on steep slopes; (2) protection of settlements and infrastructure; and (3) water protection.

The function of soil protection is reduced in older development stages, when the growth of trees and the root system is greatly reduced and there is tendency to develop a single-story structure. Moreover, the lack of mixing with other types of trees reduces the protection effect compared to the optimally mixed structure of beech forests with other conifers and deciduous trees of this type. Soil protection from erosion and water protection are best provided by beech stands in a mixture with coniferous tree species (fir, spruce and Douglas fir). Different forms of multi-seasonal structure in a mixture with conifers ensure a high level of interception (water retention), transpiration, especially in conifers in the early spring months, when deciduous trees do not have formed leaves, and through infiltration, i.e. water retention in the dead mat. By supporting mixed stands of various age structures, with a favourable condition of dead forest mat, the positive effect of forests of this farm type on soil protection against erosion, infrastructure protection and water protection is ensured, especially, as already indicated, on steep terrains in mountainous areas.

Some of the best beech forest in Albania are under protection status, including two UNESCO sites, for their high biodiversity values.

6. Economic characteristics

Beech forests are of great importance in the production of roundwood and firewood. To improve the economic value, it is necessary to define (mark) an adequate number of the best quality trees, which should be given long-term attention in the form of timely and intensively adequate care measures (lighting, cleaning, thinning), to ensure the necessary crown growth in order to intensify growth in diameter. Appropriate silvicultural treatment, based on growth in height of dominant trees and adequately developed crowns, within adequate length of the production process, prevents the appearance of false heartwood, the presence of which reduces the value of wood assortments. The percentage of the mixture with conifers and certain broadleaf trees should be increased in habitats that enable the creation of mixed stands of deciduous and coniferous trees with beech. The support of conifers should be in groups (nests) with a diameter of 10-30 meters, and for deciduous trees of 20-30 meters, to cope with the strong competitive power of beech.

The target diameter for the selected trees for the future or crop trees, depending on the quality of the site, can be 40, 50 or 60 cm. Timely and adequate thinning, based on clearly defined and marked crop trees, significantly increases the value of the wood volume that remains in the form of trees of the future at the end of production cycles. Beech, fir and spruce forests, as well as forests with various noble hardwoods, can be identified as the most economically valuable.

7. Term target structure and composition

Tall beech forests occur in smaller groups of all developmental stages, often vertically structured in small complexes of single-season stands or much more often, within a larger number of widespread complexes of multi-season forests. In a mixture with conifers, they usually build a group-like or stalk-like structure.

Restoration begins when the trees reach the target diameter, where all trees that have reached the target diameter are gradually and repeatedly used. When removing the last group of trees that have reached the target diameter, the remaining trees with thinner dimensions are also removed. In a mixture with conifers (fir, spruce and Douglas fir), conifer trees that have reached the target diameters are first removed, and then beech is managed until the target diameters begin to appear.

The long-term breeding goal in relation to the mixture is defined as the share of beech of up to 70-80% and other types of trees of up to 20-30% (conifers, hardwoods).

Parameter	The most productive sites	Sites of good productivity	Sites of average/ low productivity
Target diameter (cm)	>60-70-60	>50-60-50	>40-50-40
PCT distance (m)	>12-14	>10-12	>8-10
Number of PCT (PCS/ha)	>60-80	>80-100	>100-120
Production period (years)	100- 120	110-130	110-130
Regeneration period (years)	20-40	20-40	20-40
Height of dominant trees when selecting PCTs (m)	18-24	14-20	14-20
Branch free trunk when selecting PCTs (m)	8-10	6-8	6-8

8. Strategy of management treatments (economic function)

8.1. Strategy

Long-term goal: High-value timber has a high share of trees with a diameter of over 50 cm in the total production.

Production of 60 to 80 crop trees on very good-quality sites (on poorer-quality sites 80-100; 100-120), of the highest-quality trees above 60 cm (on poorer-quality sites 50 cm and 40 cm), per ha.

Shelterwood system (group or irregular) has a regeneration period of 30 years (20 to 40 years). In case the conditions for natural restoration are not optimal, it is necessary to apply auxiliary measures for restoration (soil preparation, seeding, removal of weeds, undergrowth, etc.) with a longer period of stand restoration. In steep terrains, the size of shelterwood area should be smaller. In stands of poor quality distance should be shortened and the target diameter of crop trees reduced. The removal of poor-quality trees should be accelerated and support continued to good-quality trees in the understory.

8.2. Treatment by development phases

Development phases during the development of beech stands can be divided into:

I. Youth stage

1. Young growth phase
2. Sapling phase DBH 2,5 cm
3. Differentiation phase DBH 5 cm, age 10-15 years
4. Young pole DBHB 6-10 cm, age 15-30 years
5. Old pole DBH 11-20 cm, age 31-60 years

II. Maturing stage

6. Middle-aged stand DBH 21-35 cm, age 60-80 (100) years
7. Maturing stand DBH 35-50 cm, age 80(100)-100(120) years

III. Old growth stage

8. Mature stand DBH over 50 cm, age over 120 years

8.2.1 Young growth and sapling phase [H = up to 3 m]

Silvicultural goals:

- Raise high-quality young trees
- Maintain and promote intraspecific competition
- Achieve stand closure as quickly as possible

Measures to achieve the goals and intervention intensity:

- As a rule, no interventions, only remove logging impact damage if necessary
- Promote and maintain stand closure in the interest of pruning
- Counteract grass encroachment (water competition and danger of mice) as far as possible by adapting the progress of utilisation
- Generally, there is no need to push back understory tree species, beech thrives excellently under understory forest
- Use larger gaps > 0.1 ha (diameter > 35 m) at an early stage for the introduction of mixed tree species

8.2.2 Differentiation and young pole phase [H= 6-12 m]

In this phase of the most intensive natural selection, there is no need for treatments on a larger scale. Negative selection is carried out, through a minimum of interventions, to force the natural pruning of the lower branches, natural selection, and positioning of the best trees in the space according to the required mutual distance. Individuals fight for space to grow and reach a favourable biological position, i.e. dominant and co-dominant position. In this phase, light tree species grow faster than shade tree species, so it is necessary to increase the competitive ability of beech or some other species with slower growth.

Silvicultural goal:

- Maintain stand closure to ensure the differentiation dynamic (natural branch pruning)
- Regulate mixture proportions; ensure proportions of sustainable light and semi-shade tree species, prerequisite: at least in small groups (Ø15 m), better in groups (Ø30 m)
- At this stage, pay attention to positive selection of mixed light tree species at an early stage
- Negative selection
- Measures to achieve the goals and intervention intensity:
- Align the number of interventions per hectare exclusively with securing the development potential of possible crop-trees, but no direct support- preservation of options
- Mixed growth regulation and negative selection in the dominant stand generally by striping
- No negative selection if the number of interventions distributed over the area is less than 50/ha, at most mixed growth regulation
- Selection and appropriate promotion of mixed tree species that culminate early in growth

8.2.3 Old pole phase [H = 12-18 m]

The crowns are largely closed and the natural pruning of branches in the lower part of the trunk continues. Trees with trunks free of branches have the potential to create the highest-quality part of the stand. In this phase, individuals continue to fight for their biological position and availability of quality upper light. Only when this phase is finished, it is necessary to select crop trees. The intensity of tree differentiation continues, and a minimum of interventions is suggested, to promote the natural pruning of lower branches, the natural selection and positioning of the best trees in the space.

Silvicultural goals:

- Preserving and improving the state of health
- Selection of future trees in mixed species (conifers, maple, ash, and cherry)
- Preservation of a dense structure to better promote the pruning of potential future trees from lower branches
- Regulating/preserving and supporting the mixture with other types of trees (regulating the mixture by preserving groups)

Measures to achieve the goals and intervention intensity:

- Preserving and improving the state of health
- Mixture control
- Removal of predominant trees of poor quality (possible ringing of unwanted trees)
- Regulating and supporting the mixture
- Intervention intensity of 10-20% of the increment

8.2.4 Middle age stand stage [H = 18-24 m; DHB 21-35 cm]

In this phase, the most important thing is to choose the optimal number of crop trees (CT) and maintain free space for the growth of their crowns by removing the strongest competitors (crop trees should grow without the shadow of the strongest competitors). In this phase, with the final selection of CT, any “mistakes” (loss of dominant tree status, damage, irregular spatial arrangement, etc.) that have occurred during the selection of the PSB are corrected.

Silvicultural goal:

- Select and promote the most vital and best-positioned trees; Kraft’s tree classes 1 and 2
- Select 60-80 crop trees on very good-quality sites (on poorer-quality sites 80-100; 100-120)
- Reach the free branch trunk, length 8 to 12 m
- Dominant height frame approximately 14 to 18 m
- Develop the largest possible crown (spacing of CT approximately 12 to 14 m, 10 to 12 m or 8 to 10 m, depending on site quality)
- Ensure dimensional (diameter growth) gains through early, strong promotion

Accessibility

- Development of an accessibility system before crop tree selection time

Measures to achieve the goals and intervention intensity:

- Remove the strongest crop tree suppressors/competitors during selection thinning
- two to three interventions per decade (intensity 10-20% of the increment)
- In the first intervention, thinning selection should be three to five crowding trees per crop tree, later lower intervention numbers
- Consider the potential for crown expansion
- In the case of crop tree groups support the groups at the edges

8.2.5 Maturing age stand phase [H = 24-30 m; DBH 35-60 cm]

Management guidelines at this development stage do not differ significantly from management guidelines for the previous stage. The difference is that maturing stands have a smaller number of trees of all species per unit area and the intensity of interventions is lower in terms of the number of competitors.

Silvicultural goal:

- Care of the confirmed selected crop trees continue
- Standing volume build-up
- Maintenance of the standing volume in the secondary stand

Measures to achieve the goals and intervention intensity:

- Continue interventions depending on the responsiveness and development of the stand
- Transition from selection thinning to stand maintenance in the dominating stand while preserving and maintaining the vertical structure
- one to two interventions per decade
- Intensity from 90% of the increment at the beginning of the phase to 60% at the end of the phase
- Preservation of standing deadwood and habitat trees

8.2.6 Maturity stand stage [H= 24-30 m]

This is the stage when natural regeneration of the stand begins, when CT begin to reach target diameters (>60, >50, >40 cm). Regeneration is carried out in such a way that, gradually, over a period of 20 to 40 (30) years, CT that reach the target diameters and trees of poor quality are removed. The removal of trees should be tied to the seed harvest, and if smaller areas appear (groups, clearings) that have not been naturally restored, it is necessary to ensure (by introducing or naturally) the young of other species in beech stands.

Silvicultural goal:

- Mature, strong trees generally from 60 cm BHD m. R. (strength class 5+)
- Observe red heart development, reduce target thickness if necessary
- Develop permanent forest
- Ensure natural regeneration
- Maintain or promote differentiation in young growth by controlling canopy cover
- Preserve habitat trees and pay attention to deadwood
- Introduce mixed tree species in good time or ensure their regeneration; mixed tree species should be rejuvenated earlier due to the competitive strength of beech; the significantly higher light requirements of mixed tree species must be taken into account

Measures to achieve the goals and intervention intensity:

- Optimal system of natural rejuvenation (renewal) is the shelterwood system (group or irregular) with two to three cuts with a long rejuvenation period
- Generally avoid large-scale felling strategies; regeneration should be largely differentiated in the course of spatially irregular target diameter cuts (due to existing stand structures, however, in many cases such structures are currently unavoidable with longer regeneration periods)
- If natural regeneration is installed under old trees of poor quality, the regeneration process should be accelerated, to obtain trees of high wood quality in the new stand

The most significant interventions (works) in this phase are:

- The first cut after CT have reached the target diameter and trees of poorer quality
- Protect remaining trees from damage during felling operations
- Removal of damaged saplings and trees from the understory immediately after felling (care of saplings)
- In the parts of the stand where restoration has not been completely successful (there are not enough saplings or saplings are damaged), fill in "in groups" with conifers (minimum group 0.1 ha) and deciduous trees (minimum group 0.2 ha)

9. Management guidelines in stands with a protective function – stands with pronounced soil protection on steep slopes

Beech stands in mountainous areas are most often found on pronounced slopes. The forest in such habitats protects the soil from erosion, as well as roads and other infrastructure. Also, beech forests in these areas play an important role in the protection of mountain watercourses.

In order to ensure the protective functions of these forests, it is essential to constantly cover the soil with trees or undergrowth. This management type is the optimal solution for soil protection. On slopes of 40-60%, a larger target diameter is recommended compared to slopes over 60%, and if there are buildings with the main purpose of protecting soil from erosion, it is necessary to go for a smaller target diameter, in order to avoid the occurrence of landslides.

On slopes above 50%, stable management should be applied. On slopes above 50%, the optimal way of extracting wood assortments is the use of cable ways.

In forests with the purpose to protect soil from erosion, all work procedures, forest mechanisation and general preparation must be adapted to the following requirements of protection:

- With an increase in the slope, the target diameter decreases, the number of trees per ha increases, the area where restoration is carried out – the final section, and the transition from group to tree management is reduced
- Exclude and prohibit large-area forms of logging as a method of regeneration
- Consider the possibility of using a cable car
- Form mixed stands with conifers of multi-story structural forms
- Exclude the technology of production of long (heavy) wooden assortments
- Logging residues should be left in the stand after felling operations
- Ban the extraction of trees along the line of greatest fall in order to prevent the formation of erosion furrows
- When designing and building timber extraction roads, adapt to the configuration of the terrain as much as possible (monitoring of isohypses)

10. Management guidelines in stands of poorer quality

Generally, qualitatively unsatisfactory stands (high frequency of twigs, steep branch scars, twisted growth, low number of stems, etc.)

Silvicultural goal:

- Production of sawn timber or energy wood
- Regenerate early and if not worthy of natural regeneration (genetic potential unsuitable), pre-cultivate with selected reproductive material or, if necessary, convert to a mixed stand with another leading tree species

Measures to achieve the goals and intervention intensity:

- Less crop trees < 25/ha
- High intensity thinning only with cost-covering interventions
- Use harvesters if possible

11. Guidelines for the implementation of harvesting works

- Maximum protection of young and other trees
- Directed felling of trees
- Design and construction of tractor roads and marking of the direction of extraction of assortments
- The means of transport for extracting wood assortments can only move along prepared and marked roads in parts of the stand where there is no undergrowth
- In the regenerated areas the long trunk method should be applied (trunk length no longer than 8-10 m) and meter-long firewood used
- Design a transport scheme
- Create working maps with a vertical representation of the terrain at a scale of 1:2,500/5,000, with forest infrastructure (truck roads, tractor trains, extraction routes, temporary storage areas)

Natura 2000 and biodiversity issues

Albania is not yet implementing the Natura 2000 in the forestry sector. In relation to the issue of biological diversity, the following elements should be taken into account:

- Habitat trees should be promoted to increase the conservation of biological diversity
- Dead trees should be kept in the stand
- Rare and endangered tree species should be promoted and protected
- Nesting trees should be protected from cutting

Establishment of a permanent sample plot for training in Stebleve, Central Albania

The pilot sample plot recommended to be used in the training of forestry professionals on the concepts of closer-to-nature forest management/silviculture was set up in Stebleve in Central Albania at the beginning of September 2023. Part of the working group were also members of the Forestry Administration of Librazhd municipality as well as staff of the National Forestry Agency under the supervision of Prof. Leonidha Peri, Prof. Elvin Toromani and Assistant Professor Enea Malaj.

The pilot sample plot has an area of 1,250 m² and is situated in a high beech forest stand (*Fagetum moesiaca montanum*) with an altitude of 1,200 m (41°18'51.52"N; 20°24'26.82"E). All trees were numbered and all the necessary dendrometric measurements performed.

In the first week of October 2023 in Tirana, a discussion was organised on the principles of closer-to-nature forest management/silviculture in general, as well as in the case of high beech forests as the main forest species in Albania.

The discussion was attended by the staff of the forestry sector in the Ministry of Tourism and Environment, the National Forestry Agency, the Forestry Administration of the Tirana Municipality and experts in the field of forestry.

Discussion participants welcomed the concept of closer-to-nature forest management/silviculture.

Many aspects of the treatment of forests according to this concept are also present in the current practice of forest management and silvicultural interventions in Albania, such as natural regeneration of forests, selection of future trees, etc.

The participants thought that it was completely possible to apply this concept in Albania, emphasizing the need to adapt the Forest Management Guidelines according to this concept.

According to the participants that could be done either by including in the Forest Management Guidelines the manner in which silvicultural interventions would be carried out or by including a manual on closer-to-nature silvicultural interventions as an annex to these guidelines. The second approach seemed to be more feasible.

Considering stations where forests are located in Albania, the participants believed the implementation of closer-to-nature forest management to be more suitable and effective in high forest stands with good productivity (production classes 1-3).

In production classes 4-5 in high forests, due to poor stationary conditions, it may be difficult to secure the necessary number of crop trees or other parameters for the proposed silvicultural interventions.

The lack of local studies regarding the development of these forest stands, but also for the other silvicultural systems should also be considered.

This lack can be one of the possible obstacles in the way of implementing a forest governance system based on the concept of closer-to-nature forest management.

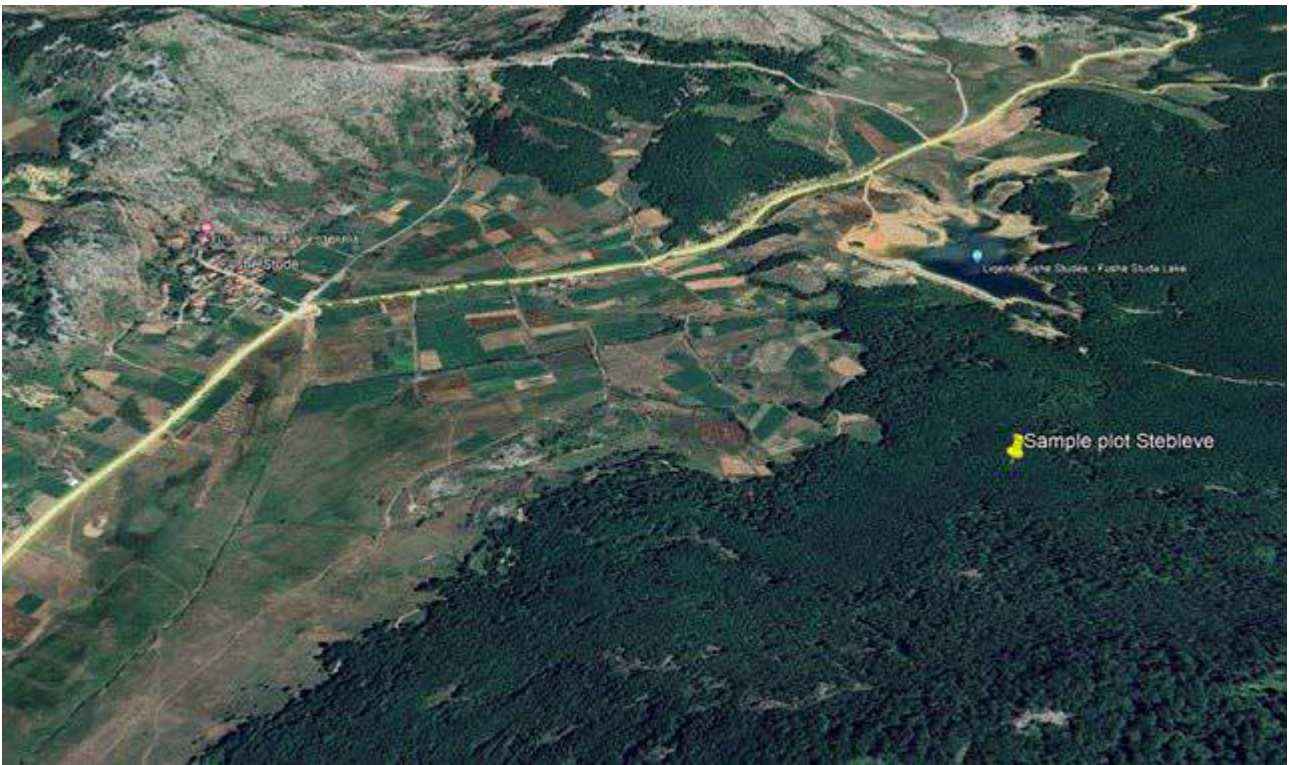
On the other hand, the implementation of this concept makes it necessary to undertake intensive studies on the impact of silvicultural interventions on the development of forest stands in different stationary conditions and treated under different silvicultural regimes.

The concept of border diameter, despite being known by forest personnel, has not been implemented so far in the practice of forest management.

All participants were unanimous about there being a great need for the development of human capacities in the forestry sector to make the implementation of the concept of closer-to-nature forestry possible in practice.

In the near future, intensive and continuous practical training of all forestry professionals will be necessary, and the National Forestry Agency must be able to respond to this challenge.





1.3. Concept of forest management guidelines on the example of one forest management type/tree species

Federation of Bosnia and Herzegovina.

Beech Coppice Forests

Prof. Bruno Maric

Guidelines for management of beech coppice forests in the Federation of Bosnia and Herzegovina

1. General characteristics of beech forests

- In Bosnia and Herzegovina, beech shows very good horizontal and vertical stratification, occurring from the lowest forest belts, where it comes together with sedge oak and sedge (*Fagetum submontanum serbicum*), followed by the hilly belt, where it builds clean stands (*Fagetum montanum*), and in the most important mountain belt, where it build our most important forests in community with common fir or fir and spruce as the beech-fir tree community (*Abieti-Fagetum*).
- The characteristics of beech forests in Bosnia are different, but the specificity in central Bosnia is that there are significant surfaces with clean beech tree forests of secondary origin.
- Those are anthropogenic forests of beech trees and fir, followed by beech, fir and spruce, through adverse human activity in the middle ages, and as such represent transitional vegetation stages.
- Beech coppice forests are spread in a mosaic within the area of secondary beech forests, created after destruction of coniferous fir (and spruce) and to a lesser extent within the area of beech-fir (spruce) forests in Bosnia and Herzegovina. In the northern parts, these forests are widespread in the submontane belt on relatively smaller altitudes above sea level in the altitude range between approximately 200 and 500 m. In the inner (central) part of the Dinarides, they are widespread in the montane (mountain) belt, between approximately 500 (600) and 1,300 m, reaching up to 1,400 m in the submediterranean area. Their lower limit is above 800 (900) m. Forests of beech and common hornbeam are most often found at altitudes between 200 and 700 m.
- In the coppice forest, trees of vegetative origin prevail, which have developed from adventitious trees predominate, budding from tree parts remaining after cutdown (from tree stumps). They are not managed by breeding low forms, but are sporadically used for heating needs and small technical wood.
- Beech coppice forests are characterised by the presence of a large number of trees, reduced crowns, thinner trees, poorer wood quality, significantly reduced productivity, extremely unfavourable tree structure in terms of thickness and age, production of lower quality and less valuable assortments, poor health condition of forests and less favourable economic effects in comparison with tall beech forests.
- Plantation forests are mostly located near settlements and roads on good and deep soils. Productivity and wood quality of these forests are weak and insufficiently used.

2. Current situation

- Beech can be found throughout the country, except for a wider belt in the west of Bosnia and the whole lower part of Herzegovina, covered by thermophilic vegetation of submediterranean formation, and also a wider belt of lowland and hilly terrain in the north and northeast Bosnia, occupied by hydrophilic and moderately thermophilic vegetation of subpannonian formation.
- Montane beech tree forests occupy the mountain belt (from 800-900 to 1,100-1,200 m a.s.l. on carbonate and from 150-200 to 1,000-1,100 m a.s.l. on acid silicate substrates)

- Forests of beech and fir (with spruce) abut mountain beech forests (primary or secondary), where they build a broad altitudinal belt from 1,000-1,100 m a.s.l. to 1,500-1,600 m a.s.l.
- Subalpine beech tree forests represent climate-regional forests of the Western Balkan and Illyrian areas and they are found in between beech and fir forests (with spruce) and mountain pine forests, on altitudes of 1,550 (1,600)- 1,800 (1,900) m. In the lower zone the forests are still high, while in the upper belt they represent bush vegetation.



Spreading beech trees (*Fagus sylvatica*) in Bosnia and Herzegovina (Fukarek, 1970)

3. History of forest management planning

- Coppice beech tree forests in Bosnia and Herzegovina are a degradation stage, formed as mistakes in management, by ad-hoc and uncontrolled cutting, mainly to supply heating for the local population.
- In the twentieth century, they were formed through negative influences of biotic factors (human, livestock), in the majority cases by devastation by humans or more recently, mistakes in forest management on tall breeding forms.
- In the last 40 years, the areas under coppice forests in B&H have increased. The reason for this is that in 1960s and 1970s, beech was not particularly interesting for the wood processing industry.
- In the existing coppice forests, planned care and restoration measures have not been implemented on the tall breeding form.

- Beech has an exceptional application in the wood processing industry, but the ways of felling and restoring tall beech forests do not differ significantly from those of 40 and more years ago. In mature stands, beech is cut according to the principle of selection. Good and high-quality trees are marked, individually and in groups, which corresponds to the group-selective management system. This management method, from the biological, ecological, breeding and economic point of view, is not suitable for beech tree and cannot enable continuity of its optimal development and renewal, but in time leads to further degradation towards lower degradation stages, i.e. coppice forests
- Beech coppice forests with a share of quality trees of at least 120-150 per hectare should be converted into a higher cultivation form through indirect conversion, while those lower quality should be directly converted into high forests.
- In order to carry out the direct conversion of coppice forests into a high breeding form, clean cuts are allowed in coppice forests of poorer quality. Unfortunately, this felling method has often been misused, so the best and the highest quality beech forests were not renewed by fertilisation logging, but were cut “to bare” after which afforestation with coniferous species was performed.

4. Environmental and production characteristics

5. Forest functions

- Beech coppice forests in Bosnia and Herzegovina cover an area of 432,100 ha. Out of the total of 432,100 ha of beech coppice forests in B&H, 318,100 ha belongs to production forests, which in addition to its production functions (production of wood and non-wood forest products) also ensures the function of biodiversity protection, soil and water protection and have a social role.
- The main role of forestry experts is not exclusively related to the exploitation of these forests but focuses on progress and improvement of their quality. The goal is to ensure sustainable forest ecosystems for future generations, which will provide to the industry – high-quality wood; to the local population – the opportunity for leisure, sports and clean air; to researchers – basis and opportunity for further research; and also to contribute to fight and mitigate climate change at the global level.
- Forests mitigate negative effects of stormy winds, long and heavy rains, extremely high and low temperatures. In the process of photosynthesis, they adopt CO₂ from the atmosphere and introduce it in their biomass. This is why we can say that forests, in addition to economic importance, represent a very important ecological mechanism regulating climate at the local and global levels, mitigating its negative effects. All this tells us that breeding activities in coppice forests should go in the direction of improvements of production options and improvement of other generally useful, primarily environmental functions of these forests. Production and ecological functions of coppice forests cannot be observed separately.

Every breeding measure should aim at simultaneous improvement of the quality of wood in coppice forests and preservation and promotion of other ecological functions.

6. Economic characteristics

- Coppice forests in Bosnia and Herzegovina are mainly found on good habitats, especially on deep soils, so that the production potential of the habitat is underused, which particularly reflects on the weak quality of trees.
- Previous research has shown that despite that the quality of trees is poor, in most of the studied beech coppice forests there is a minimum number of trees that could form a base for improving the situation in a relatively short time.
- In addition, it has been concluded that there are beech trees of seed origin, as well as other types of hardwoods, so there are realistic conditions to convert these coppice forests into a tall mixed forest, by applying forest care measures.

Coppice beech and mixed beech forests do not have the potential for the production of technical wood. In these forests, 80-90% is for heating wood production and wood for mechanical and chemical processing and only up to 10-20% technical and micro technical wood.

- In order to increase the economic value in these forests, a minimum number of trees of seed origin should be promoted (10 to 30 per ha), in order to increase economic effects.
- In the case of beech coppice forests, the best economic effect is achieved if they are harvested as soon as possible to produce the maximum amount of firewood and increase the share of technical and micro technical wood above 10%.

7. Long-term target structure and composition

The biggest part of beech coppice forests are in the phase of maturity (age >50-70/80-90 years), with a large number of trees, i.e. a large share of trees with small crowns and with a small increase in thickness.

Long-term goal:

- Renew bad coppice forests by clean logging
- Create young coppice forests
- Maximum production of wood in minimum period of time
- Production of certain quantities of technical wood

Production goals:

- Based on a detailed analysis of coppice forests, height degrees (height degrees of dominant trees) have been defined:
 - < 16m: Production goal mainly heating wood; breeding system: low forest; low trees reserves; permanent forest with spare trees; permanent forest, a structural form with continuous production on the entire surface; structurally diverse entire surface; structurally varied stand, with different age-groups
 - 16-21m: Production goal heating and technical wood; breeding system: stand similar to high forest
 - 21-24 m: Production goal heating and technical wood; breeding system: stand similar to high forest; high forest
 - > = 24 m: Production goal technical wood; breeding system: high forest

Parameters	Poorer-quality habitats	Better-quality habitats
Production goal	H/DS* <16m 100% heating wood	H/DS 16 < to > 21 m 80-90% ogle tree 10-20/% technical wood
Desired diameter /target diameter	25-30 cm	Coppice origin 30-40 cm Seed origin 35-40 cm
Space between FT*	4-6 m	6-7 m
Number FT	150-200	120-150
Maximum number of trees of seed origin	10-30/ha	10-30/ha
Number of competitors	3-1* 2-1	3-1 2-1
Trunk length without branches	5-7 m	6-8 m
Intensity of coverage	60-80%	60-80%
Production period	40 to 50 years	50 to 60 years

- Beech coppice forests, which are still prescribed to be managed as coppice forests, are in most cases 50 to 70 years and over 70 years old, of poor quality in poorly productive habitats. The main characteristics of coppice forests are a large number of trees, reduced crowns, small diameters, poor quality, significantly reduced productivity, extremely unfavourable thickness structure, lower quality and lower value products, poor health conditions and reduced economic effects.
- In beech coppice forests, in somewhat better habitats, a certain number of future trees of coppice origine should be selected at 120 to 150/ha, at a distance of 6 to 7 m, and in poorer habitats, 150 to 200/ha, at a distance of 5 to 6m, and manage them until they reach the target diameter and maximum wood quantity production.
- In coppice forests where there is also a minimum number of trees of the main species of seed origin (10 to 30 Ha), such trees should be cared for and used to restore parts of the stand naturally (similar to reserves) and technical wood production of higher value, and in the rest of the stand carry out clean cutting in as short as possible period of time. Produce the highest possible quantity of heating wood and wood for chemical and mechanical processing.
- In beech coppice stands, in poorer habitats where it is not economically justifiable to single out future trees, managing is by clear cutting, so that halfway through the production process (around 20 years) one thinning of stronger intensity is carried out and later the maximum production of fuel wood and wood for mechanical and chemical processing is reached.
- Goal: in relation to the quality of the habitat, to provide an optimal number of the highest quality trees, i.e. 120 to 150/ha (in poorer habitats 150 to 200/ha) of target diameter, regularly distributed over the area at the end of the production process.
- Middle-age stand is the stage of selection and marking of future trees, 120-150/ha at a distance of 6-7m (in poorer habitats 150-200/ha at a distance of 5-6m). At this stage, dominant trees in better habitats have reached a height of 15–20 m and have a trunk clear of branches of 6m to 8m (in poorer habitats, the dimensions of the dominant trees are somewhat lower than 14-17m). In this stage, it is necessary to carry out larger-scale thinning operations, with the goal to remove all competitors to future trees. In the initial phase in middle-age stands, as a rule, 3-1 strongest competitors to future trees are removed.

All beech coppice forests can be classified in four categories or breeding groups:

Category I (cultivation group 1) of high-quality beech coppice forests, mainly composed of shoots from healthy stumps. These stands are located in the best habitats that are suitable for beech. High-quality coppice forests of different ages fall under this group, which we can distinguish as adults and younger ones. The management goal in them is to gradually convert them to a high breeding form.

Category II (cultivation group 2) of coppice forests, thickets and thicket-like formations of poor-quality beech and low economic values, which are found in relatively good habitats where economically appealing production could be achieved, and where the existing inventory does not use the production potential of the habitat at a satisfactory level.

Category III (breeding group 3) of coppice forest is of relatively good quality, located in poor habitats. They most often appear on shallow limestone soils with expressed rockiness. Coppice trees of good quality prevail in them. These coppice forests have, above all, a protective function. Their conversion into a high cultivation form by clear felling is not recommended, not even renewal by fertilizing felling is suitable because these habitat conditions make the development of natural young beech trees uncertain.

Category IV (breeding group 4) includes all other very poor beech coppice forests with a significant presence of xerothermic elements, such as white hornbeam, black ash, hawthorn, roses. The mentioned species indicate xerothermic habitats, and they inhabit rocky areas and shallow eroded land in extremely unfavourable pedoclimatic conditions and highly sloping terrains.

Breeding goals for beech coppice forests

Stage goal 1	Stage goal 2	Stage goal 3
Deciduous trees or conifers	Quality adult beech coppice forest	Quality productive low forest
Final goal 1	Final goal 2	Final goal 3
Tall forest deciduous trees or conifers for wood production	Tall ecologically stable productive beech (and fir) forest with other generally useful functions	Low forest unlimited use of fuel wood

Final goal 1 – Production of maximum amount of wood mass. If the final goal is the maximum production of wood, then coppice beech is removed by clear felling. Afforestation is carried out on the bare surface by planting or sowing seeds of domestic or foreign tree species. Successful afforestation and good development of growing trees is a stage goal set on the way to the final goal. The final goal is defined by the production period, that is, the desired products from the forest. If the goal is wood for chemical processing, then shorter production periods are used. For getting wood intended for mechanical processing longer production periods are set.

- Final goal 2 – Ecologically stable productive tall beech (and fir) forest. Existing coppice forest, in addition production, also performs other ecological functions. If the goal is to preserve the stability and increase the productivity of coppice forests, then all cultivation interventions are focused on the care and natural renewal of coppice forests into a highly stable beech or beech and fir forest. Here the stage goal is an adult good-quality beech coppice forest grown from seed. The final goal is reached by stand renewal by natural rejuvenation under the crowns of beech parent trees. The rejuvenated stand is of seed origin and by using the right care measures, cleaning and thinning, we get ecologically stable and productive beech tree stand of tall breeding form.

- Final goal 3 – Productive low beech forest. Lately more and more people are talking about biomass as a renewable energy source. Biomass (wood, branches) can be used from coppice forests owing to better growth of coppice trees at a younger age. After the culmination of growth, clean cutting is applied, and from the remaining stumps new shoots are developed that will make the future stand.

Coppice forest category	Degradation degree	Age	Type of breeding
Breeding group 1	Good quality maintained coppice forests	Adult	Fertilisation cutting
		Younger	Selective thinning, regular thinning
	Good quality unmaintained coppice forests	Adult	Fertilisation cutting
		Younger	Selective thinning with clearing redundant, bad, deformed, sick and leftover shoots on stumps. The next action is selective spacing or regular spacing.
Breeding group 2	Poor quality beech coppice forests in good habitats	Adult	Fertilisation cutting. If stumps are not producing shoots, perform under seeding with beech or fir trees. After sprouting perform a follow-up, and later when the plants grow to 1 m also final cutting. Less often apply clean cutting and afforestation.
		Younger	Cleaning bad shoots from stumps. If good development of remaining shoots from stumps cannot be expected, clean cutting and afforestation.
	Degraded beech coppice forests in which the predominates are skunks	Adult	Fertilisation cutting. If stumps are not producing shoots, perform under seeding with beech or fir trees. After sprouting perform a follow-up, and later when the plants grow to 1 m also final cutting.
	Shrubs and bushy beech formations in good habitats	Younger	Removal of degradation causes, cleaning and thinning, renewal by fertilisation cutting. In certain cases renewal by clean cutting and afforestation with good-quality beech seedlings.
Breeding group 3	Good quality coppice forests in poor habitats	Different	Free thinning, selective thinning
Breeding group 4	Poor quality beech coppice forests in poor habitats	Different	Removal of negative factors which contribute to further stump degradation. Follow-up cleaning and free thinning
	Shrubs and bushy beech formations trees in poor habitats	Different	Removal of negative factors that contribute to further degradation of shrubs or shrub-like beech formations. If conversion is of priority significance (outing site, objects of special purpose) clean cutting should be performed in stripes and renewal afforestation with seedlings protected by the rest of the thicket.

9. Special treatment strategy for important forest functions

In addition to their production function, coppice forests also ensure protective functions in the form of erosion prevention (land protection on steep slopes), settlement and infrastructure protection from wind and noise, water regime regulation and ensure potable water. Beech coppice forests in mountainous areas of Bosnia and Herzegovina, are most often found on steep slopes. The forest in such habitats protects the soil from erosion, but also the roads and the remaining infrastructure. Also, beech forests in these areas play an important role in protecting mountain watercourses. On steep terrains, where beech tree height cannot reach over 16 m, they have an exclusively protective function. With the aim to ensure the protective function of these forests, full coverage of soil with trees or undergrowth is of essential importance. Coppice forests are a very good solution for soil protection. It is forbidden implement clean cutting in forests with protective function and it is recommended to apply individual cutting as management method. On slopes above 50% inclination, the optimal way of extracting wood products is to use cable transport. In forests with protective function from soil erosion, it is necessary to adjust all management activities, prepare for the implementation of forest exploitation activities, use forest mechanisation and potentially animals in a way enabling forest functions.

- Use cables and animals in the process of exploitation
- Form mixed stands with coniferous species
- When tailoring forest wood products, it is necessary to avoid longer and heavier ones
- When designing secondary forest communications, it is necessary to follow isohypses and make logging trails so that their effect on forest flora and fauna, biodiversity and the overall ecosystem is minimal

10. Measures in case of disasters

The harmful consequences of natural disasters can be significantly reduced by carrying out appropriate cultivation measures, according to the found state of the forest and biological rules within habitats. In this the desired vitality is maintained, as well as the state of health and stability of trees and the forest as a whole. Whenever possible perform restoration of stands naturally.

In the case of wastelands > 0.2 ha, it is necessary to reforest. Breeding goal in this case should be focused on rehabilitation of endangered and damaged areas.

Cultivation measures include:

- Afforestation on non-vegetated areas created by the effects of natural disasters (fire, wind, snow, ice and similar)
- Afforestation on areas where regeneration and reforestation failed
- Afforestation on areas that have been desolated– illegal felling, etc.
- Establishment of forest order

Breeding works shall include the following activities:

- Measure and show damaged areas for rehabilitation on maps
- Measure and register damaged trees by category of damage (break, fall, drying, fires and others), type of trees and product structure (technical, spatial and residue)
- Make a rehabilitation plan
- Urgently remove damaged trees
- Perform complete preparation of the terrain for afforestation (larger groups)
- Carry out afforestation of larger groups using an appropriate choice, above all, fast-growing and other tree species, of appropriate age, type of planting material and number (planting distance), respecting habitat conditions for the specific object
- Preserve the natural young, where possible, by applying appropriate breeding measures to enable their competitiveness in relation to artificial species inputs.

11. Guidelines for the implementation of works on forest utilisation

Priority guidelines for quality implementation of works on forest exploitation (cutting, production and extraction of wood products):

- Maximum protection of young and standing trees,
- Determination the direction of felling trees
- Directed felling of trees
- Designing and constructing tractor trails and marking the direction for extracting products
- When pulling wood products, means of transport can only move along the marked ways and trails on the parts of the stand where there are no young trees
- Size alignment (diameter, length and volume) of the produced wooden products of maximum dimensions with the power of the means of transport
- In parts of stands where it is well rejuvenated, apply the trunk method of making wood products (the length of the trunk need not be longer than 8-10 m), and use side branches of thinner dimensions for fuel wood measured by metres
- Remove the remaining thinner branches from the saplings and arrange them on the parts of the stand where there are no young trees or on stumps, opposite the direction of wood product extraction
- If possible, design a transport scheme – pulling with a winch uphill, and pulling with a vehicle downhill
- Create working maps with a vertical representation of the terrain at a scale of 1:2,500, 5,000, with mapped forest infrastructure (truck roads, tractor trails, extraction directions, temporary warehouses).

1.4. Concept of guidelines for forest management on the example of one forest management type/ tree species – Kosovo*. Mixed Beech Forests.

Prof. Faruk Bojaxhi

Management Unit: Koritnik 1, Dragash

Forest parcel: 87

1. General characteristics of the management type

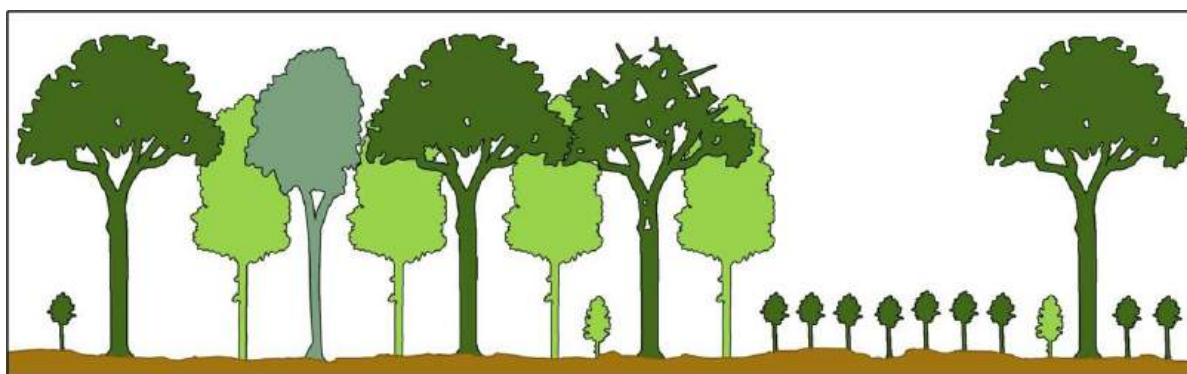
Mixed beech forests studied are located in the National Park Malet e Sharrit at a distance of 5 km from Brezne village. The trees are straight and tall, well developed, with vital crowns. Forest stand composition consists of beech, silver fir, Bosnian pine, wild cheery, wild service tree and maple trees.

In mixed beech stands, wild service tree mainly forms the second layer together with some young silver fir trees. The forest stand is dense, and tree crowns are cleared in the lower part of the trunk from branches and protecting the soil from weeding.

In this habitat, beech and silver fir are the dominant species covering 46% each, while other species appear with a share of 1 to 3% in the mixture, mostly from a single to 3 trees.

At some locations, smaller groups of old and strong trees can be found, and some of them are partially or completely dry. These trees are a habitat for many plant and animal species.

This management type includes the category of forests – **1220 Mixed beech forests, silver fir, spruce and other broadleaves.**



2. Current situation

2.1. Distribution/Area

Forests in Kosovo* occupy an area of 481,000 hectares (KEPA, 2012), 60% of which is public property managed by the Kosovo* Forestry Agency and 40% is privately owned. Beech forests in Kosovo* are distributed in various parts of the country and lie over the oak belt at an altitudinal range between 900 m and 1,320 m in all expositions with a total forest cover of 80-100%. Beech forests are also mixed with species like silver fir (*Abies alba*), maple (*Acer pseudoplatanus*), Bosnian pine (*Pinus heldreichii*), etc.



Figure 1. Distribution map of beech in Kosovo*

Beech distribution at country level: Beech forests are situated in northwest part of Kosovo* on the border with Montenegro, in Decan and Prizren bordering with Albania and Sharr National Park bordering with North Macedonia as well as in the northeast part bordering with Serbia.

Elevation: Forest stands in this study area are situated at an elevation of 1,304 m above sea level.

Climate: These forests are well adapted to mountainous conditions. The climate is Alpine with some continental influences. Mean monthly temperature ranges from -1.3°C in January to 20°C in July, whilst precipitation ranges between 600 mm in lowlands to 1,300 mm in high mountainous areas, depending on the elevation.

Soil: In the geological sense, beech forest stands are located on limestone bedrocks. In the study area, brown soils or Lithic Leptosols dominate, stretching in hilly-mountainous regions, along mountains. Such soils have a deep profile with black colour in the upper layer and are generally fresh with medium moisture, granular structure and an acid to neutral reaction.

Area: The forest stand is part of the management unit Koritnik 1. This management unit is located in the southernmost part of Kosovo, it lies in the northeastern part of Albania on the border with the town Kukes. The altitude of this management unit varies from 294 m (which is also the lowest point in all of Kosovo) to 2,130 m above sea level. The total area of the management unit is 5,300 ha. The forest stand is the habitat for various birds, butterflies and mammals, like *Ursus arctos*, *Capreolus capreolus*, *Lynx lynx*, *Canis lupus*, etc.

3. History of forest management planning

Beech stand management has been lacking in the area since 2013 when it was part of the National Park. Based on data collected from previous management plans, we found that final cutting was applied in three phases 60 years ago followed by a few thinning cuttings, but not regularly. The forest stand is natural originating from seeds of remaining old trees and it needs periodic thinning, with the aim of supporting the development of potential crop trees. With this way of management we intend to establish a mixed forest stand of beech and silver fir with several accompanying species like Bosnian pine, maple and others.

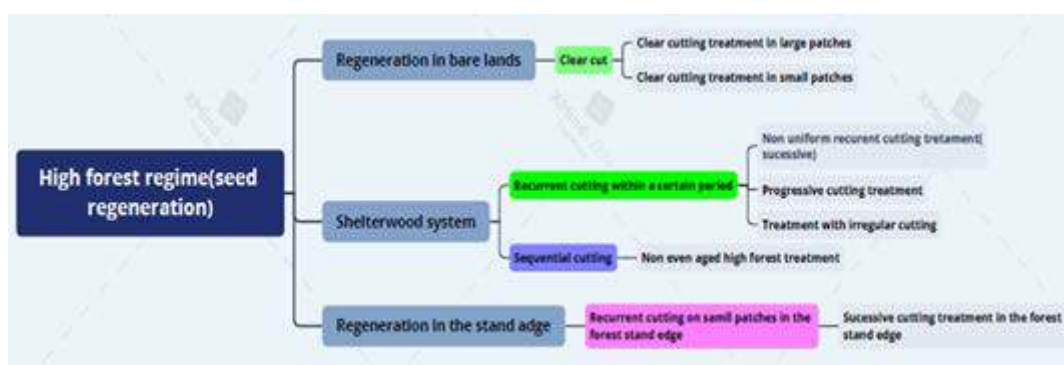


Figure 2. Regeneration of high forests from seeds and relevant treatments

In the sample plot, we found that beech and silver fir have an equal proportion of 46% each but at the level of management unit, the beech species dominates with about 70%. The total number of trees per 1 hectare was 784, with diameter ranging from 10 cm to 58 cm. The total stand volume was 665.5 m³/ha and the current increment range is from 6 to 9.2 m³/ha/year, depending on the tree age and vigour. Crown density of the forest stand was 0.9, with trees from 8.7 to 29.4 m high of good health status with only one dead standing tree and rare cases of bark beetles.



4. Environmental and production characteristics

Pure and mixed beech forests have been created as a result of various natural (habitat) conditions and long-term planned management based on the application of various management interventions described in management plans. This forest stand has been used for production of valuable roundwood and firewood with long rotation periods (from 80 to 105 years) depending on stand productivity and site index. Under natural conditions, beech is highly shade tolerant. It can be regenerated naturally in continuous silvicultural system covers. However, in young dense forest stands, beech is affected by snow causing trees bending and tips breaking. Therefore, in such conditions thinning should be moderated and tree spacing should be gradually increased. Beech favours soils that roots can easily penetrate. Best growth is attained in moist soils on calcareous rock beds. Beech does not grow on rocky sites, in very dry areas, on sites with stagnant water or regularly flooded sites. In mountainous sites, beech and silver fir are widely distributed because they out-compete other tree species due to their efficient use of light. In our study area, beech and silver fir were the dominant species, where they both created low light levels in the understory where beech and silver fir seedlings survive better than other species. Mixed beech forests show a high degree of stability and vitality. At their ecological optimum, in habitats with favourable site conditions, mixed beech forest stands will be more resistant to climate change than in less favourable habitats. Their additional resistance to the effects of climatic and other limiting factors will be supplemented by adequately conducted silvicultural treatment, based on biological laws of growth and development in the given habitat conditions. These conditions must be harmonised with economic-business criteria, with the aim of maximizing financial performance.

5. Forest functions

The forest stand within Koritnik 1 management unit is part of the Sharr Mountain National Park. Therefore, its primary function is protection due to specific natural values. The flora of the park is represented by 1,558 species of **vascular plants**. The fauna includes 32 species of **mammals**, 200 species of **birds**, 13 species of **reptiles**, 10 species of **amphibia**, 7 species of **fish** and 147 species of **butterflies**. In terms of **phytogeography**, the Sharr Mountain National Park belongs to the **Illyrian Province** of the **Circumboreal Region** within the **Boreal Kingdom**. It falls entirely within the **Balkan mixed forests** terrestrial **ecoregion** of the **Palaearctic temperate broadleaf and mixed forests biome**. The landscapes of the Sharr Mountain are shaped by geological, fluvial and glacial processes and finally by human influence through the centuries. Different traditions and ethnic and cultural backgrounds of the local population have contributed to the diversity of ten different types of landscapes.

6. Economic characteristics

Within mixed beech forests, it is possible to produce high quality and valuable wood (best product characteristics like veneer logs), but the protection function is predominant due to its status as a national park. It is also possible to produce other products of high economic value and a long period of use, storing significant amounts of carbon from the atmosphere and soil. Due to its status, the economic importance is more pronounced based on habitat ecological value, however depending on park zoning and associated restrictions, only timber extracted from silvicultural tending can be sold in the market. Considering this situation, our target will be to select and preserve the best beech and silver fir trees having a minimum diameter at breast height (Dbh) of 40 cm with straight trunks and small crowns. We assume that such trees are considered as “elite” trees due to a faster diameter in-

crement and might reach a Dbh of 60 cm after 20 years or 80 cm after 40 years. In order to accelerate their diameter increment, our focus will be to remove all competitor trees around elite trees to give them more space and reduce competition. In addition to such trees we will keep also dead standing trees because they serve as habitat trees for bark beetles and other xylophagus.

7. Term target structure and composition

Beech high forest is managed by the shelter wood system, where through selective cutting all trees older than 80 years have been subject to cutting in 3 phases for a period of 20 years. During the first and second cuttings 30% of the standing volume are removed for a period of 5-7 years, while 40% of the standing volume of the remaining trees are removed at the end of the period of 20 years. In the last intervention 70 to 100 trees per hectare of beech trees distributed uniformly are left to ensure seed production for natural regeneration. Based on the measurements in the sample plot with an area of 1,250 m² (50 m x 25 m) beech trees have a mean Dbh of 26.5 cm and tree height of 22.1 m.

	Species	Mixture	Age	Mean basal area tree	
No.				Dbh (cm)	H (m)
1.	F. sylvatica	46	70	26.5	22.1
2.	A. alba	46	55	22.7	15.8
3.	P. heldreichii	3	95	39.9	22.6
4.	P. avium	3	60	27.7	16.6
5.	S. torminalis	1	25	13.5	10.0
6.	A. pseudoplatanus	1	80	39.0	19.5

Based on the dimensions of the dominant trees in the mixed beech forest stand we concluded that the forest stand belongs to **middle aged treatment phase** and the treatment applied is **thinning aiming to support future trees**.

No.	Treatment phase	Dbh(cm)	H (m)
1	Sapling	< 5 cm	0-3 m
2	Young pole	3-20 cm	3-12 (15) m
3	Old pole	15-25 cm	12-17 m
4	Middle-aged stand	20-35 cm	17-25 m
5	Maturing stand	35.1-60 cm	> 25 m
6	Mature stand	> 60 cm	> 30 m
7	Unevenly aged selection or group		

Current composition (mixture): 46% beech; 46% silver fir; 3% Bosnian pine; 3% wild cherry; 1% maple and 1% wild service tree.

Based on the mean height of beech and silver fir and tree age we determined the site index using production tables and found that the forest stand measured has good productivity. That means that target diameters for each species will be: **beech – 50 cm; silver fir – 60 cm; Bosnian pine – 60 cm; maple – 50 cm**. The trunk of crop trees of each species should be free of branches at least from 6 to 8 m from base (about 27-35% the mean height) for the production of quality products/technical wood.

The long-term silviculture goal in relation to mixture is determined as the share of beech up to 50%, silver fir 30%, Bosnian pine 10% and other tree species up to 10% (maple, wild cherry, wild service tree, etc.).

Parameters	The most productive sites	Sites of good productivity	Sites of medium productivity
Target diameter (beech- conifer- broadleaves) (cm)	> 60- 70- 60	> 50- 60-50	> 40- 50- 40
Distance between crop trees (m)	>12 – 14	>10- 12	> 8- 10
Number of crop trees (tree/ha)	> 60 – 80	> 80- 100	> 100- 120
Production period (years)	110 – 130	110- 130	110- 130
Regeneration period (years)	20 – 40	20- 40	20- 40
Height of dominant trees when selecting crop trees (m)	17 – 25	14- 17	14- 17
Branch-free trunk when selecting crop trees (m)	8 – 10	6- 8	6- 8

8. Strategy of management treatments (economic function)

8.1 Strategy

The management system in mixed beech forests is to establish uneven forest stands through selective cuttings and maintain the number of future trees from 80 to 100 trees per hectare considered as Z trees. The aim is stock building maintenance of the secondary stand. Referring to the development stage in the forest stand thinning operations will be applied aiming to alternate from selection thinning to yield management in the dominant layer, as well as to preserve and maintain the vertical structure. Thinning intensity will be 2 interventions in a period of 10 years and considering the national park status all standing dead trees and habitat trees will be preserved.

The long-term silviculture goal in relation to mixture is determined as the share of beech up to 50%, silver fir up to 30%, Bosnian pine up to 10% and other tree species up to 10% (maple, wild cherry, wild service tree, etc.).



8.2 Treatment by development phases

GOAL: In relation to the quality of the habitat, provide an optimal number of the highest quality trees 80/ha (100) at the end of the production process evenly distributed over the area with a target diameter > 50- 60- 50 cm. Current development phase of the mixed beech forest is **middle-aged treatment phase**. The middle age stand is the phase of selecting and marking potential crop trees (PCT). In this phase, the dominant trees in the productive habitats reach a height of 17 m to 25 m and have branch-free trunk of at least 6 m. At this phase, it is necessary to carry out more intensive thinning with the aim of removing the strongest competitors from potential crop trees (5-2 comp./PCT). The minimum distance between potential crop trees depends on the number of selected potential crop trees and the target diameter, and ranges from 10 m to 12 m in good productive habitats.

Middle age phase[H= >17-25 m]

At this phase, the most important is the selection of the optimal number of crop trees and the maintenance of free space for the growth of their crowns, removal of the most vital competitors (potential crop trees should grow without the shadow of the strongest competitors). During previous operations at the age of young pole crop trees have been selected and their first competitors removed. In this way, the spatial distribution of crown trees is partly already determined aiming to provide an even distribution in the forest stand area. In this phase, with the final selection of crop trees any “errors” are corrected (loss of dominant tree status, damage, irregular spatial distribution, etc.) that occurred in the process of PCT selection.

Silviculture goal:

- Preservation and improvement of health status
- Achieving optimal dimensions of the crowns of the highest quality trees, through proper selection of the optimal number of tree crops
- Forcing further uninterrupted growth and development of potential crop trees of Pedunculated oak, or high-value mixed tree species
- Maintaining the desired mix of the stand
- In high quality non-homogeneous stands, it is possible to select the most vital/high quality trees in groups

Measures to achieve the goals:

- Tending of stand/crop trees: high selective thinning
- Positive selection of main tree species

Silviculture works:

- Selection of 80 to 100 potential crop trees, at a distance of 10-12 m
- Removing the strongest competitors that are touching the crown of the potential crop trees, (5-2/ PCT)
- Interventions (thinning) should be done on the basis of the dynamics of the height growth of dominant trees (increase of the upper height of the stand by 3 m), in this management period 1 to 2 times, in the following management period proceed with thinning of 1 to 2 times, depending on the habitat and stand conditions
- Felling intensity from 60% to 90% of increment
- Removal of damaged (sanitary) trees in order to improve the quality and vitality of the stand.

9. Special treatment strategy for important forest functions

Forest management for this parcel is closer-to-nature management. There are specific rule and regulations for this management, which limit certain activities in the area.

10. Measures in case of disasters

Harmful consequences can be significantly reduced by the implementation of adequate silviculture and management measures, in accordance with the state of forests and biological laws within the habitat. In this way, the desired vitality, health condition and stability of trees and forest as a whole is maintained. Considering the current situation, we aim to regenerate the forest stand in a natural way.

10.1 Afforestation in damaged areas

The idea is to perform afforestation or supplementary planting in earlier development phases using native species.

Silviculture goal:

- Rehabilitation of endangered or damaged areas

Silviculture measures:

- Supplementary sowing/afforestation/supplementary planting on barren areas caused by natural disasters (fire, wind, snow, ice, etc.)
- Supplementary sowing/afforestation/supplementary planting on areas where regeneration and afforestation has failed
- Supplementary sowing/afforestation/supplementary planting on areas where devastation has been occurred – illegal harvesting, etc.

Type of treatments/works:

- Measure and present damaged areas for selection in maps
- Measure and record damaged trees by category of damage (breaks, slides, drying, fires, and other), tree species and product structure (technical, firewood and other)
- Prepare a rehabilitation plan
- Urgent removal of damaged trees
- Complete preparation of terrain for afforestation (clearings – larger groups)
- Supplementary sowing/afforestation/supplementary planting of clearings (larger groups) by adequate selection, above all, of fast-growing tree species and other tree species, of adequate age, of the type of seedlings and its number (planting distance), taking into account habitat conditions for a particular object, or sowing seeds of the main tree species
- To preserve natural sapling with adequate silviculture measures, where possible, in order to enable its competitiveness in relation to artificially introduced species

10.2 In case of damage on a smaller area (group of trees) afforestation is not necessary

Type of treatments/works:

- Measure and record damaged trees by category of damage (breaks, slides, drying, fires and other), tree species and product structure (technical, firewood and other)
- Urgent removal of damaged trees
- Establishment of forest order

11. Stands of poorer quality

11.1. Stands of poorer quality – when there is a possibility select less than 20-40 (50)/ha trees of better quality

In stands that are located on the soil of poorer quality or which are the result of natural disasters (drying, wind-breaks, snow-breaks, pests and diseases, etc.), in which the number of crop trees (Z trees) is not sufficient, we choose a smaller number of best trees 20-40 (50) pcs/ha (selected or promoted trees), which we tend until reaching the target diameter; we complete the regeneration by combining natural and artificial regeneration methods in the shortest period of time.

Goal:

- Obtain trees with lower target diameters/shorter regeneration of stands

Measures to achieve the goal:

- Selection of 20-40 (50) trees of the best quality per hectare
- Selection of trees can also be done per groups where 2 to 4 trees can form a group,
- Tending of a stand when it is economically justified
- Earlier beginning of regeneration
- Regeneration using shelterwood system of the short rotation period
- Artificial introduction of genetically suitable seedlings or seedlings of other tree species
- Change of future tree species within unsuccessful regeneration from the previous point

Type of treatment/works:

- Removal of trees that reached the target diameter
- Removing trees from old stands
- Sowing of seeds/corns or afforestation with appropriate seedlings
- Artificial introduction of genetically suitable seedlings or seedlings of other tree species
- Fencing the area where sowing of acorns was done
- Protection against rodents
- Coating stumps
- Protection against powdery mildew
- In the event of unsuccessful regeneration, change the future main tree species

12. Guidelines for the implementation of works on forest utilisation

Priority guidelines for quality implementation of works on forest utilisation (thinnings) are:

- Maximum protection of sapling and standing trees
- Determining felling directions
- Oriented felling of trees
- Design and construction of roads to extract timber and use in case of wildfires
- Transport means for wood products can only be moved along the marked directions and constructed roads, and parts of stand where there is no sapling
- Remove the remains of thin branches from the sapling and place them on the part of the stand where there is no sapling, or on stumps
- Create work maps with a vertical representation of the terrain in the scale 1:5,000, 10,000 with mapped forest infrastructure (truck roads, temporary warehouses)
- Implement works at the time of vegetation dormancy

13. Natura 2000 and biodiversity issues

At the moment there is no Natura 2000 network in Kosovo. Regarding biodiversity, the following elements should be taken into consideration:

- Hollow trees should be promoted for increase of biodiversity preservation
- Dead trees should be kept in the stand
- Rare and endangered tree species should be promoted and preserved
- Nest trees should be protected against thinning operations

1.5. Concept of guidelines for forest management on the example of one forest management type/ tree species – North Macedonia Beech High Forests

Prof. Nikolco Velkovski

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1. Introduction

Beech forests have a wide ecological amplitude and a wide horizontal and vertical distribution on the territory of the Republic of North Macedonia (RNM). They are spread on almost all mountains.

Beech forests develop as single-aged or multi-aged forests. Some of them are characterised by high natural values and are of great importance for biological diversity.

Beech in RNM is spread over about 300,000 hectares, which represents 30% of the territory under forest. Most of the beech forests (80%) are pure, and others (20%) are mixed, consisting of two or more species such as: Scots pine, Austrian pine, Macedonian Pine, fir, spruce, hornbeam, oak and other species.

The total wood mass in beech forests is about 42 million m³, which represents 56% of the total wood mass in forests in the country, and the total annual growing stock is about 844,000 m³, which represents 46% of the total annual increase in total wood mass in the country. In pure beech stands, average wood mass is 168.3 m³/ha, and average annual growing stock per area is 3.41 m³/ha. These indicators for pure beech stands are better compared to other pure stands at the level of RNM, in which the average wood mass is 95.5 m³/ha, and the average annual growing stock per area is 2.29 m³/ha. And in mixed forest stands, where beech is represented, average wood mass and average annual growth per 1 ha are greater compared to those in mixed forest stands, which are composed of other species where beech is not represented. Thus, for example, in mixed beech forest stands, the average wood mass is 301.5 m³/ha, and the average annual growing stock per area is 6.74 m³/ha.

The given data clearly indicate that beech is not only the most widespread but also the most important forest tree species in the Republic of North Macedonia, which has great economic but also biological and ecological significance.

The best and the most productive beech forests are found in the middle forest belt at an altitude between 1,300 and 1,650 metres. In this forest belt, beech forests have good structural characteristics and good regenerative potential, due to which beech suppresses other forest tree species to a significant extent, leading to the creation of pure beech forests. Above 1,650 meters above sea level, beech forests have weaker structural and regenerative characteristics, although on many mountains it represents the upper limit of forest vegetation. Remains of subalpine beech forest are also found in the subalpine belt at 1,950 meters above sea level. In this subalpine belt, beech forests primarily have a great biological, ecological and public function. In the forest (submontane) belt between 1,000 and 1,300 meters above sea level, beech forests are of significantly lower quality than those in the highlands. A large part of them is in poorer habitats and with weaker structural characteristics, greatly influenced by zoo-anthropogenic activities in the past.

Part of beech forests are high forests (of generative origin), but a significant part are coppices (vegetative origin). In certain locations, there are also forest stands in which there are stems of both origins.

A method of management that has mainly been applied in the past years in beech forests are the Shelterwood system and selective cuttings. In coppice beech forest, a clear cuttings on a large area is applied. While in medium beech forest (mixed high and coppices), thinning is applied. A special problem in the management of medium-stemmed forest stands was created in 1998, when they were omitted from the Rulebook for the preparation of forest management plans, so some of them were assigned as high, some as coppice forests. In those that have been assigned as coppice forests, clear cuttings was applied, that cause their conversion in real coppice forests. This omission in the Rulebook was corrected in 2019, when medium-stemmed forests were reinstated as a separate man-

agement category, which can also be translated into high forests in a simpler way.

A problem in the management of beech forests in Macedonia is also the large application of clear felling on a large area in some degraded high forests. This way does not allow the improvement of the structure of the forest stands and contributes to their further degradation.

In the high forests, where selective or shelterwood cut is mainly applied, the structure of the forests is better and the regeneration process is satisfactory, but still they are not managed according to the principle of forest management closer-to-nature, as a modern concept that should be aimed at forest management in the future.

Also, cultivation and care measures are insufficiently applied in young forests, especially in the first stages of development, which significantly affects the structure and quality of the forest.

2. Main data on forests in the Republic of North Macedonia

2.1. Forest Area

According to data from the State Statistical Office, forest areas in the territory of the Republic of North Macedonia have undergone continuous changes. Over the past 80 years, a trend of consistent increase has been observed. Figure 1 illustrates the trend of changes in forest areas from 1938 to 2022.

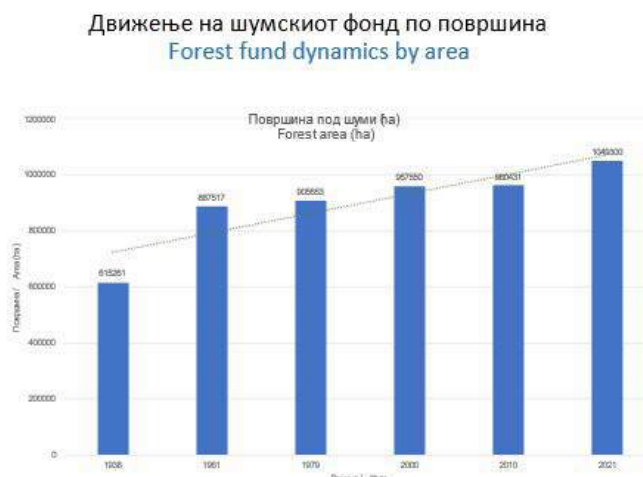


Figure 1. Forest fund dynamics by area

The presented data in Figure 1 shows that in 1938, the territory of the Republic of North Macedonia had 615,261 hectares of forest. The forest fund census in 1961 recorded 887,517 hectares, and in 1979, it reached 905,653 hectares. According to the latest data from the State Statistical Office of the Republic of North Macedonia, as of 31 December 2021, 1,049,300 hectares were recorded.

The increasing trend in forest areas is attributed to various factors, including:

- Afforestation of bare areas, which has been continuously carried out for the past 70 years by forest management organisations, entities managing forests, and private owners of forest and agricultural land
- Natural regenerative and successional processes of the forests
- Reduction in livestock numbers

- Abandonment of cultivation of hill and mountain fields, meadows and pastures
- The established system of planned forest management
- Measures for the protection of forests, etc.
- Measures for the cultivation and regeneration of forests, etc.

The current state of forest areas is presented in Table 1 and Figure 2.

Table 1 Forest area per ownership (year 2020) in ha

	Forest areas,	total	state forests	privately owned forests
Total	1 042 321	1 049 300	907 255	142 045
Deciduous trees	616 339	620 874	524 101	96 773
Coniferous trees	62 170	69 327	62 570	6 757
Mixed forests	319 427	315 758	277 402	38 356
Degraded forests	44 385	43 341	43 182	159

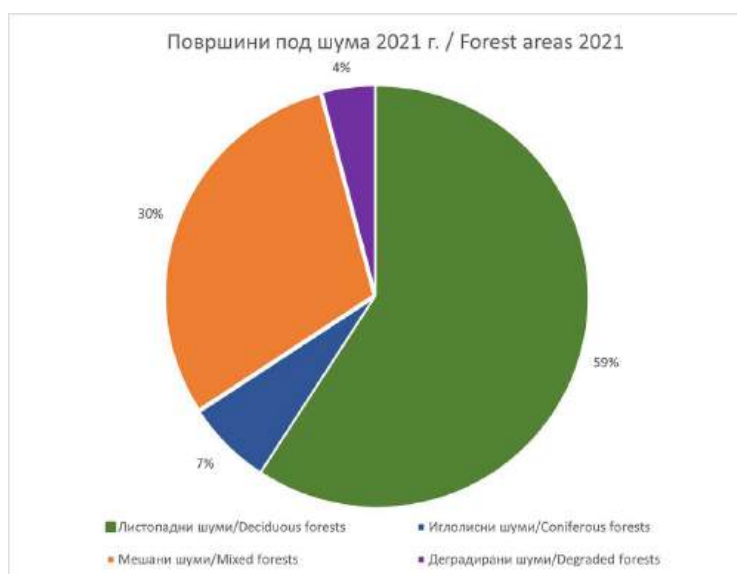


Figure 2 Forest areas by forest types

From the data presented in Table 1 and Figure 2, it can be seen that out of the total forest area (1,049,300 ha), 907,255 ha or 86.5% are state-owned, and 142,045 ha, or 13.5% are privately owned. The majority of the country's forest areas are deciduous forests (59%), followed by mixed forests (30%), coniferous forests (7%), and degraded forests (4%).

The extent of the forest fund according to forest types in the last 25 years is shown in Table 2 and Figure 3.

Table 2. Forest Fund by Forest Types in hectares for the period between 1997-2021

Година	Листопадни шуми	Иглолисни шуми	Мешани шуми	Деградирани шуми	Вкупно
Year	Deciduous trees	Coniferous trees	Mixed forests	Degraded forests	Total
1997	560 156	78 567	329 310	-	968 033
1998	560 915	78 648	328 999	-	968 562
1999	545 087	77 506	328 001	-	950 594
2000	551 088	76 546	329 916	-	957 550
2001	578 151	78 004	341 219	-	997 374
2002	569 156	83 239	336 651	-	989 046
2003	539 666	109 454	306 174	-	955 294
2004	553 456	85 104	309 093	-	947 653
2005	555 495	83 665	316 068	-	955 228
2006	560 389	87 569	311 301	-	959 259
2007	551 681	80 009	310 279	-	941 969
2008	547 186	80 576	315 286	-	943 048
2009	549 869	83 583	315 877	-	949 329
2010	566 693	71 809	280 207	41 722	960 431
2011	569 635	75 589	286 646	49 942	981 812
2012	574 604	72 206	297 207	44 818	988 835
2013	597 657	66 479	280 061	43 348	987 545
2014	600 847	68 670	270 525	43 346	983 388
2015	610 228	65 091	276 230	42 854	994 403
2016	605 661	66 774	286 315	42 915	1 001 665
2017	602 279	65 032	289 822	44 356	1 001 489
2018	608 211	66 608	287 717	44 559	1 007 095
2019	596 715	63 884	314 278	44 376	1 019 253
2020	616 339	62 170	319 427	44 385	1 042 321
2021	620 874	69 327	315 758	43 341	1 049 300

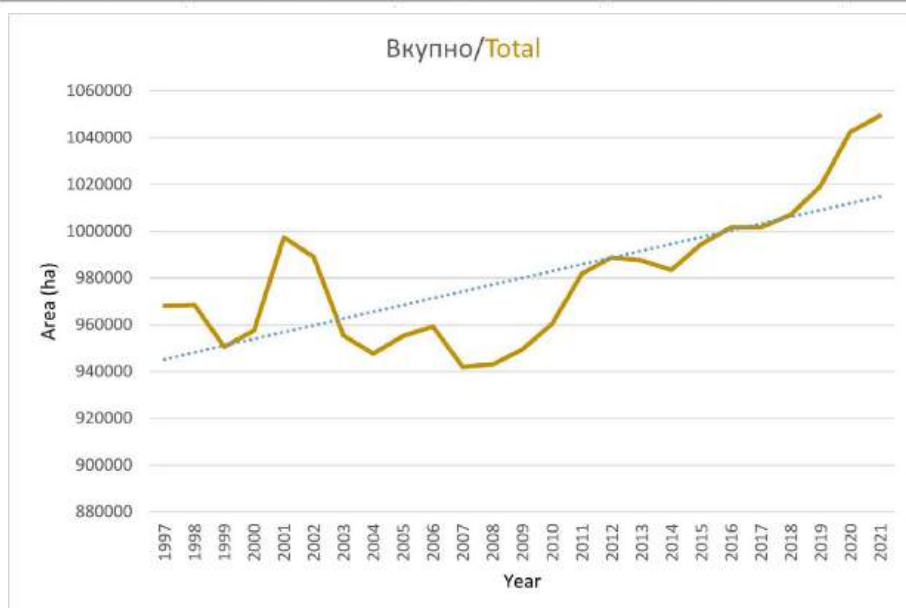


Figure 3. Forest Fund in hectares for the period 1997-2021

From the data presented in Table 2 and Figure 3, it can be observed that with certain fluctuations, the overall forest fund has had an increasing trend. Some oscillations and decreases in areas in certain years are due to forest fires that affect significant areas, illegal logging, and other factors.

There is a significant increase in deciduous forests, covering an area of 560,156 ha in 1997 and reaching 620,874 ha in 2021. A decrease is observed in coniferous forests, with an area of 78,567 ha in 1997 and 69,327 ha in 2021, as well as in mixed forests, with an area of 329,310 ha in 1997 and 315,758 ha in 2021. These decreases are attributed to the loss of coniferous species, occurring due to forest fires, successional processes, and natural regenerative processes through which deciduous species suppress coniferous species.

The trends in changes in areas under deciduous, coniferous, mixed and degraded forests are depicted in Figures 4, 5, 6, and 7.

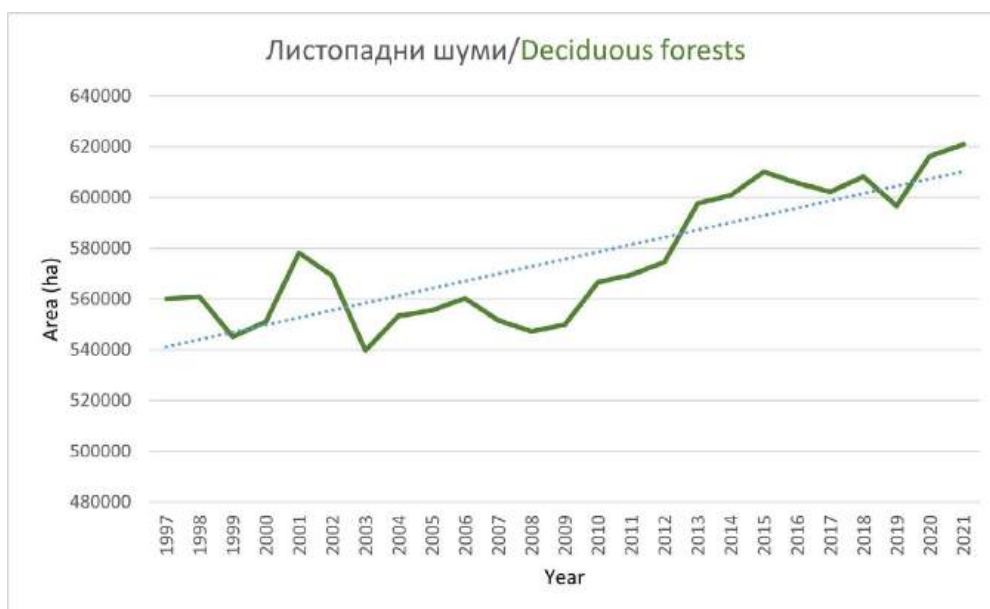


Figure 4. Deciduous forests area



Figure 5. Coniferous forests area

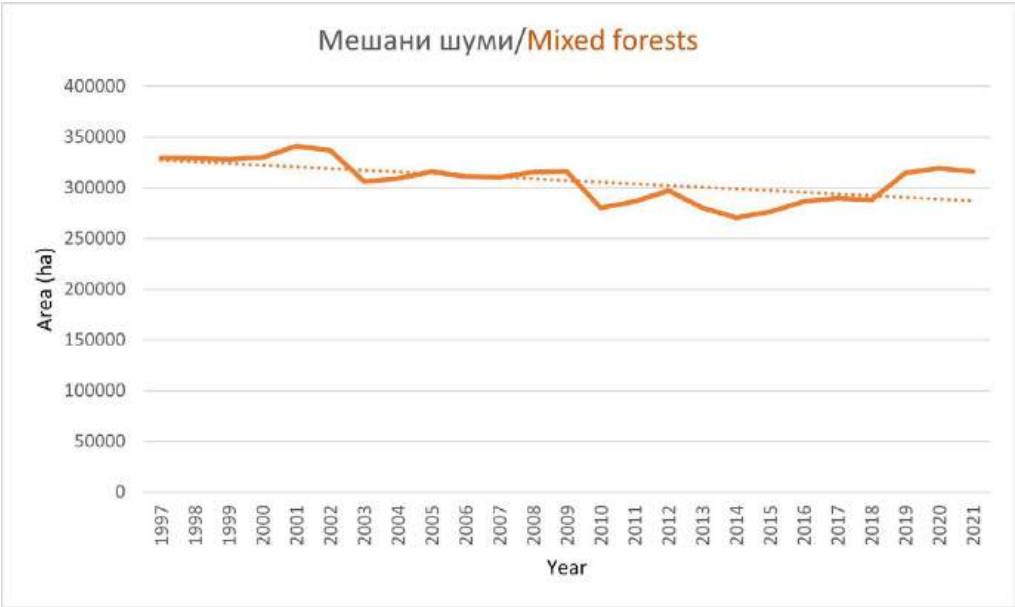


Figure 6. Mixed forests area

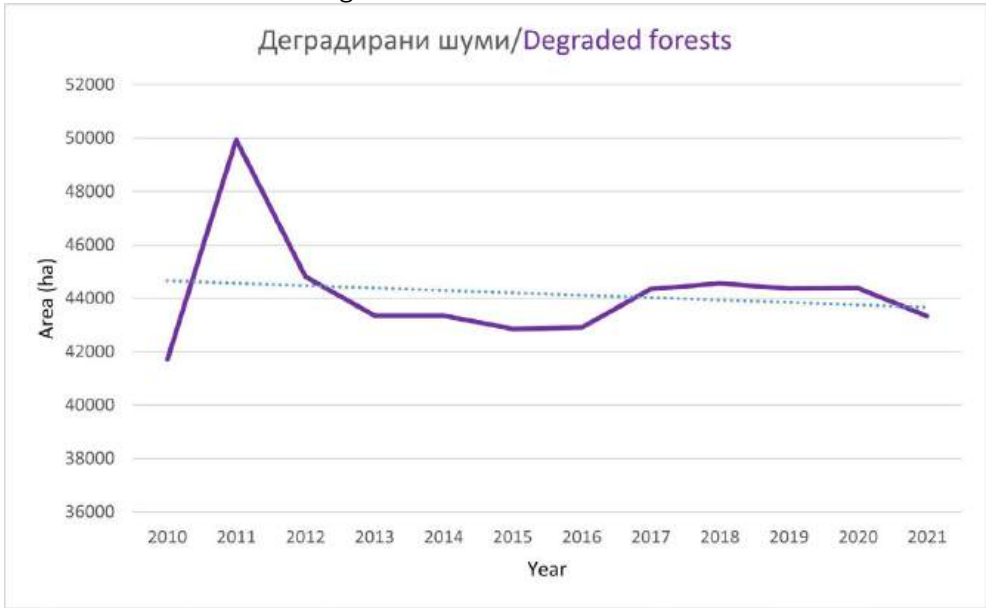


Figure 7. Degraded forests area

3. Silvicultural methods in beech forests in the Republic of North Macedonia

Forestry includes all measures and activities that are undertaken from the moment of creation of the forest stand until the moment of reaching the stage of maturity. For this purpose, from the earliest age in the development of young forest stands, measures are taken to regulate the number, quality and development of the stems. At the same time, the regulation of the lighting regime has a very important role in the future development of the forest stands. At different ages of the forest stages, different cuttings are applied, which aim to constantly improve its quality structure. Thus, depending on the age of the beech forests, the following cultivation cuttings are undertaken:

- Cuttings for lighting, up to 10 years of age
- Cuttings for cleaning, from 11 to 20 years of age
- Thinning, from 21 to 40 years of age;
- Selective thinning, from the 41 to 60 years of age
- Cuts for space, from 61 to 80 years of age

Cuttings for lightening of young beech trees are carried out until the age of 10, when they are 1.0 to 1.5 meters tall. In that period, three groups of individual trees are formed in the young forest stand. One is higher than the rest (dominant), the others are medium (co-dominant) and the third suppressed. The trees with bad phenotypic characteristics, the most branched ones and the ones that are damaged are affected by felling. Felling is carried out 2 times in the period of up to 10 years during the rest of the vegetation, and the crown cover must not be below 0.8.

In the period between 11 and 20 years of age, clearing cuts are performed. At that time, the saplings are taller than 2 meters and there is greater differentiation of stems in the stand. Some of the stems have a more intense growth and form larger canopies that overshadow others and affect the irregular development of the canopies and stems in younger trees, while others lag behind in development more or less. Due to more intensive growth during that period and the competitive struggle, a greater number of young individual trees form bad phenotypic characteristics and irregular canopies. Therefore, stems with bad characteristics should be removed twice between 11 and 20 years of age. About 10% of the stems are affected by felling, and the density of the stand is expected to be below 0.8.

In the period between 21 and 40 years of age, thinning is performed. It is a period when trunks need more space for development and therefore it is necessary to thin out twice, once between 20 and 30 years and again between 30 and 40 years. In this period, there is already a strong differentiation of stems in terms of their quality and dimensions, so it is already possible to select the best quality stems that would be the bearers of the future development of the stand, the so-called stems of the future.

Around the age of 40, the stems of the future should already be separated. Their number depends on several factors, primarily on the biological characteristics of the species and the conditions of the habitat. According to different authors, the optimal number of trees for the future is 180-200 trees per ha (Jurča et al. 1973; Mraček 1989), 160-280 trees per ha (Kostadinov et al. 1995), 200-300 trees per ha (Stojanović et al. 1994, Aleksić 1994), 300 stems per ha (Batkoski 2006), etc.

The stems of the future are selected from dominant and best developed trees in the stand with the best phenotypic characteristics and good health status. It is recommended that they have a 25-50% larger diameter than the middle stem in the stand (Garelkov et al. 1995), i.e. have a slenderness coefficient of 80-120, which ensures greater stability and resistance to abiotic influences, especially to

wind (Kostadinov K, Stalev Z (1995). The purpose of thinning is to provide the selected stems of the future with enough space for the development of the canopy and to form a quality trunk. Thinning should not reduce the density of the stand below 0.8. Thinning is carried out in the middle age of the stand and in the period of maturation (40 to 60 years) at a time when the climax of growth in height has passed, and the goal is to increase the growth in thickness of the highest quality stems. This is achieved by removing the stems that affect growth and quality development and selected stems of the future, as well as those that are damaged or diseased, thus ensuring greater access to light in the stand. The intensity of spacing should be moderate, i.e. it should be about 20% of wood mass or the number of trees. It would be optimal to set aside 200 to 300 trees of the future per 1 hectare.

Group cuttings on a larger area (cutting for space) in beech forests are carried out during the ripening period. The purpose of performing them is to increase the space for the development of the best quality trees of the future and to increase their growth in thickness. With these cuttings, the stems get used to a more orderly assembly and create greater resistance to abiotic influence.

Table 3 – Silvicultural measures per silvicultural type

Stage	x (m)	Measure	Aim
New growth	Height and diameter of dominant stems [H: 0-3] m; DBH < 5 cm]	Lightning	Creation of conditions for unlimited development of the best individuals of the selected species
Young forests (early)	Height and diameter of dominant stems [H: 3-12 m; DBH 3 – 20 cm	Clearing	Cleaning – removal of competitive and low-quality stems
Young forests (late)	Height and diameter of dominant stems [H: 12-17 m; DBH 15 – 25 cm]	Clearing	Cleaning and selecting the stems of the future (crop-tree)
Mid-age	Height and diameter of dominant stems [H: 17-25; DBH 20 – 35 cm]	Thinning	Selection of the optimal number of stems of the future, provision of free space for canopy development and removal of competing trees
Ripening	Height and diameter of dominant stems [H > 25 m; DBH 35-50]	Selective thinning and cut for space	Reducing the number of stems per unit area and providing space for the development of the stems of the future
Mature stage	Height and diameter of dominant stems [H > 30 m, DBH cm >= 50 Depending on the targeted diameter	Renewable cut	Removing parts of maternal stand and creating conditions for restoration

For appropriate development of beech stands, in addition to the listed silvicultural measures per silvicultural type other measures are also necessary

- Soil treatment (weed removal)
- Cutting of saplings
- substitution (filling)
- Enlightenment
- Clearing
- Pruning of branches
- Thinning
- Cuts for space

Soil treatment (weed removal), filling, cutting of shoots and enlightenment are cultivation measures that are carried out in the new growth stage.

Clearing and pruning of branches are tending measures that are carried out in the development phase of early and late young forest.

Thinning is a breeding measure that is carried out in the period of middle age or in the maturation phase.

Space cuttings are a breeding measure that is applied during the maturation stage (ripening) of the stand.

Soil treatment against weeds is done mainly during artificial afforestation, when the seedlings are up to 5 years old. It can be done manually or mechanically, removing the weedy vegetation that depends on the development of the young.

The question is carried out on terrains where there are conditions for it, i.e. on unhardened or weakly hardened land in order to dig up the land, improve its physical-mechanical composition and prevent loss of moisture from the soil. This will achieve a faster development of the seedlings.

The cutting of shoots and offshoots is carried out in the forests of shoot and mid-stem origin. This cultivation measure is carried out in forest crops up to 15 years old (until the beginning of the assembly of the canopy). It can be done mechanically or chemically. The removal is carried out gradually, starting from the worst and unpromising shoots.

The filling of insufficiently restored parts, as a growing measure, is carried out in cases where restoration is weaker than 80% of the area planned for restoration, i.e. when there are unrenovated areas above 20%. There should be no unrenovated areas larger than 20 ares.

Enlightenment is carried out in the period of early and late juveniles in order to create an unprecedented development of the highest quality individuals of the main species. This is achieved by removing competing stems, as well as stems with poor phenotypic characteristics, damaged stems, etc. This creates favourable light conditions for the development of the best individuals.

With the cleaning, an additional selection of the best individuals and removal of their competing stems is carried out. This enhances the natural differentiation of the best quality stems and accelerates their growth in height.

Pruning of branches is done during the remaining period of the vegetation. It can be manual or mechanical. This helps the development of the forest stand and improves the light and heat regime.

Thinning and cutting for space are performed in the period of middle age and at the time of maturation of single-aged forest stands, as well as in growing groups in multi-aged forest stands. The best time to separate the stems of the future is the middle age of the stand. In this age of good vegetation, the height of the dominant trees is between 17 and 25 meters, and the trunk is clear of branches 8 to 10 meters. In areas with medium productivity, the height of the dominant trees is 14 to 17 m, and the trunk is clear of branches 6 to 8 m. At this stage, it is necessary to perform thinning in order to remove all the stems that represent competition for the stems of the future. The minimum distance of the selected trees of the future depends on their number and the target diameter that is planned to be achieved. It amounts to 12-14 m, and in worse grades it amounts to 10-12 m or 8-10 m. In the initial phase of the middle age, as a rule, 3 to 5 trunks are removed, which are the biggest competition for the selected trunks of the future, and in the maturation period, when there are already enough formed and developed trunks of the future, one more competing trunk is removed.

Table 4 shows thinning according to development stages and the number of trees of the future, and table 3 the method of performing thinning in pure beech stands.

Table 4. Thinning in various phases of stems of the future

Development phase (stage)	Target diameter $d_{1,3}$ (cm)	Distance between stems of the future m	Number of stems of the future	Number of concurrent stems	Number of actions
Middle age	40	8-10	100-120	3-5	1- 2
	50	10-12	80-100		
	60	12-14	60-80		
Ripening period	40	8-10	100-120	0.5-1	1
	50	10-12	80-100		
	60	12-14	60-80		

Table 5. A way of carrying out of thinning in pure beech stands (Kohnle. U.,)

Species	Target diameter $d_{1,3}$ (cm)	Number of stems of the future	Distance between stems of the future m
Beech	50	125	9.0
	60	80	11.0
	70	65	12.5
	80	50	14.0
	90	40	16.0

During selection of the stems of the future, attention should be paid to their spatial distribution, which should be equal on the entire surface.

The following criteria should be taken into account when carrying out interim measures: stand density, number of trees per 1 ha, preservation, wood mass, health condition, development stage, purpose of the forest and natural conditions of the area.

High intensity selective thinning and mixed thinning with moderate intensity (about 20% of wood mass), with a thinning interval of 6 to 10 years and selection of 200 to 300 trees of the future per 1 hectare are considered the most favourable way of thinning in middle-aged beech stands (Milin 1994; Stojanović and Krstić 1997).

During selection of the stems of the future, attention should additionally be paid to tree health, trunk

straightness, clearance of branches, development of the canopy, height, spatial distribution and the target diameter that is planned to be achieved.

The following criteria should be taken into account when carrying out interim measures: stand density, number of trees per 1 ha, preservation, wood mass, health condition, development stage, purpose of the forest and natural conditions of the area.

High intensity of selective thinning and mixed thinnings with moderate intensity (about 20% of the wood mass), with a thinning interval of 6 to 10 years and selection of 200 to 300 trees of the future per 1 hectare are considered the most favourable way of thinning middle-aged beech stands (Milin 1994; Stojanović and Krstić 1997).

When choosing the trees of the future, attention should be paid to tree health, trunk straightness, clearance of branches, development of the canopy, height, spatial arrangement and the target diameter that is planned to be achieved.

4. Restoration of beech stands in the Republic of North Macedonia

An important thing for the survival and sustainable development of beech forests is the process of their natural restoration. Regeneration of beech forests can also be achieved artificially, but in modern science and practice, preference is given to natural regeneration, and only in places where this is impossible or unsuccessful, an artificial method of regeneration is carried out. A basic prerequisite for the occurrence of natural regeneration is the sufficient amount of quality seeds in the plantation. Therefore, when carrying out renewal cuttings, the characteristics of the beech seed, which is heavy and cannot be blown to greater distances by the wind, must also be taken into account. In addition, young beech, as a mesophilic species, needs more shade than the mother plant at a younger age. That is why greater intensity and greater illumination does not suit beech trees.

Stand structure is of great importance not only for the appearance and development of natural regeneration of beech, but also for its quantity, quality and survival. Under favourable conditions in beech forests in good habitats, natural regeneration of beech occurs in large numbers. In conditions of high crowding, 55 to 60% of juveniles die by the third year, and another 90 to 95% from the third to the fifth year. After the fifth year, only a small part of the natural renewal remains, in places where there is a sufficient amount of diffused light (Garelkov and Turlakov 1978).

The intensity of reduction in the size of natural regeneration depending on the composition of the plantation is shown in Table 6, and it applies to the beech forests of the Maleshevski Mountains (Velkovski 2007).

Table 6. Canopy density impact on the number of young individuals (Velkovski 2007)

Units per 1 ha				Total	Cover (%)
New growth		Young forest			
Immature	Adult	Immature	Adult		
138,600	41,400	20,500	9,500	210,000	30
70,000	35,000	11,800	6,200	123,000	40
59,100	31,500	9,300	5,400	105,300	50
53,200	26,300	8,200	4,600	92,300	60
42,700	21,300	7,100	3,900	75,000	70
18,900	10,900	5,200	2,100	37,100	80
6,800	4,700	3,500	900	15,900	90

An increase of density of the native forest stand leads to a decrease in the number of stems in the younger development stages due to a lack of free space for growth and development and insufficient amount of light, because with an increase in the age and dimensions of the stems, their needs for light and space also increase. The stems that do not have enough space, first slowly progress in development and then die.

In addition to the quantity of natural regeneration, its quality is also of great importance for successful natural regeneration. The space in which it develops plays a big role in that. Large openings, due to biological mesophilic properties of beech, are not suitable for its quality structure.

Figure 8 shows the quality structure of young beech that develops in openings of different sizes, from which it can be seen that as the opening in the forest increases, the number of quality individuals decreases. The largest number of quality units is in the opening of about 500 m², which can be considered as an optimal and recommended space for the period of the young, which should then be expanded.

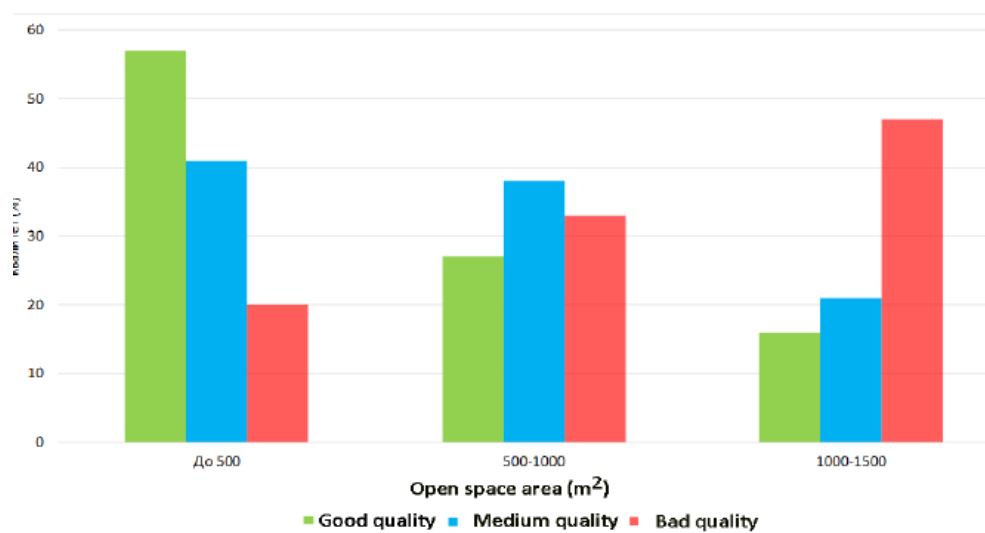


Figure 8. Quality structure of beech offspring in canopy openings of different sizes (Velkovski 2007)

The quality structure of the natural regeneration is also influenced by its distance from the parent plant, so that with increasing distance from parent trees, its quality decreases.

Care should be taken when carrying out restoration cuttings, especially during stronger operations, because due to the appearance of raspberries, blackberries and other vegetation, the restoration process may be difficult or unsuccessful.



Figure 9. Weeding in conditions of large canopy openings

The choice of methods of natural restoration of beech forests largely depends on the natural conditions in which they exist, their condition, as well as the biological properties of beech as a mesophilic species.

For pure beech forests in good habitats, which have an even-age structure, good results are achieved by applying shelterwood cuttings (preparatory, fertilised, additional and finished) performed on 3 or 4 occasions. They can also be applied in beech forests of uneven age, but in that case the rejuvenation period should last over 40 years.

In selective beech forests, selective logging is applied as a way of natural regeneration, which gives good results even in worse habitat conditions. It can be performed as single-tree or group selective cutting with a repetition of 10 years. Regardless of the structure (except in rainforests), care measures should also be carried out in all other stands.

Considering the bioecological characteristics of beech, clear cutting is not a good choice for natural regeneration. It can be applied in beech forests only in rare exceptional cases of favourable habitat conditions, in degraded and thinned forest stands with a cover below 40%, where natural and artificial restoration is combined (Stojanović and Krstić 2005).

Management systems for high beech forest based on natural regeneration of small areas, such as the Swiss improved Femmelschlag, are one of the best ways to successfully restore and maintain the structure best suited to beech as a forest tree species (Commarmot et al., 2005). Regeneration methods that ensure continuous forest coverage of large areas such as the Dauerwald system are also very

favourable for the regeneration of beech forests and the fulfilment of their multi-purpose functions. The creation of multi-aged beech forests from groups with different ages also contributes to better economic effects (Biehl 1991; Schütz 2001).

For the natural restoration of uneven aged and mixed forests, good results are achieved with the application of group cutting (Milin, 1988) but also various combined methods such as Gaer's system of group shelterwood cutting in the form of circles with a rejuvenation period of 20 to 40 years, Wagner edge felling, Eberhard edge or wedge-shaped edge felling, free cultivation technique, Swiss group selective cutting system, group selective and procedural system, combined method of Bonnemann, etc. (Stojanović and Krstić 2005).

5. Management for achieving target diameter

In the maturity phase of the forest, natural restoration begins, at a time when the trunks of the future have reached the target diameter (>70 , >60 , >50 , >40 cm). The restoration process is carried out by gradually removing the trunks of the future, which have reached the target diameter, over a period of 20 to 40 years. In addition, stems of poor quality are also cut.

Beech as a species reacts very quickly to all cuttings and quickly uses the free space by expanding its canopy, thereby increasing its growth. With correct and timely felling measures in beech forests, the target diameter can be reached up to 20 years earlier (Krstić and Cvjetićanin 2005).

In the restoration process, the restoration of beech is ensured, and through the application of care measures, the restoration of some rarer and damaged species is supported, such as wild cherry, maple, ash and other deciduous trees. During the entire process, care should be taken to protect standing trees and natural regeneration from mechanical damage.

In certain places, if there is no natural regeneration from beech and the regeneration process is difficult, it can be filled with saplings of fir, spruce, Douglas fir, oak, wild cherry and other species. Filling should be on areas larger than 0.2 ha.

The target diameter for forest stands is lower and, depending on their quality structure, amounts to (>20 , >25 , >30 cm). Their restoration process is more specific, more difficult and should take place in the direction of stimulating natural regeneration from seeds and their gradual translation into medium-stemmed and tall-stemmed forests. Also, more valuable species of conifers or deciduous trees of seed origin can be introduced into them. In that way, it will be possible to increase their productive but also protective and public function (Garelkov and Turlakov 1978).

6. Implementation of silvicultural and restoration measures in RNM

Silvicultural measures encompass all actions taken in forest stands from the moment of establishment until reaching the mature forest stage. These measures influence young forest stands from the earliest age during their development to form healthy, stable, and sustainable forest stands that can naturally regenerate when reaching the mature forest stage. To achieve this, it is necessary to implement all nurturing measures at various intervals.

One of the fundamental silvicultural measures, unfortunately often insufficiently implemented in practice, is the protection of young forest stands, as well as the safeguarding of newly established forest cultures. Consequently, successfully raised forest cultures or young forest stands are damaged or destroyed by various abiotic or biotic factors. This frequently occurs in areas with livestock grazing, illegal construction, land encroachment, forest fires, etc.

Moreover, regrettably, other nurturing measures crucial for sustainability, stability, and development of forest stands have shown a decreasing trend over the last 25 years. Table 7 illustrates the intensity of implementation of silvicultural measures for the period 1997-2022, in hectares at the national level.

Table 7. Intensity of implemented silvicultural measures for the period 1997-2022 [ha]

Year	Care of new growth	Clearing	Thinning	Enrichment of forests	Conversion	Substitution	Resurrection	Total
1997	154	1039	5041	269	540	0	367	7410
1998	208	305	3681	118	56	19	133	4520
1999	42	1049	3955	560	2	18	38	5664
2000	2	1248	3724	275	209	0	708	6166
2001	156	709	2192	76	59	0	133	3325
2002	28	283	1436	128	78	13	20	1986
2003	5	801	1623	54	0	93	46	2622
2004	30	1465	4445	15	2949	15	6184	15103
2005	17	1070	3465	6	245	12	197	5012
2006	31	364	1342	53	92	0	87	1969
2007	28	297	1607	45	163	10	178	2328
2008	1	25	4757	22	33	2	442	5282
2009	4	378	1576	4	200	0	91	2253
2010	8	254	2156	0	678	4	764	3864
2011	0	362	1473	0	90	136	173	2234
2012	77	126	1260	40	74	55	163	1795
2013	0	0	1210	94	8	0	49	1361
2014	0	97	759	0	248	0	187	1291
2015	0	28	2031	0	0	0	65	2124
2016	0	0	667	0	0	0	67	734
2017	89	0	740	0	28	0	56	913
2018	10	28	1054	0	0	0	44	1136
2019	43	18	512	0	0	0	45	618
2020	43	0	591	0	0	65	12	711
2021	0	0	706	0	17	0	217	940
	976	9946	52003	1759	5769	442	10 466	81361

From the presented data in Table 7, it can be observed that silvicultural measures have been implemented on 81,361 hectares over a period of 25 years, with varying annual volumes and dynamics.

The care of young forest stands through the execution of soft lighting measures for the undergrowth shows a significant decreasing trend. In 1997, illuminations for the undergrowth were implemented on 154 hectares, in 1998 on 208 hectares, in 2020 on 43 hectares, and in 2021 on 0 hectares.

The trend of implemented measures for illuminating new growth for the period 1997-2022 is shown in Figure 10.

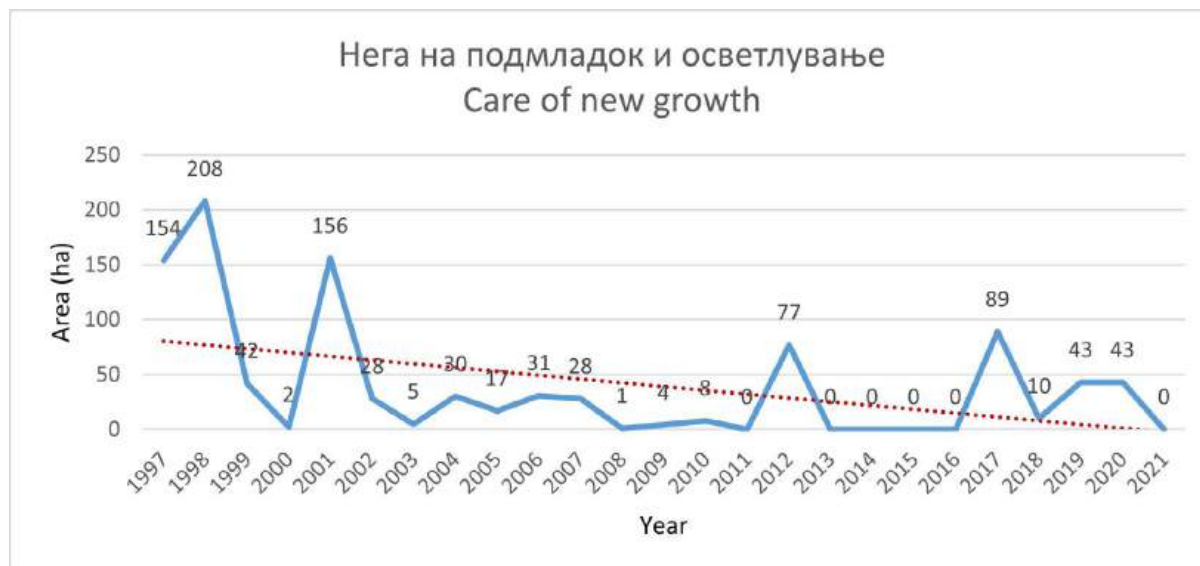


Figure 10. Implemented soft lighting measures for the new growth

The measures for new growth cleaning in the period 1997-2022 also show a decreasing trend. In 1997, they were carried out on an area of 1,039 hectares, in 2004 on 1,465 hectares, and then progressively decreased, reaching 0 hectares in both 2020 and 2021.

The trend of implemented measures for new growth cleaning for the period 1997-2022 is shown in Figure 11.



Figure 11. Clearing of new growth

Thinning, as a fundamental silvicultural measure, is carried out in the mid-age stage of forest stands with various fluctuations each year. However, the largest areas were thinned in 1997, with 5,041 ha, in 2004, with 4,445 ha, and in 2008, with 4,757 ha. In the last three years, thinning was conducted on the smallest area in the analysed period, namely, in 2019 on 512 ha, in 2020 on 591 ha, and in 2021 on 706 ha.

Such a significant reduction in the areas subjected to thinning, along with the decrease in the areas where illumination and understory cleaning were performed, indicates insufficient care for young forest stands. The trend of executed thinnings for the period 1997-2022 is depicted in Figure 12.

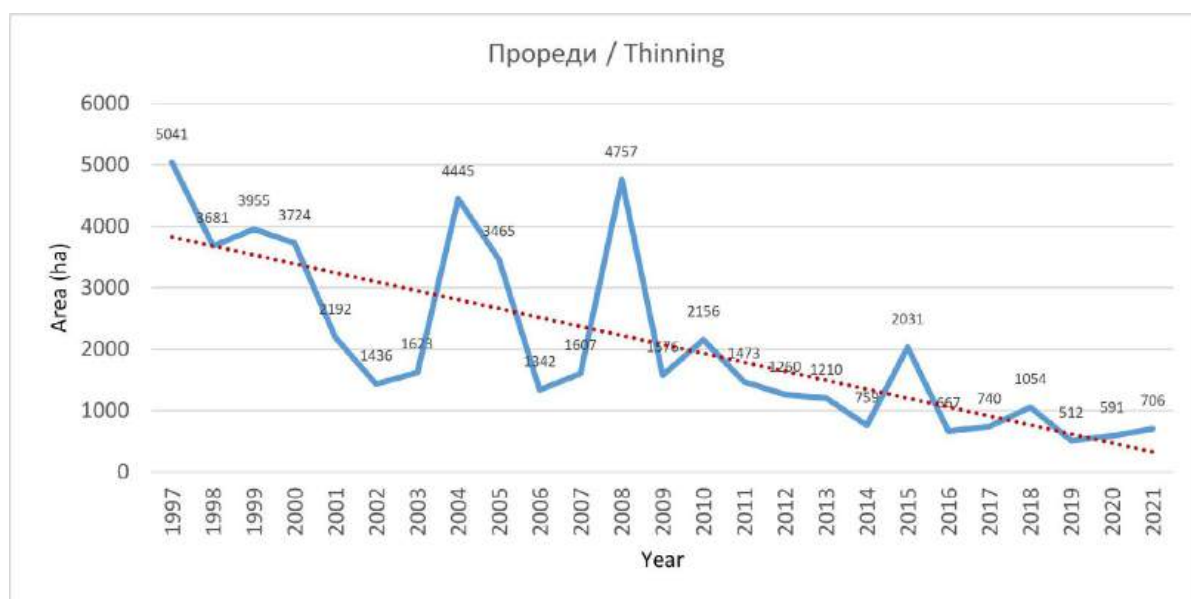


Figure 12. Thinning

Enrichment of forests with economically valuable and significant tree species, as a silvicultural measure on a larger scale, was applied until the year 2000. In 1997, enrichment was carried out on a surface area of 269 ha, in 1998 on 118 ha, in 1999 on 560 ha, and in 2000 on 275 ha. However, from 2001 to 2014, there was a significant decline in the areas where forest enrichment was conducted. From 2014 to 2022, no enrichment was carried out at all.

The trend of executed forest enrichments with economically valuable tree species for the period 1997-2022 is depicted in Figure 13.

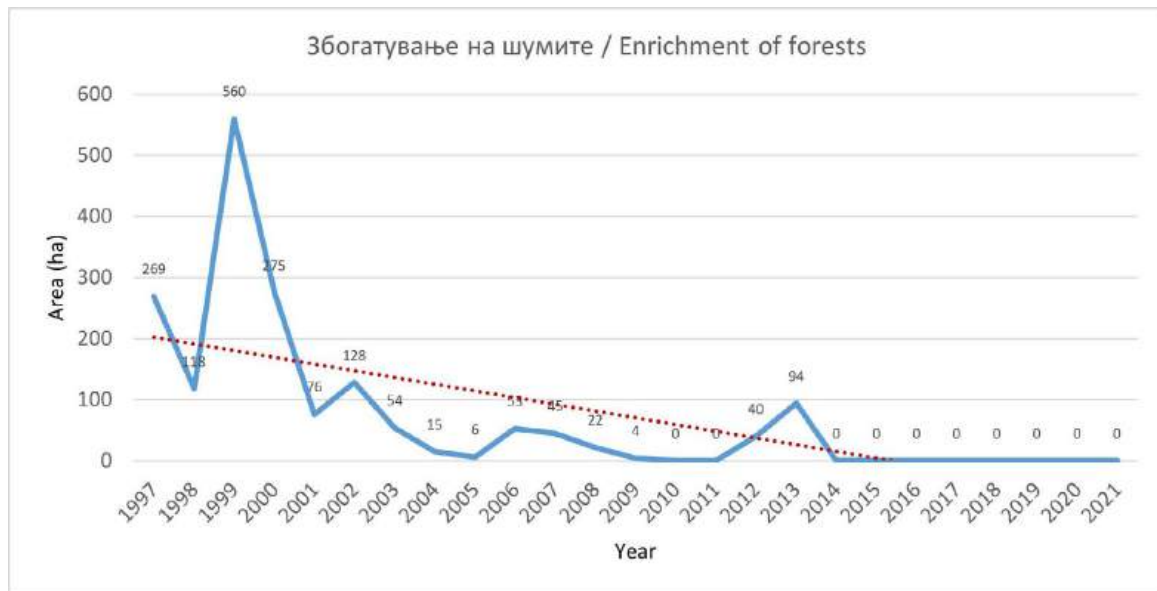


Figure 13. Executed enrichment of forests with more valuable tree species for the period 1997-2022

Conversion, as an important silvicultural measure assisting in the transformation of degraded, damaged, or coppice forests into forest stands of natural seed origin, has been applied in various years of the analysed period in different volumes. Thus, larger areas were subjected to conversion in 1997, covering 540 ha, in 2004, covering 2949 ha, and in 2010, covering 678 ha. In other years, conversion was carried out on smaller areas, while in 2003, 2015, 2016, 2018, 2019, 2020, and 2021, no conversion was conducted at all.

Considering that the country possesses a low-quality forest fund and the strategic determinations that larger activities should be undertaken to transform low-quality forest stands, indicators shown suggest insufficient efforts in that direction.

The trend for the areas subjected to conversion for the period 1997-2022 is depicted in Figure 14.

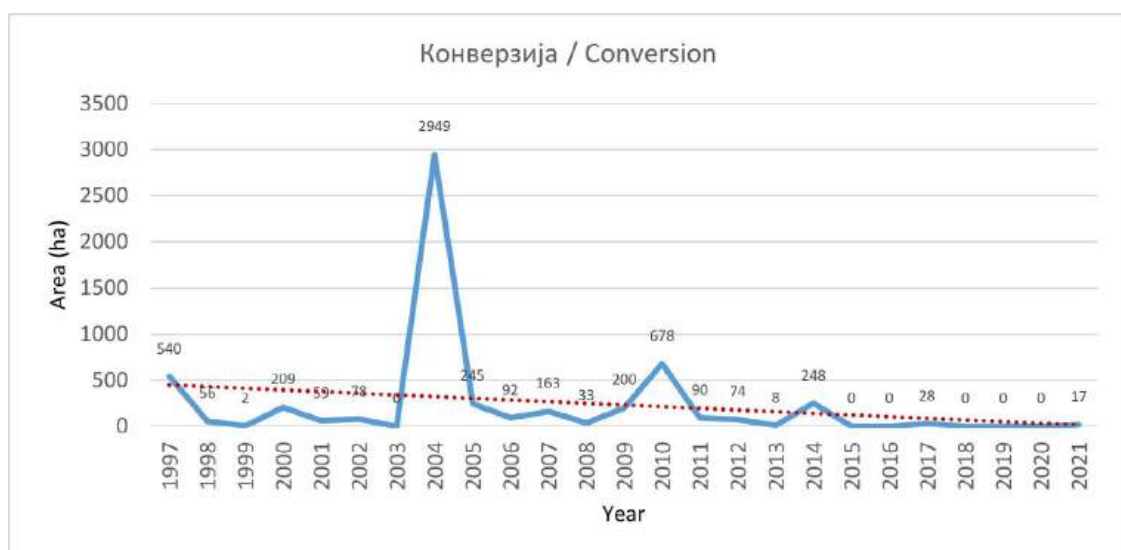


Figure 14. Areas subjected to conversion for the period 1997-2022 (ha)

The replenishment of unrenewed forest sections, as a silvicultural measure aiding restoration processes in various years of the analysed period, has been applied in different volumes. Thus, the most extensive work was done in 2011, covering 136 ha, in 2003, covering 93 ha, and in 2020, covering 65 ha. In a larger number of years, however, no replenishment of unrenewed forest sections was conducted at all.

The trend of the areas where replenishment of unrenewed forest sections was carried out for the period 1997-2022 is shown in Figure 15.

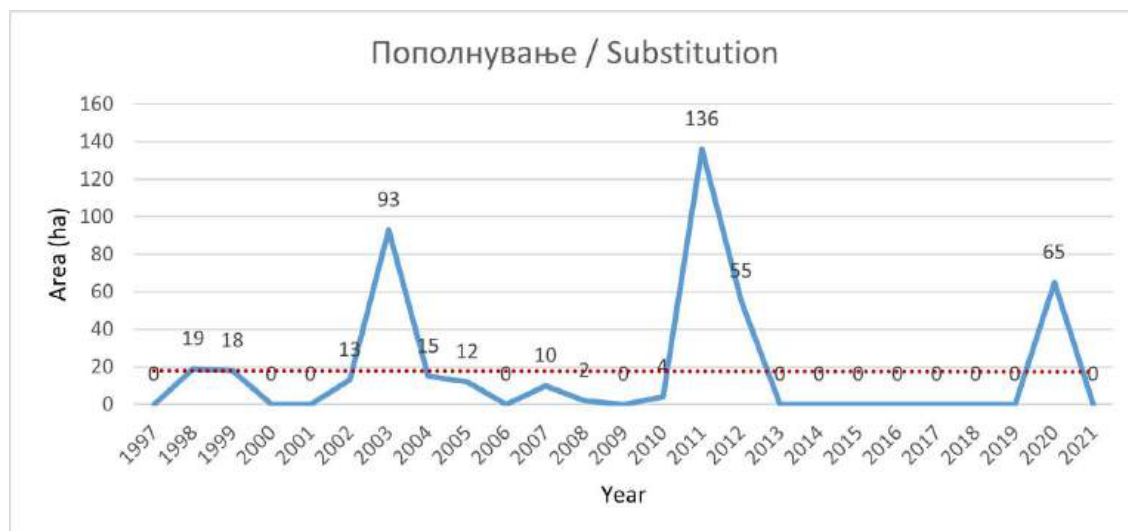


Figure 15. Trend of the areas subjected to replenishment of unrenewed forest sections for the period 1997-2022 (ha)

Resurrection, as a measure for the restoration of coppice forests, has been applied in various volumes in all years of the analysed period. On the largest surfaces, it was carried out in 2004, covering 6,184 ha, then in 2010, covering 764 ha, and in 2000, covering 708 ha. On the smallest surfaces, this measure was implemented in 2020, covering 12 ha, and in 2002, covering 20 ha.

The trend of the volume of areas subjected to resurrection for the period 1997-2022 is depicted in Figure 16.

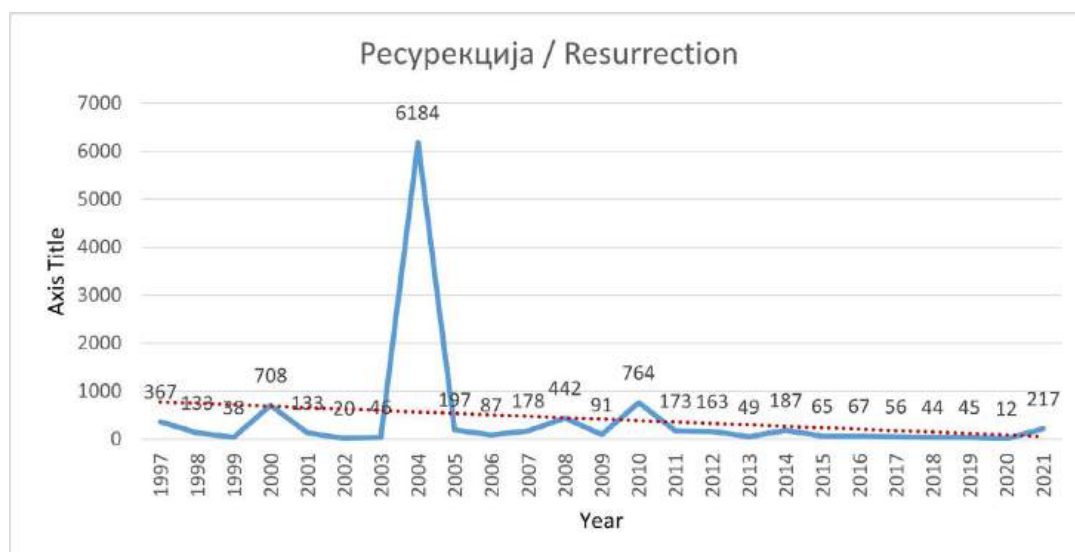


Figure 16. Trend of the areas subjected to resurrection (ha) for the period 1997-2022

From the aforementioned, it can be observed that for the period 1997-2022, silvicultural measures were implemented on 81,361 ha. Measures for the illumination of new growth were conducted on an area of 976 ha, measures for new growth cleaning on 9,946 ha, thinning on 52,003 ha, enrichment planting on 1,795 ha, conversion on 5,769 ha, replenishment of unrenewed forest sections on 442 ha, and resurrection on 10,466 ha.

The percentage ratio of implemented silvicultural measures for the period 1997-2022 is illustrated in Figure 16.

Restoration measures are taken in mature forest stands to create natural or artificial regeneration, enabling the restoration and maintenance of the old forest stand in the long term.

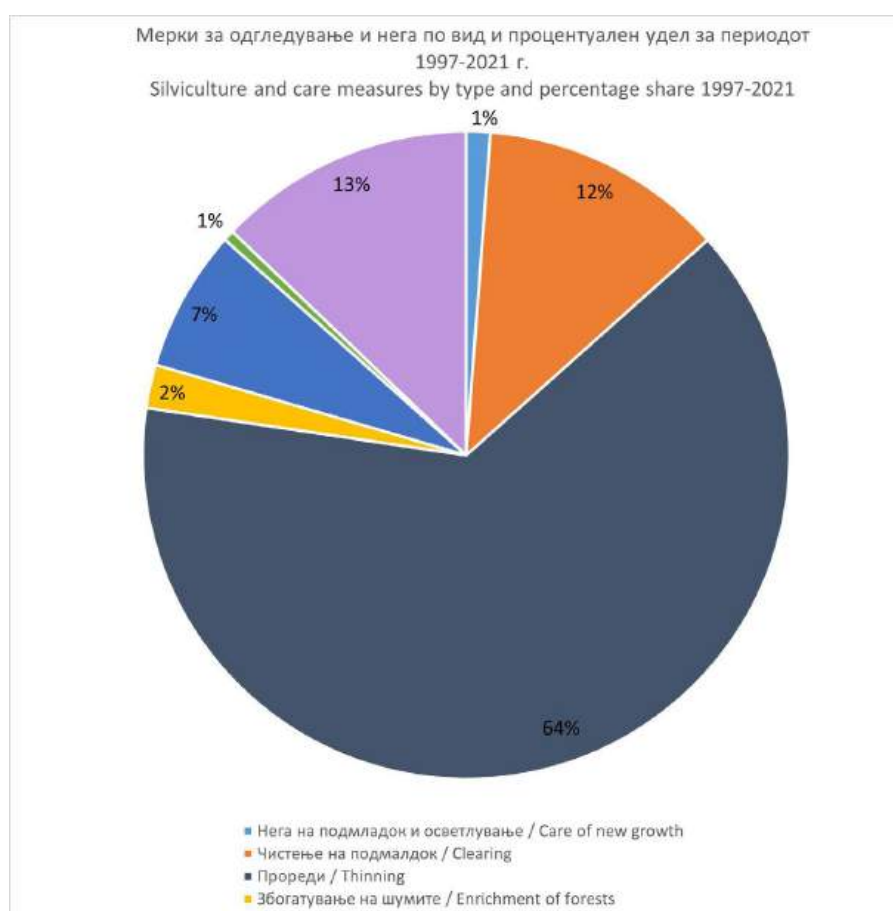


Figure 17. Percentage ratio of implemented silvicultural measures for the period 1997-2022

According to established traditional and legal practices in the country, various restoration measures are applied. Thus, in high-stem diverse-age forest stands, selective stem and group felling is applied, while in high-stem even-aged forest stands, seed tree cutting is applied. In forests originating from vegetative (sprout) sources, clear-cutting is most commonly applied. Combined methods of natural regeneration, the concept of sustainable forest management, and the concept of closer-to-nature forest management are still not widely applied in forestry practices, despite a certain desire and progress in that direction.

The implemented silvicultural and restoration measures, in forests and on bare surfaces, together with other biotic and abiotic influences, have greatly influenced the current appearance and condition of forest resources in the country.

The insufficient, unprofessional, and untimely implementation of silvicultural and restoration measures in forest stands also has a significant impact on the structural indicators of forest quality. Thus, the average wood volume in the country's forests is only 77 m³/ha, and the average annual increment is only 2.02 m³/ha. According to these indicators, the quality structure of forest resources in Macedonia is among the weakest in Europe. The reason for this is that only 30% of forest resources consist of seed-origin forests managed in high-stem form, while the other 70% of the forests are degraded or of vegetative origin managed in low-stem form.

The distribution of different types of forests according to the management form is shown in Figure 18.

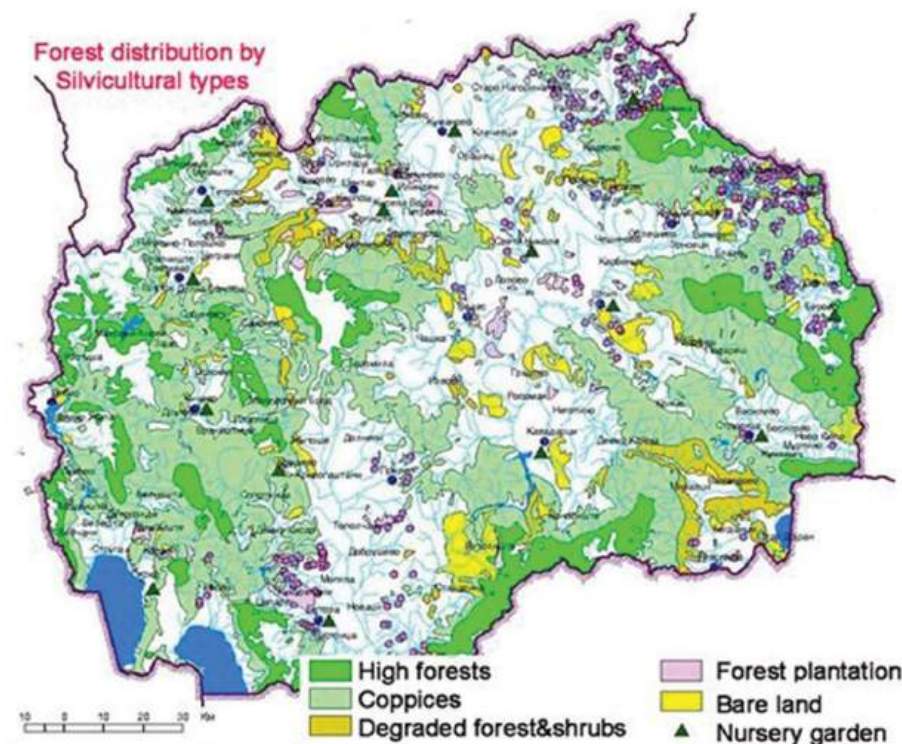


Figure 18. Forest distribution by silvicultural types

From the information presented earlier and the map shown in Figure 18, it can be observed that there are significant areas in the country covered by low-quality, low-productivity forests (degraded and coppice), as well as clearings where activities on afforestation, cultivation, and regeneration can and should be carried out.

The areas with a significant degree of erosion, as well as all other bare surfaces where there is no conflict of interest between managers and users, should be considered as a priority for afforestation.

The areas with degraded and coppice forests situated in more favourable locations should be considered a priority for improving the structure of forest resources.

7. Implementation Criteria for Sustainable Forest Management in the Republic of North Macedonia

Due to the established principle of permanent forest management, many of the requirements provided by the criteria and indicators are fulfilled in our country.

Criterion 1: Maintaining and adequately increasing forest resources and their contribution to the global carbon cycle.

The activities envisaged by this criterion are fulfilled almost entirely; it is the result of the corresponding forestry activities throughout the historical period, and mostly of the afforestation of bare places. It should be noted that from 1914 to 2020, about 250,000 ha of bare places and heavily eroded lands were reforested, thereby increasing forest resources and their contribution to the carbon cycle.

Criterion 2: Maintaining the health and vitality of forest ecosystems.

The health status of the forests is constantly monitored. It is the responsibility of the manager of the forestry management unit, who is obliged to note any changes in the “forest chronicle” section of the plan. In addition, in the event of a mass outbreak of a pest or disease, the MAFWE is informed, as well as the Reporting and Diagnostic Service (RDS), while appropriate measures are taken.

Criterion 3: Maintenance and improvement of productive functions of forests (wood and non-wood products).

The maintenance and improvement of forest production functions for timber products have been in the plans and practiced for a long time. Because there are many degraded forests and wooded areas in the Republic of North Macedonia, it is necessary to intensify activities for their revitalisation and melioration. The openness of forests with forest transport infrastructure is low (8.41 km/km²), so this should also be worked on in the future. On the other hand, non-wood products are neglected in commercial forests and not enough attention is paid to them. Only in protected areas is the maintenance and improvement of non-wooden products planned.

Criterion 4: Maintaining, protecting and enhancing the biodiversity of forest ecosystems.

To meet the requirements of this criterion, considerable work is needed. Biodiversity has generally been maintained so far. There used to be a trend of introduction of allochthonous species, mainly coniferous, due to the needs and demands of the wood industry. In addition, large bare fields are forested with allochthonous pioneer species for several reasons, primarily due to engineering requirements (ability to bind soil to the root system and protection against erosion), but also financial (low cost of production and reforestation, that is, the most optimal cost-benefit). After one rotation is completed (about 100 years) and when, above all, the conditions at the place of growth improve, it is possible to think about the reconstruction of the plantations and the introduction of indigenous species, such as contemporary trends.

Criterion 5: Maintaining and improving the protective functions of forests (especially soil and water).

Until the 1998 Law on Forestry and the establishment of PE National Forests, there were officially 17.617 hectares of protective forests in the country (for the purpose of protection against erosion and sedimentation in reservoirs), managed by local water supply and irrigation companies. With the integration of these forests into existing economic units and transfer under the authority of PE National Forests, they have lost that status, but three years ago the process of delineation of the protected forests has begun and would continue for the next 7-8 years until the completion of the cycle of the development of all special plans.

The global average is about 10%, while the European average is about 32%.

For different types of forest protection (whether for water production, erosion protection, protection from natural disasters, etc.), different specific forestry measures are applied, which requires additional training of engineers.

Criterion 6: Maintaining socioeconomic functions and conditions.

If we look at the indicators for Criterion 6, we can say that some are respected, while others are not. Regarding ownership, what is missing is data on private companies related to forestry (supply, logging and transport of timber varieties, warehouses for sale of wood, companies working with non-wood forest products, sawmills, etc.).

The actual share of forestry in GDP is unknown (it is estimated at 0.4-0.5%). Workforce data, as well as occupational safety data are fragmented and incomplete. Data on consumption, timber trade and energy from timber are also lacking.

Regarding recreational resources, there is still no data on the number and frequency of people using the forest for recreational purposes. Objects and locations that have cultural and spiritual values are not included in the plans at all, so their number and location are not known.

8. Main findings and recommendations

8.1. Main findings

1. According to the latest data from the State Statistical Office of the Republic of North Macedonia, as of 31 December 2021, a total of 1,049,300 hectares of forest were recorded. Over the past 80 years, there has been a consistent trend of increase in forested areas. However, despite this trend, forest resources in the country have a significantly weak and low-quality structure, compared with the quality structure of forest resources in EU countries. The reason for this is the low representation of generative forests (30%) in the overall forest fund and the high representation of degraded and coppice forests (70%), which have weak structural, production, and ecological capacities.
2. Beech forest in RNM is spread over about 300,000 hectares, which represents 30% of the territory under forest. Most of beech forests (80%) are pure, and others (20%) are mixed, consisting of two or more species such as: Scots pine, Austrian pine, Macedonian Pine, fir, spruce, hornbeam, oak and other species.
3. The total wood mass in beech forests is about 42 million m³, which represents 56% of the total wood mass in the forests of the country, and the total annual growing stock is about 844,000 m³, which represents 46% of the total annual increase in total wood mass in the country. In pure beech stands, the average wood mass is 168.3 m³/ha, and the average annual growing stock per area is 3.41 m³/ha. These indicators for pure beech stands are better compared to other pure stands at the level of RNM, in which the average wood mass is 95.5 m³/ha, and the average annual growing stock per area is 2.29 m³/ha.
4. Part of beech forests are included within the protected areas proclaimed according to the IUCN categorisation and the Law on Nature Protection. Part of beech forests are delineated as protective forest and are parts of forest management units managed by PE National Forests and this process of delineation of protective forests continues.

5. Measures for care and management of forests have not been adequately implemented for an extended period of time and have had a decreasing trend.
6. A problem in the management of beech forests in RNM is the large application of clear felling on large areas in some degraded high forests. This way does not allow the improvement of the structure of forest stands and contributes to their further degradation.
7. Measures for the conversion of coppices into middle and high forests are inadequately implemented. The reasons include insufficient financial resources, lack of expertise, inadequate organisation, and weak capacity of forest managers.
8. Within the Strategy on Sustainable Forestry Development 2006-2026 with Action Plan, various measures for sustainable forest management are planned, including amelioration of degraded forests and shrubs, but the implementation is very low.
9. Some contemporary concepts, such as sustainable forest management, closer-to-nature forest management, forest restoration through combined natural regeneration methods, etc., are still inadequately applied in forest management despite certain prerequisites and desires for it.
10. Generally, forestry in RNM is managed in the traditional way and one of the main reasons is that PE National Forests that manage the most of state-owned forests is a self-financing company without enough funds for this matter.
11. Beech forest as well as all forests in the country are subject to illegal cuts, which exacerbates the condition of beech forests.

8.2. Recommendations

1. Forestry in the Republic of North Macedonia should follow new global trends and align its practices and activities with the European Green Deal, the Green Agenda for the Western Balkans and the European Forest Strategy (2021-2030), focusing particularly on effective afforestation and forest protection and restoration as a priority goal.
2. The Ministry of Agriculture, Forestry and Water Economy (MAFWE) should take more significant initiatives to develop and implement the concept of holistic forest ecosystem management that will replace the current linear (fossil) economy with a circular bioeconomy in accordance with European (international) forestry policies.
3. The government should initiate strengthening the capacities of PE National Forests in the direction of professionalism of its employees, as well as improvement of the material and financial basis for appropriate implementation of activities on sustainable forest management.
4. MAFWE should consider the possibility of changes in the approach to the valorisation of the role of forests (considering their comprehensive multifunctional utility role) by introducing the PES approach – payment for ecosystem services.
5. MAFWE should initiate the creation (adoption) of by-laws for the adaptation and effective implementation of the criteria and indicators for monitoring the results of sustainable forest management.

6. The competent institutions (MAFWE and the Ministry of Environment and Physical Planning, MEPP) should initiate changes in the legislative framework to allocate financial resources (compensation) for the costs of sustainable forest management, thus fulfilling the obligations assumed by various ratified conventions and other agreements (CO₂ credits, green tax – financial instruments).
7. MAFWE should prepare a by-law specifying the methodology for the delineation and categorisation of protective forests, as well as appropriate engineering measures for each special type and category, as well as a recognised method for the financial sustainability of protective forests.
8. A long-term strategy for forest regeneration over a period of 10 or 20 years needs to be developed. This strategy should outline plans for optimal areas for regeneration and ensure financial, professional and technical capacities to achieve the goal.
9. A study with action plan is required to identify priority areas and surfaces for regeneration. This study should analyse all national areas and surfaces earmarked for long-term regeneration, providing detailed information.
10. The long-term conversion of coppice and degraded forests can provide greater stability of the forests, increased wood mass production, greater biological diversity, larger carbon sequestration capacity, and enhanced overall beneficial and protective functions.
11. To improve the quality structure of the forests, it is necessary to implement silvicultural measures in all developmental phases of the forest, but stable financial resources need to be secured to finance these silvicultural measures for the forests.
12. Stable sources of funding need to be identified for continuous and long-term conversion of coppice and degraded forest stands into middle and high forests.
13. A new institution in the state's forestry sector needs to be established, the Forestry Agency, responsible for monitoring EU policies, strategies, regulations and standards, and for implementing national strategic and legal frameworks in forestry.
14. Build professional capacities for implementing contemporary concepts such as sustainable forest management, closer-to-nature forest management, forest restoration through combined natural regeneration methods, and the application of other modern models and techniques.
15. The priority areas for improving the structure of forest resources should be the regions with degraded and coppice forests situated in more favourable locations. However, defining priorities and the method of conversion requires a comprehensive analysis of both the current state and the structure of forest stands earmarked for conversion. Given that conversion is a lengthy process, successful execution demands meticulous organisation and effective on-site implementation, complemented by regular measures for nurturing and cultivation.
16. Investments in the gradual conversion of outgrowths and degraded forests into highly productive forests of generative (seed) origin in order to improve their structure, stability, productivity, naturalness, and fulfilment of other ecological, socio-economic and protective functions.
17. Improvement of forest planning, which should be aimed at permanent maintenance and preservation of areas under forest and forest land, as well as promotion of ecological, economic, cultural and social values of the forest, including land and water protection.
18. To implement the concept of sustainable forest management and the concept of growing forests closer-to-nature to prevent activities that lead to forest degradation.

19. To reduce the use of clear cutting, especially on large forest areas, and to take measures for the revitalisation of degraded forest ecosystems.
20. To carry out forest certification, which will provide evidence of sustainable forest management and the application of forest practices that provide assurance that wood and non-wood products from the forest are produced in compliance with the highest environmental, social and ethical standards.
21. Increasing the capacities and knowledge of inspectors through professional training to eliminate weaknesses and improve their financial and technical equipment to perform their work. The integration of the Forestry Inspectorate in the future AS should improve their functioning.
22. Strengthening the capacities of civil associations, as well as motivating other associations to get involved with activities in the field of sustainable forestry to help establish monitoring, lobbying, and other types of assistance for the efficient implementation of public policies.
23. Improvement of inter-institutional cooperation and collaboration with the civil sector among MAFWE and MEPP, and PENF.
24. The Parliament should initiate a supervisory hearing to discuss illegal logging, the corruption that dominates in the forestry sector and other criminal activities (primarily causing fires). Such a debate, in the long term, would contribute to reducing crime and corruption.
25. The system for electronic monitoring of the transport of wood mass should be implemented.
26. Competent institutions should initiate and conduct appropriate investigative proceedings for the perpetrators of violations and crimes.

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1.6. Concept of guidelines for forest management on the example of one forest management type/ tree species – Montenegro: Beech Forests

Mr. Ranko Kankaras

Instructions for managing beech forests in Montenegro¹

Introduction

Beech (*Fagus moesiaca*), or more specifically Mesian beech, is the most numerous type of forest tree in Montenegro. Its share in the total area is about 20%, and in the volume of all forests in Montenegro it is about 49 million m³, or slightly more than 42%.

Beech forests in Montenegro consist of autochthonous, mostly pure beech stands, single-season or multi-season structures.

Likewise, beech is a significant factor in selective forests in Montenegro, appearing in stands of fir and beech, fir, spruce and beech, while in some localities it is mixed with black pine, such as for example in the elite stand of black pine in Crni Podi, or with other deciduous trees. The Biogradska Gora rainforest is an area where tall natural forests of the rainforest form are preserved, with a recorded mixture of several types of forest trees in Montenegro, including beech, fir, spruce, ash, mountain maple and other noble deciduous trees.

When it comes to single-season forests, the structure of those beech stands includes strong and true trees of the same or similar age, while multi-season stands are characterised by a pronounced vertical structure. The admixture in these forests consists mainly of noble hardwoods, fir, spruce, hornbeam, birch and pine, the proportion of which is quite variable and depends on the altitude, the substrate and the way of management.

Beech stands are of heterogeneous growth depending on habitat conditions. At higher altitudes, its quality and growth are not economically satisfactory. These forests are characterised mostly by good natural regeneration, with a pronounced biological dominance of beech. These are subalpine formations of beech forests, which have a high natural stability and resistance to extreme climatic conditions prevailing in this zone.

In the main areas of distribution of beech forests, in addition to pure beech stands, beech often occurs in a mixture with other types of trees, of which fir can be a competitive species while helping the development of those stands through economic measures. On more acidic substrates, the competitiveness of beech is reduced compared to spruce and fir. Also, on poorer skeletal substrates, competitiveness is reduced compared to noble hardwoods, hornbeam, black pine and other species.

Beech forests also participate in the forest fund of low and coppice forests of the central and coastal part of Montenegro, where they are mostly in degraded forms and poorly resistant to forest fires and constant threats characteristic of those areas (primarily climate and human influence).

Distribution

Beech forests form closed communities at altitudes between 800 and 1,800 meters in which beech occurs alone or with fir, spruce, maple, and other deciduous species. As a species, Mesian beech has a wide distribution amplitude depending on the geological substrate, soil type, exposure, temperature, while it has a slightly smaller amplitude in relation to the humidity of the habitat. It occurs in a wide range of forest vegetation, from the community of beech and autumn sedge, through the montane beech forest to the belt of subalpine beech. Beech forests and autumn sedges spread in the karst area

1 Translated via Google Translate

of the southern slopes of the Dinarides and represent a border community between the Euro-Siberian-American and Mediterranean regions. It is the most important thermophilic beech community in which, in addition to beech, the following trees are mixed in the floor: deaf maple, black hornbeam, mountain maple, common whitebeam, black ash, and in the layer of ground vegetation there is autumn sedge (*Sesliero autumnalis*) as a typical representative of the thermophilic flora. Mountain beech forests (***Fagetum montanum* Ht 1938.s.lat**) extend from the mountain to the subalpine belt and represent climate-regional vegetation, forming a belt between oak and hornbeam forests on one side and beech-fir forests on the other. Acidophilic communities of ***Fagetum moesiaca montanum* Bleč at** are formed on acidic soils and calciphilous communities of ***Luzulo-Fagion moesiaca* Lak et.al. are formed on carbonate soils**. As a special belt on the medium-high and continental mountains of the central and northern part of Montenegro at heights of 1,600-1,800 meters, there is a belt of subalpine beech (***Fagetum subalpinum* Ht. 1938 s. lat.**). The characteristic of this sub-association is that its trees are stunted, sabre-like bent at the bottom, that is, they have the so-called subalpine form.

Beech forests occur on all exposures and steep slopes. The geological background is different from sedimentary to volcanic silicate rocks. Soils are dominated by humus-accumulating cherts on limestone and rankers on acidic volcanic rocks.

Beech forests are spread over all credit classes of land that have been set aside in Montenegro. The poorest lands on which beech forests develop are located in the wider area of the Sub-Mediterranean, with the southernmost point at the Reč locality in the municipality of Ulcinj.

Environmental characteristics

Beech forests are relatively stable forest ecosystems with medium-fast humification processes and a good process of natural rejuvenation. Beech forests grow on all native substrates, basophilic, neutrophilic, acidophilic. Beech tolerates the shade of deciduous trees best. Young beech trees are sensitive to frost and drought. They have a thin bark, so they are sensitive to sudden illumination of stands, which must be taken into account when applying household treatments.

Beech takes root well and firmly, its root adapts well to the conditions on the ground, so beech is very important as a bio melioration species. Beech trees are also very wind resistant.

Cultivation measures should aim to increase the participation of mixed species as well as to create a multi-season vertically well-structured stand. Without the participation of other types of trees, the stand structure is relatively monotonous, but these forests represent natural ecosystems that give a satisfactory visual appearance.

Climatic conditions and development of beech forests

The specificity of Montenegro's position, from the aspect of weather and climate, stems from the fact that it is located in the zone of pronounced thermal asymmetry, between the cold northern Europe and the very warm northern Africa. Just above Montenegro, there is intensive exchange of warm air masses that go to the north and cold air masses that go from the north to the south. Air masses with extremely different physical and meteorological characteristics collide and mix very often over Montenegro.² Such climatic conditions, considering the above-mentioned distribution and participation in wood volume, obviously correspond to the development of beech as a type of forest tree, which means that it occurs in very different climatic conditions.

2 <https://www.meteo.co.me/page.php?id=39>

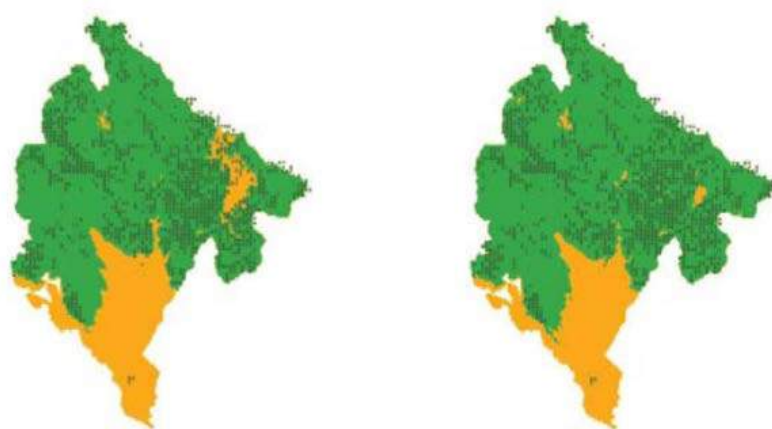


Figure 1: Assessment of beech distribution 2071-2100 (A1b scenario) Figure 2: Assessment 2071-2100 (A2 scenario)

The Second National Report on Climate Change, which Montenegro is preparing according to the United Nations Framework Convention on Climate Change, presents projections for the growth and distribution of the main types of forest trees in Montenegro in relation to climate change. Based on the obtained projections, beech will preserve the largest part of its current area, with the exception of some bordering habitats, such as the areas of Rumija, Primorje and Polimlje (Figures 1 and 2). There is a possibility of beech spreading in dry areas of high mountains of Montenegro, where other habitat conditions permit, primarily sufficient land potential. In general, in the territory of Montenegro, there will be no significant reduction or increase in the area of beech forests, if the existing climate scenarios are realised.

The relationship between the availability of water and nutrients in the soil and beech growth has not been sufficiently investigated in Montenegro. From the stand inventories, it can be seen that the largest increase in volume of beech was found in pure beech forests in Komovi, in the area of the municipality of Kolašin, where the average annual amount of precipitation exceeds 2000 mm/m². In that area (farm unit Komovi I), the largest average increase in volume of beech in Montenegro was recorded in the amount of 8.6 m³/ha, which is a realistic situation for good habitat conditions in that area.

Long-term development goals for beech forests

Maintenance of natural beech forests and gradual conversion of approximately same-age forests into multi-aged and selective forests. This objective promotes the economic and ecological value of trees. An important level of this goal is the achievement of a mixed forest, in such a way that the other species in the mixture, wherever they appear, should be helped.

In the ecological sense, the proposed goal achieves high ecological stability of beech stands, improvement of the environment and protection of land from degradation and erosive processes.

In the economic sense, breeding treatments should be aimed at selecting trees of the future with the basic idea of promoting forest management at tree level (clear orientation and expediency given below in the description of breeding treatments). In this way, the gradual development of the productivity of these forests is achieved in order to meet the society's needs for wood. High-quality technical timber and firewood are obtained from beech.

In **beech forests in which a selection structure has been formed, manage group selection cuts**, the

size of the initial cores of 10-30 ares, and renew them in such a way as to achieve a multi-seasonal structure and an optimal ratio of deciduous and coniferous trees.

It is necessary to manage approximately single-season beech forests (naturally built and supported by incorrect cultivation measures) with a group-stage system (Femmelschlagbetrieb) with the aim of converting them into multi-season forests.

In coppice beech forests, carry out conversion to tall forests where there are conditions for it.

- Composition of the mixture: beech 80-100%, other hardwoods and conifers (Acer, Abies, Picea) 0-20%.
- Form of mixture: individual trees, small groups, groups (diameter of 15-30 m).
- Structure: temporary vertical structure depending on the development stage of the stand.
- Optimal depth stock: 200-300 m³/ha, the length of the cycle is 120-160 years depending on habitat conditions.

In coppice beech forests where habitat conditions do not allow conversion to a higher growing form, it is necessary to manage in the **classic way of coppice forest management**, where the renewal period (or rotation) is about 40 years.

Silvicultural development of existing stands

- Optimum use of liquid growth when cutting mature beech trees, chest diameter of at least 55 cm, at high altitudes of 45-50 cm or less, depending on the process of formation of the red heart of the beech wood, and coniferous trees with chest diameter of at least 60 cm.
- Maintaining a closer-to-nature forest community that has flora and fauna typical of that location.
- Promoting the appearance of mixed species (stemming, noble deciduous trees).
- Preservation of the soil protection function in forests on steep habitats.
- Leaving a certain number of dry and hollow trees after their natural decay.

Types of treatment / forestry measures

When carrying out care measures in young beech stands, keep in mind it is a distinct type of shade with a late culmination of growth, avoid sudden and excessive opening of the assembly, in young stands the critical degree of slenderness is from 180 to 220 cm. The aggressive species has a strong competitive power, in the youth the intensity of care in beech forests must be stronger than the care of fir and spruce stands. If care measures (cutting to moderate extent) are carried out correctly and on time, the share of technical wood increases by 20%, and the time of patrolling is shortened.

Care of the young of dominant height (DomH) 1-13 m

- At the height of the saplings of 1-1.5m, the first set is formed, in this phase carry out clearing fellings, apply negative selection (remove damaged, diseased, low-quality individuals), regulate density and spatial arrangement, regulate the composition of the mixture. The intensity is such that the assembly is reduced to 0.8-0.9, the operation is repeated after 3-5 years.
- Around 20 years of age, when the trees are 5-7m tall, thin them out in the dominant floor, remove bad and damaged individuals. This is the key moment for the development of the stand because clearing cuts are usually absent, so the goals from the stand clearing phase must also be achieved

in these intervals. If the implementation of this phase is delayed, we will have unstable stands with a large number of trees and a high degree of slenderness. Cultivation in this phase regulates the basic goals of managing beech stands stability, structure and **selection of potential trees of the future (PSB)**. After the negative selection, switch to positive selection, select candidates for potential trees of the future and remove their competitors in the upper parts of the canopy. In this phase, about three times more PSB are identified than the number that is eventually managed by the end of the patrol, which means 600-900 trees (the reason is preservation of stability, cleaning of the lower branches, the so-called useful trees, protection from unpredictable risks).

Row spacing (dominant height 14-24m)

- At around 40 years of age, select 120 to 130 PSB beech trees (and mixed tree species), mark them permanently and devote all care measures to them. Distance between PSB 8-9 m, minimum 6 m. If the distance on one side is less than the minimum, more space must be provided at other sides.
- Carry out a highly selective thinning of moderate intervention intensity aimed at the increase of PSB, by consistent and continuous removal of certain competitors with potential trees of the future, with the aim of maintaining the base of the crown at $\frac{1}{4}$ of the final expected height of PSB.
- Normally there is no intervention in the intermediate stages of growth in the middle floor, if necessary, only the removal of strong trees of poor quality.
- Favouring the desired mixed species of slow-growing trees through consistent promotion of the development of their crowns and the formation of small groups (up to 15 m in diameter).
- The thinning interval of 5-10 years, for the first thinnings it can be shorter, with a maximum of 80 m³/ha of wood that is removed in each intervention.

Care (thinning) of maturing stands (dominant height >24 m, DBH <40 cm)

- Implementation of thin-cutting, removal of bad or damaged mature trees (based on data on the appearance of red heart in beech). Removal of the so-called useful trees when the process of cleaning lower branches from PSB is completed in order to make room for the expansion of their crowns and the intensification of thickness growth.
- The volume of each felling ranges up to 80 m³/ha.

Stand rejuvenation (chest diameter >40 cm)

- Create conditions for natural rejuvenation by felling individual trees that have reached the diameter of blade maturity.
- The diameter of blade maturity of better beech trees, depending on the layout and experience with red heart, minimum 55 cm (at higher altitudes it is less than 45 cm), the blade diameter of beech with a recognizable class of poorer quality (e.g. subalpine beech), is about 40 cm, for conifers at least 50 cm, if the branches are undercut then 60 cm.

Regeneration of stands that have reached the diameter of blade maturity

Renewal is carried out by applying a group-stage management system, which was created as an effort to convert single-season forests into multi-season forests and maintain them as such. The application of this system can be started at any stage of the development of the stand and through it great attention is paid to the care of individual trees or groups of trees, as well as all development stages. The type and form of felling is freely chosen, trees are removed individually or in groups depending on the specific situation, and the goal is to restore the beech forest. Juvenile cores gradually expand and merge, passing from young to older developmental stages, which achieves the desired diversity. Renewal is directed towards the removal of the old stand and the expansion of the new one in the desired direction, whereby all care measures in individual parts of the forest are replaced one after the other in a certain time and space, following the development of the stand by stages. The undergrowth period is determined freely according to need, this system does not recognise patrolling, it is only a rough orientation size that adapts to certain parts of the forest, and the principle of individuality and maximum stability of beech forests applies. An important rule in this system is that the total area under forest in the sapling phase must not be more than 20% of the total area of the stand to preserve the durability of the yield.

Opening the assembly above the existing sapling cores and removing qualitatively poor saplings, including care after felling – removal of damaged saplings.

On steep slopes, cut down trees of poor quality (split, damaged). After that, in certain zones, cut down the trees from the upper floor and, after the appearance of natural saplings, remove the remaining parts of the stand in rejuvenated zones.

In the case of poor-quality stands or stands with a large occurrence of red heart, repeat the felling of trees from the upper floor on several occasions without waiting for the diameter of the blade to reach maturity through frequently repeated interventions with the successive removal of the remaining parts of the old stand in rejuvenated zones, promoting the participation of mixed tree species of high economic value.

- **In general:**

The level of intervention is normally not higher than 80 m³/ha per felling, except on hard-to-reach steep slopes (use of cables) and when systems are used to protect young trees by shading the parent stand. The intervention interval is 3-10 years, and the rejuvenation period is 40-50 years.

Accelerating the rejuvenation process if a greater participation of mixed tree species (e.g. fir, spruce, maple) is desired.

On terrains with difficult natural rejuvenation: planting conifers adapted to the habitat in smaller groups (≤15 m diameter) and deciduous trees.

Assortment: Spruce/spruce 2+2, 2+3;

Deciduous trees: 1+2

Spacing: Spruce/fir 3-4 x 1.5-2 m, max. 1,600 plants/ha

Beech (other deciduous trees) 2x1 m, max. 2,000 plants/ha

Measures in case of accidents (damage from snow, wind, bark, beetle attack)

Complementing the existing natural rejuvenation, planting beech and other desired species on protected border areas as well as on clearings larger than 0.3 ha. Do not plant beech in open spaces larger than 1 ha.

In the contact zones of beech forests with fir at higher altitudes, where the presence of fir in the mixture is insufficient, it is necessary to help the spread of fir by natural means (the so-called stemming). This is best achieved by creating smaller openings in the stand – groups. It is essential to provide enough light for the fir saplings and not enough for the beech and keep in mind that the beech quickly expands its crowns and closes smaller openings. Here, the existing fir sapling must be urgently freed from the shade, and the existing fir trees should be considered as seedlings, they can exceptionally be removed for sanitary reasons.

In the subalpine belt of beech forests, at higher altitudes up to the upper limit of vegetation, on steep terrains, where the conditions for natural regeneration are difficult, as well as in protective forests, only felling of a sanitary nature should be applied.

1.7. Concept of guidelines for forest management on example of one forest management type/ tree species – Republic of Srpska, Bosnia and Herzegovina: Beech High Forests

Prof. Dragan Comic

Guidelines for Management³ of the High Mountain Beech Tree Forests in the Republic of Srpska



Banja Luka, 2023

ABOUT THE PROJECT

The Standing Working Group on Regional Rural Development (SWG), as a platform for networking and regional cooperation, was established during the Agricultural Policy Forum in 2005 (Rural Development Opportunities for Cooperation in SEE) in June 2005. The overall objective of SWG is to facilitate close cooperation between the ministries of agriculture and other interested parties in the field of agriculture and rural development, as well as to support the integration of the countries of Southeastern Europe into the European Union.

In April 2022, in its coordination role with the Ministries of Agriculture of the Western Balkans, SWG was engaged in the establishment of the Regional Forest Advisory Working Group (REAWG). On the basis of successful cooperation, the German Federal Ministry of Food and Agriculture (BMEL) approved the implementation of a three-year regional project in the Western Balkans, entitled Dialogue on Agricultural Policy Germany – Western Balkans. The main goal of this project is to support the countries/territories of the Western Balkans in their efforts to strengthen the implementation of the Green Agenda of the EU for the Western Balkans and alignment with the Common Agricultural Policy of the EU for the period 2021-2027. Within this project, partner organisations discussed the possibilities of expanding to topics related to forestry and sustainable forest management. Based on successfully completed negotiations, part of the project was approved on the forestry sector and with the goal of strengthening mutual benefits in the field of forestry policies (EU – Western Balkans), as well as linking and strengthening regional cooperation and exchange of good practices of sustainable forest management. Representatives of official institutions, businesses and the academic sector are involved in the project.

The main goal of the project for 2022 was to develop a national assessment of the state of sustainable forest management in the countries/territories of the Western Balkans, as well as to give recommendations for sustainable forest management in accordance with EU policies. Within this initiative, potential activities and challenges in the field of forestry that are common to all countries in the region and that can be worked on together have been defined.

Based on the above results, a new project was launched in 2023, entitled Support to the Regional Expert Working Group for Sustainable Forest Management in the Western Balkans, based on the concept of closer-to-nature forest management, with two main goals:

Objective 1: Prepare, present and discuss the concept of forest management guidelines with a concrete example of one forest management system and/or tree species in each state/territory, with the following main activities

- Five-day study visit to the German province of Hessen and practical field work with representatives of the company HessenForst
- Prepare a demonstration plot (0.1-0.2 ha) in each country/territory and organise a practical demonstration of the application of the guidelines in the field

Objective 2: Prepare a document with an analysis of existing policies and recommendations for improvement related to the concept of closer-to-nature forest management, including biodiversity protection in climate change-related challenges.

The main idea behind all the activities is to strengthen the network with a transfer of knowledge and technologies between the countries of the Western Balkans and German forestry partners.

PROJECT TEAM

Dragan Comić PhD – National Expert and Coordinator for the Republic of Srpska

Zoran Govedar PhD – Expert for Area Forest Cultivation and the main author of the Guidelines for Management of the High Mountain Beech Forests in the Republic of Srpska

Boris Marković MSc – representative of the Forestry Department in the Ministry of Agriculture, Forestry and Water Management of the Republic of Srpska

Slaviša Opačić MSc – representative of the PE Forests of the Republic of Srpska

1. GENERAL CHARACTERISTICS OF HIGH MOUNTAIN BEECH FORESTS

The total area of beech forests in the Republic of Srpska is 236,503.15 ha (28.8%). Of this area, unmined beech forests occupy an area of 213,688.80 ha or 90.4% of the area of beech forests. Mined beech forests occupy an area of 22,814.35 ha or 9.6% of the area of beech forests. In the total beech forest stock (owned by the state), stands of high (generative) origin dominate, which account for 171,903.34 ha or 72.7%, coppice forests cover an area of 64,599.91 ha or 27.3%. In the total forest fund, beech degraded high forests occupy an area of 11,944.73 ha or 5.1%. From a geographic, genetic and synecological points of view, high beech forests are differentiated into groups of mountain beech forests in the interior, fir-beech forests and subalpine beech forests. Within the high mountain beech forests there are pure beech forests, beech and common hornbeam forests, beech and white hornbeam forests, beech and black hornbeam forests and beech forests with aspen and birch. These forests are structurally not homogeneous, although homogeneous growing situations (**gupa**) can be distinguished in them. A frequent phenomenon is damaged structure, weediness, insufficient natural regeneration, poor quality, unfavourable composition of stands, insufficient openness to truck roads, etc. Pure one-season stands occur in places, but the disordered multi-seasonal structure of double-story stands or close to selection stands dominate in cases of presence of fir and spruce. This farm type includes the category of forests: high single-season and high multi-season beech forests.



Image 1. High mountain clean beech stand

2. DESCRIPTION OF THE SITUATION

Table 1. Regional community of high mountain clean beech forests

CARBON SUPSTRATES								
Pure beech forests on ilimerised loamy and clay soils on limestone		Clear beech forests on brown loam and clay soils on limestones			Pure beech forests on limestone black and sandy soils dolomite rendzinas		Clean beech forests in the deep slope pseudogley	Not processed
Clean beech forests on ilimerised deep, loamy, clay soils on clean limestones	Clean beech forests on ilimerised in shallow, loamy and clay soils on clean limestones	Clean beech forests on brown shallow, loamy soils on limestones	Clean beech forests on brown deep loamy soils on limestones	Clean forests beech trees on brown deep clay soil on limestones	Clean beech forests on limestone chernozem	Clean beech forests on sandy dolomite rendzina	Clean beech forests on the deep slope pseudogley	Clean beech forests on rendzina on marl and marl limestones
ACIDIC SILICATES ROCKS								
Clean beech forests on ilimerised soils on silicate rocks and deep acidic brown soils							Pure beech forests on acidic brown, shallow loamy-sandy soils	
Clean beech forests on ilimerised deep soils on silicate rocks	Pure beech forests on ilimerised soils on silicate rocks		Pure beech forests on acidic brown soils, deep loamy clay soils		Clean beech forests on acidic Brown soils, deep sandy soils		Pure beech forests on shallow acidic brown soils	
BASIC AND ULTRABASIC ROCKS								
Clean forests beech trees on topsoils above the basic eruptive rocks		Not processed						
Clean beech forests above basic eruptive rocks		Clean forests beech trees on brown soils on peridotite		Pure beech forests on podzols and brown podzols soils		Clean beech forests on skeletal loamy deluvium		

4. FOREST FUNCTIONS

Pure beech forests and mixed forests in which beech is an edicator and an important species for cultivation are the most economically important forests in the Republic of Srpska. In addition to the production function, they have an increasing ecological (protection of soil from erosive processes, sequestration of carbon dioxide, preservation sources drinks water and etc.) and social (tourist-recreational, health, etc.) function. Forests fulfil these functions in a better way if they are structurally diverse and have a mixed composition with autochthonous conifers such as fir and spruce. The presence of noble deciduous trees in them increases their ecological value, ambient importance and biodiversity. Depending on the area and locality, priority functions can be the following:

1. Production of wood
2. Production of food and medicinal herbs

3. Breeding and hunting of game
4. Production of secondary products
5. Protection of soil
6. Water management
7. Climate function
8. Recreational – health
9. Defensive – protection
10. Nature protection and spatial development
11. Educational

5. ECONOMIC ASPECTS

Beech forests represent widespread forest communities, which are of great importance in the production of technical wood and firewood. The heterogeneity of the habitat and stand (structural) conditions that arose as a consequence of the current way of management led to the emergence of very different breeding situations (breeding groups). For them, it is necessary to define clear breeding goals (general and staged) and breeding measures to achieve them. In order to improve the economic value, care measures that influence the improvement of quality and thus increase the economic value and the effects of management are very important. Depending on the growing situation, it is necessary to select and mark an adequate number of the best quality trees, which need long-term attention in the form of timely and by intensity adequate care measures in order to ensure the necessary crown growth and intensify thickness increase. Appropriate treatment, based on the growth in height of the dominant trees and adequately developed canopy, within the framework of adequate length production process, prevents the occurrence of red heart, which reduces the value of wood assortments. The percentage of the mixture of fir and certain deciduous trees (noble deciduous trees, oak) should be increased in habitats that enable the creation of mixed stands of deciduous and coniferous trees with beech. The support of conifers should be in groups (nests) with a diameter of 10-30 meters, and for deciduous trees of 20-30 meters, in order to cope with the strong competitive power of beech. The target diameter for the selected trees of the future, depending on the quality of the habitat (quality), can be 50, 60 or 70 cm. With timely and adequate spacing according to the intensity of the impact, established on clearly defined and marked trees of the future, significantly increases the value of wood volume that remains in the form of future trees at the end of the production process. Beech, fir and spruce forests, as well as forests with noble hardwoods, can be identified as the most economically valuable.

6 LONG-TERM TARGET STRUCTURE AND COMPOSITION

Tall beech forests occur in smaller groups of all developmental stages, often vertically structured in small complexes of single-season stands or much more often, within a larger number of widespread complexes of multi-season forests. In a mixture with conifers, they usually build a group-like or stem-like structure. Given that the implementation of management plans is related to management classes, i.e. ecological vegetation classes and production traits of high beech forests, the target composition is defined depending on production potential or quality. The long-term breeding goal is the production of 60 to 80 (of poorer quality 80-100; 100-120) of the best quality trees above 60 cm (on poorer quality 50 cm and 40 cm) per hectare.

Table 2 . Morphological characteristics of trees in beech stands of “ideal structure”

Morphological mark	Natural young trees				Middle age	Ripening
Age trees (year)	10	15	20	25	35	88
Upper height (h)	3-3.5 _	3.5-4 _	5-6 _	7-8 _	12-13 _	28.4
Degree of slenderness (h/d)	232	198	189	155	140	71
Relative crown length (l/h)	0.58	0.59	0.55	0.50	0.50	0.55
Shape crowns (l/w)	2.60	2.76	2.37	2.30	2.13	2.00
Degree of crown spread (b/h)	0.22	0.21	0.23	0.22	0.23	0.28
Share of crown light (l_o/l)	0.49	0.44	0.48	0.49	0.40	0.38
Degree of crown expansion (b/d)	51	42	44	34	33	15

Table 3. Basic elements of the target composition within the regional community of high mountain beech forests**REGIONAL COMMUNITY OF HIGH MOUNTAIN BEACH FOREST**

Geological substrate	Type of soil	Potential	Goal	Management system
HIGH MOUNTAIN BEECH FORESTS				
Limestones	Ilimerised, loamy and clay soils	The best habitat conditions for beech, the best quality for beech in particular on deep soils	High quality beech with noble deciduous trees and fir	Group system
Limestones	Brown, loamy and clay soils	Good habitat conditions but a relatively low yield because of anthropogenic use	Beech tree with spruce and fir and with noble hardwoods and fir	Group-selective system
Limestone and dolomite	Limestone chernozem rendzinas	Poorer habitat conditions	Conversion into mixed stands with spruce and fir on limestones and pines on dolomites	Group-selective system
Alluvium	Deep slope pseudogley	Good habitat conditions, low productivity, overripe stands, the smallest increment of all beech stands	Conversion into mixed beech and white pine stands with spruce and fir on limestone and pines on dolomites	Group
Silicate rocks	On ilimerised soils deep acidic brown soils	Good habitat conditions, good natural restoration, poor stock quality	Conversion into mixed stands of beech and fir (white pine)	Group-selective
Sandstones, clay and corneas	Shallow and acidic brown soils	The poorest habitat conditions, low productivity	Conversion in mixed stands of beech and fir (white pine)	Group-selective
Basic eruptive rock	On glands	Good habitat conditions, low productivity	Objective: conversion to mixed stands of beech and noble hardwoods	Group-selective

HIGH MOUNTAIN BEECH AND COMMON HORNBEAM FORESTS

Clean limestones	Ilimerised deep and loamy clay	The best habitat conditions	Conversion into mixed stands of beech and white pine and larch with fir	Group and group-selective
Silicate rocks	Deep slope pseudogley and ilimerised deep soils	Good habitat conditions	Conversion into mixed stands of beech trees and white pine and larch with fir	Group
	Acidic brown deep soils	Good habitat conditions	Conversion into mixed stands of beech with noble deciduous trees and white pine and larch with fir	Group

HIGH MOUNTAIN BEECH AND OAK FORESTS

	Acidic brown deep soils	Good habitat conditions	Conversion into mixed stands of beech, oak and white pine	Group one-time smaller groups but with beech tree on the lower floor
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HIGH MOUNTAIN BEECH AND HOPHORNBEAM FORESTS

Limestone	Chernozem	Very poor habitat conditions	Conversion into black pine forests but also with beech	Group-selective
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According to Instructions for Forests Management in Serbia, basic parameters for defining targets the structures of tall mixed beech forest are presented in Table 4.

Table 4. Basic parameters for defining targets structures for high mixed beech forests

Parameters	The most productive habitats	Good productivity	Mediocre productivity
Target diameter (beech: coniferous: deciduous), (cm)	> 60-70-60	> 50-60-50	> 40-50-40
Distance in between trees of the future (m)	> 12-14	> 10-12	> 8-10
Number of trees (N/ha)	> 60-80	> 80-100	> 100-120
Production period (year)	110 up to 130	110 up to 130	110 up to 130
General renewal period (year)	20 to 40	20 to 40	20 to 40
Height dominant trees when setting SB (m)	17-25 _	14-17 _	14-17 _
Length of trunks without branches (m)	8-10 _	6-8 _	6-8 _

7. MANAGEMENT SYSTEMS IN HIGH MOUNTAIN BEECH FORESTS

The management system includes all biotechnical (biological, cultivation, development, economic, technical and technological) measures that are applied in the planning, execution and control of forest management, for the ultimate purpose of fulfilling the goals of forest management, including the most efficient and complete satisfaction of social needs for products and general beneficial effects of forests, without questioning the survival of forests, i.e. ensuring their optimal and permanent functioning as an ecosystem. In one forest management class, one management system is applied. One management class entails a set of stands with similar ecological production and development characteristics for which a single goal of management is planned, which means, among other things, that one management system is applied. The main characteristic of some management systems is internal spatial building of stands, which includes the specific spatial arrangement of stand parts (group, line, floor, form of assembly, storage, network of primary and secondary openings, etc.), with the aim of creating the most favourable conditions for the most efficient achievement of forest management goals.

Fertilisation cutting

With several cuts we remove the old (native) trees on the surface which we rejuvenate. First, we cut down a part of the old trees, in order to create conditions for fruiting and the emergence of a new generation of trees. By gradual removal, in several cuts, we gradually release newly formed young trees on the surface. The dynamics of release depends on the biological characteristics of individual tree species. The period from the beginning to the end of the removal of old parent trees we call the juvenile period. Fertilisation felling has the character of cutting for use and renewal, and it can take place simultaneously on small areas in groups, or large, when it includes the entire stand – section. In the conditions of clear differentiation of cultivation situations and separation of groups, the application of fertilisation felling within the system of management of high beech forests is based on strengthening the biological stability of forests. There is a need for strict spatial order (spatial planning), which requires modern forestry planning. Restoration begins when trees reach their target diameter, where gradually and on several occasions all trees that have reached the target diameter are used. When removing the last group of trees that have reached their target diameter, the remaining trees of smaller dimensions are also removed. In a mixture with conifers (fir, spruce), conifer trees that have reached target diameters are removed first, and then beech is managed until the target diameters begin to appear. At the end of the planned production period, when preparations for natural renewal (preparatory cutting) are initiated, about 300-350 trees per hectare are required, which enables more abundant fruiting. According to the current experiences in France, parts of Germany, Austria and Slovenia, special tree management system is practiced and recommended (the term **tree** refers to trees of the future), whereby the number of trees of the future do not exceed 100 pcs/ha, according to some to the authors 50-80. Duration of juvenile and consumption periods depends on the speed of reaching the desired maturity diameter for cutting (most often 60 cm). The management of single-season stands by using fertilisation felling involves a relatively short period of generally juvenile time, lasting up to 20 years (within one age class for high forests with natural renewal). Renewal is performed by applying three fertilisation cuttings (preparatory, fertilisation and final cut), at intervals determined by the frequency of abundant and high-quality fruiting and the speed of development of the young. The highest quality stands on deeper soils and mesophilic habitats, i.e. with a favourable moisture regime, come into consideration. The terrains should be medium to little hilly and slightly to moderately steep, that is, they are mostly hill, submountain and mountain forests.

Preparatory fertilisation cutting is carried out several years before an abundant seed crop is expected. The purpose of felling is to prepare the trees and stands for successful fruiting and to prepare the soil for seed germination and growth. If the stands have been cared for in a timely manner and protected from strong winds, the preparatory cut can be omitted.

Marking: Damaged trees, trees of less valuable tree species, if there are no such trees, because they should have been removed by transparency cutting, then trees of bad phenotypic traits are taken. Bearing in mind that in practice the cultivation and technical classification is applied by marking, it is necessary for the preparatory cutting to mark trees of breeding and technical class III (possibly of coppice origin in high forests, bad phenotype, badly injured, diseased, rotten top, branched all the way to the ground, bent or twisted in the lower part of the tree, injured with more than 10 cm of horizontal injury, trees with frost cracks, broken, dry top and infected trees). In addition, trees with developed crowns and fruit-bearing trees are also removed, in order to bring as much light and heat as possible to the soil (preparation of the soil for natural restoration). This cut removes 20-30% of the existing wood volume. Logging is carried out during winter (winter logging comes in the period 01 October – 31 December and 01 January – 31 March).

Fertilisation cutting is carried out in the year of the full beech harvest, when most of the mature trees in the stand bear abundant fruit, i.e. when all the goals of the preparatory felling have been achieved in the stand. The period between the preparatory cut and the fertilisation cut is called the fertilisation period because during this time the trees fertilise the reproduction surface with their seeds. The main goal of performing a fertilisation cut is to reduce the number even more trees in stands seed security best conditions for germination, and for the development of youth). It is important to assess whether the majority of mature trees will produce abundant beech seeds after preparatory cutting based on the number of flower buds. A quick and easy way to determine the hardness of a seed is its cross-section (an indirect, physical method of cutting the grain).

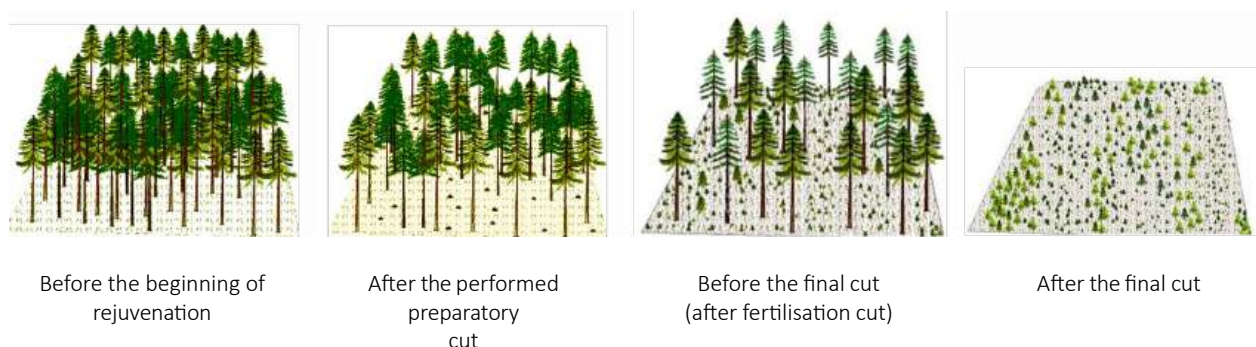
Marking: The goal is to break the stand assembly (incomplete assembly 0.5 to 0.6), heavily branched trees are marked, after felling the remaining trees should be evenly distributed. Only high-quality trees with regular crowns, which are resistant to wind blows, trees that can subsequently inseminate the reproductive surface if necessary, and trees that are less threatened by bark inflammation are left. By keeping these trees until the final cut, we try to intensify and use the increase in volume to the maximum. The strength of the intervention is about 30 to 50% of the volume of the stand after preparatory cutting. No cut should be more than 150 m³/ha.

The fertilisation cut is carried out in the year of full seed harvest or one year after a good seed harvest due to beech's ability of subsequent germination. If the fertilisation of the reproductive surface fails, we resort to artificial rejuvenation under the canopy of the crowns of old trees. Younger growth, especially if it is clustered and dense, should not be removed.

The final fertilisation cut implies the removal of the remaining old trees from the undergrowth, when it is determined that the undergrowth is not in any danger from extreme air temperatures. Retention of old trees in a well-restored stand would be harmful because the young would bend and lose quality. The interval between the fertilisation and the final cut of beech depends on the speed and quality of the development of the sapling as well as the conditions of the habitat, and ranges from 5 to 10 years. In beech stands, the time of making the final cut is recommended when the sapling reaches a height of 1.0 m. Leaving old trees in order to use the increase in light is not desirable in beech, especially on close exposures due to the possibility of inflammation of the bark. If the secondary network is not optimal then all the earlier forestry works are endangered and can become unsuccessful. In order to protect the young, the final cut and extraction of wood mass obtained should, as a rule, be

carried out during winter, when the sapling is protected by snow.

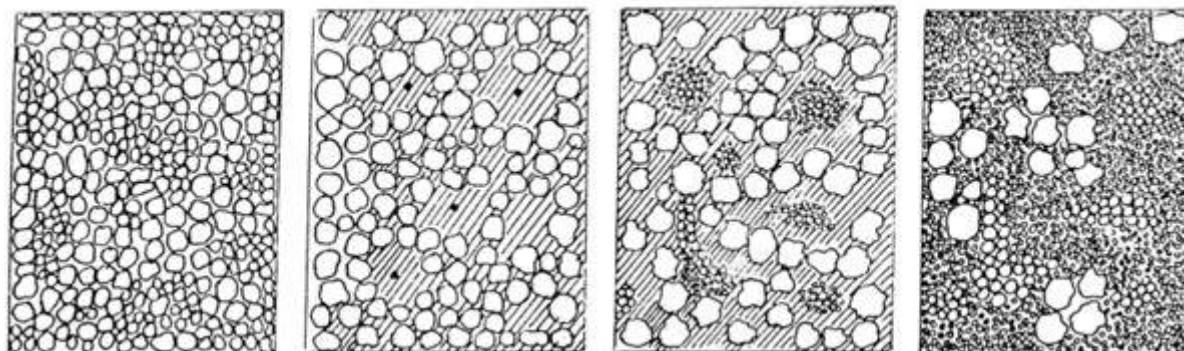
Follow-up fertilisation cut is usually carried out between the fertilisation and the final cut in case when the expected effects of the renewal of the stand have not been achieved. If only one subsequent cut is performed during fertilisation cutting, it is performed 2 to 3 years after performing the fertilisation cut, and if two are performed, then the second cut is also performed 2 to 3 years after the first follow-up cut. With this cut, half of the wood volume that remained in the stand after the fertilisation cut is usually marked. Selection of trees for the is carried out so that the phenotypically best and most valuable trees remain, which should be evenly distributed on the cut area.



Scheme 1. Phases of fertilisation cutting in the process of stand (or group in the stand) rejuvenation

Group management system

Group felling implies restoration stands on small surfaces (per groups, Femmelschlag), on which clear and fertilisation cuttings are combined. The duration of the rejuvenation of all groups (the entire stand) is called the general rejuvenation period, and the duration of the rejuvenation of one series of groups is called the special rejuvenation period. By applying this management system, stands are formed with gradual composition, and which, looking at the thickness and height structures, form a conversion between multi-seasonal and single-seasonal stands. The restoration of stands is carried out in groups, which are distributed around the stand in a certain way, depending on the way of management. The areas of individual groups reach up to 0.5 hectares. Rejuvenation of groups is natural, performed by fertilisation (preparatory and final) or edge cutting. The period of rejuvenation of certain groups (especially the juvenile period) is short (usually 1 to 3 years), and the period of rejuvenation of the entire stand (general rejuvenation period) is significantly longer, 30 to 60 years, but much shorter than the production period. If this period is shorter (around 30 years), stands according to their structure look more like single-age stands, particularly before the end of the production period, and if the general rejuvenation period is longer (around 60-80 years), the stands look more like multi-ages ones in terms of their structure.



Consistency at the time of
maturation

Renewal begins at
the age from $u - m/2$ yr., by
formation of young
core (u – fertilisation; m –
general rejuvenation period)

Young cores grow gradually wider and connect, crossing from
younger to older developmental phases until the last tree of the
old stand is removed and

Scheme 2. Management system of group cuttings

The sizes of individual groups are very different (which depends on the composition and structural development of the stand) and they move, under B&H conditions, from around 0.05 to 2 and more hectares. The formed groups are then classified into as many series, as many operations the stand will be renewed during the selected general rejuvenation period. If, for example, the general rejuvenation period is 40 years and the cutting round (development period) is 10 years, the formed groups are classified into 4 series of approximately equal areas. In the first round, the groups of the first series (closer to the transport borders, i.e. further away from the tractor trails. In the next round, the second group series are renewed, in the third round the third group series and in the fourth round the fourth group series (closest to the tractor trails and farther from the transport borders). The management system of group felling in certain categories of forests in Bosnia and Herzegovina was proposed by Matić V., Pintarić K. and Drinić P. (1969). Proponents of the group felling management system envisioned its application in high beech forests with very good habitat conditions (I and II quality rating) as well as in those forests that will be created by the conversion of coppice beech forests and thickets that are in very good habitat conditions. Tall beech forests of medium and poor habitat conditions should be gradually transformed into mixed forests of fir, spruce and beech with a group structure by tree species. In this way, the yield of these forests will increase by increasing the growth and its value. The ratio of conifers and broad-leaved trees to be aimed for in these habitats should be 60% of conifers and 40% of broad-leaved trees. The main reasons to propose the application of the group felling management system are:

- Satisfy biological needs of beech regarding growth and renewal, avoiding risks which occur by applying a management system in which felling and restoration are carried out on large areas
- Increase yield values and amounts
- Enable more application of mechanisation
- Form stands more resistant on harmful actions of biotic and abiotic factors

Group-selective system

Group-selective system is a management system combination for group cuttings. By applying this management system multi-seasonal, most commonly mixed stands are formed. As a rule, regeneration of stands is combined (natural and artificial) and is not time limited. Artificial regeneration (planting seedlings) is used to complete natural regeneration in the parts of the stand where natural renewal has not succeeded. The bottom line of the system is that all stands of one economic class, during the management period (cutting cycle), felling is carried out with the function of restoration and use on groups, and felling in the function of care and use outside groups. Groups are primarily formed in places where the existing inventory does not satisfactorily use the production potential of the habitat. These are parts (parts of the stand surface) with scarce and bad trees or with no trees at all, parts where old, as a rule, thick trees predominate, i.e. where it is too late for renovation, two-level parts, if the lower part is dense enough, and should be freed. Groups are also formed in parts of the stand where there are mature, high-value trees, which we want to use for wood and restore that part of the stand. We form groups for this reason, if the state of the stand is relatively good, where for the former reasons (where the production potential of the habitat is not used satisfactorily), no groups were formed, or they were formed, but their total area is relatively small. The average size of the group ranges from about 0.3 ha in favourable conditions to about 0.8 ha in unfavourable conditions, considering the configuration of the terrain and the conditions of the stand. With this management system, there is no production period significance when defining the technical goal of management, because neither its beginning nor its end for the stand as a whole can be defined (rejuvenation is a continuous process). If the cutting cycle is 10, 15 or 20 years, and the assumed production period of the groups is 100 years, then the total area of all groups established in the farming class in one cycle should be 10/100, 15/100, 20/100 of the area of the entire management class. This amounts to 10%, 15% and 20% of the area of management class. On the groups where there are conditions for natural regeneration, entirely or in a large part, fertilisation felling, or some stages of fertilising felling, are carried out. Most often, this is the final cut of the fertilisation felling, which frees the already established young layer or the well-developed undergrowth (the final cut of the fertile felling in groups), or the preparatory cut if there are conditions for natural renewal, and the undergrowth did not appear due to too dense a structure (preparatory cut of the fertilisation felling on the group), or fertile felling if the fellings are carried out in the year of full seed harvest (fertilisation cut of fertilisation felling on the group). Various types of so-called edge cuttings are also possible on the group, when it comes to rejuvenated cores that need to be expanded and conditions created for the natural renewal of larger groups. In groups where there are no young trees, nor is it expected that they will appear in a timely manner, all trees are marked and cut down (bare felling on the group). After felling, such groups are reforested with high-quality saplings of the appropriate tree species (completion of restoration). Therefore, different types of renewal fellings are carried out in the same stand on individual groups, depending on the condition of each group, considering the conditions of its renewal. Outside of the groups, treated in one round of felling, on the remaining part of the surface of each stand in the management class, thinning must be carried out in the same round according to the principle of positive selection. Intensity of these thinnings depends on the condition of the part of the stand where the thinnings are planned. In principle, only those trees that hinder the development of better trees are removed, as well as trees that do not have any function anymore, and the entity that manages the forest is interested in using them. In the part of the stand that is thinned out, young are not taken into account in the given round.

8. MANAGEMENT TREATMENT STRATEGY

Breeding treatment – general guidelines

Breeding treatment or management system, in addition to the type of forest can also be determined on the basis of habitat conditions, i.e. the quality and height zoning.

Table 5. Management System depending on habitat conditions and stand structures

Habitats conditions	Structural shape	Management system
In better habitats (I and II quality rating)	Two-story stands	Fertilisation cutting on large surfaces
	Irregular selective	Group management system
In medium and poorer habitats, humid climate, over 500 m a.s.l. (III and IV quality rating)	Two-story stands	Fertilisation cutting on large surfaces
	Irregular selective	Group-selective management system
On medium and poorer habitats, humid climate, below 500 m a.s.l. (III and IV quality rating)	Two-story stands	Fertilisation cuttings on large surfaces
	Incorrectly selective	Group management system
On medium and poorer habitats, xerothermic climate (III and IV quality rating)	Two-story stands	Fertilisation cutting on large surfaces
	Irregular selective	Group management system

Renewal felling method is determined by the structure and the texture of the stand:

- Management of single-season stands on larger or smaller areas – clear and fertilisation cuttings of general rejuvenation period up to 20 years
- Management of transitional stands, between single-season and selective, or multi-season forests – group system, various forms of Femmelschlag, fertilisation cuttings of long general rejuvenation period of over 20 years, or almost all combined methods
- Management in selective forests of stable or cluster form – selective felling (not a good way in practice due to the bioecology of beech)

Within the framework of the realisation of the management system, in addition to the renewal cuttings, it is necessary, depending on the cultivation situation, to carry out care measures. Homogeneous breeding groups can be distinguished that characterise the breeding situation and, accordingly, the appropriate breeding goal (usually staged) and clear breeding measures to achieve the goal. In this sense, development stages can be used to define breeding situations:

- **Young stand** (stand which consists of plants several years old until the dominant stalks reach 180 cm) – breeding measure illumination of young trees.
- **Early sampling** (starts from the time when the dominant floor trees reach the height of 180 cm and until the time when they reach a thickness at chest height of 7 cm) – breeding measure clearing.
- **Lath** (the beginning of this phase is considered when the chest diameter of the tree of the upper floor reaches 7 cm, and the end when it reaches 20 cm) Trees with a chest diameter of 7-10 cm

(thinner lath), and 11-20 cm (thick lath) – breeding measure thinning. At that stage, the dominant trees are the most productive in the habitats have reached a height of 17 m to 25 m and have a trunk clear of branches of 8 m to 10 m (dominant trees in the habitats of good productivity and medium productivity reach heights of 14-17 m and have a trunk clear of branches 6-8 m).

- **Adult stand** (stand age is higher by half of its rotation, height growth after the culmination starts to decrease suddenly, and reaches its culmination in terms of thickness) – breeding measure volume tending.
- **Mature stand** (most trees in the stand are capable of fruiting) – breeding measure natural renewal

Treatments per breeding situations

Considering the breeding situation (condition) of stands or individual parts of them, it is necessary to carry out breeding measures to restore or care for stands. The restoration of tall beech stands aims at the natural regeneration of stands with a sufficient number of high-quality saplings. Due to its pronounced heliotropy, beech saplings should have even lateral shading in order to intensify height growth.

Table 6. Elements for the assessment of rejuvenation and renewal of stands

Class	Rejuvenation assessment	Surface renewal characteristics
I	Good	Saplings occupy 75-100% of the surface, it is evenly distributed with over 10,000 pcs per hectare
II	Satisfying	Saplings occupy 50-75% of the surface, distributed evenly or in groups, with 5,000-10,000 pcs per hectare
III	Unsatisfactory	Saplings are located on 25-50 % of the surface, distributed evenly or in groups, with 3,000-4,000 pcs per hectare
IV	Bad	Saplings occupy 25-50 % of the surface, distributed unevenly, with 500-2,000 pcs per hectare
V	Very bad	Saplings occupy 15-25% of the surface unevenly distributed, with under 400 pcs per hectare
VI	None	There are no saplings or they appear in groups which occupy under 15% of the surface, with under 300 pcs by hectare

For successful natural renewal, depending on the situation found, the following may be applied:

- In single-age stands – fertilisation cutting
- In multi-age stands – group system, various forms of Femmelschlag and fertilisation felling of a long rejuvenation period (20-40 years), i.e. all methods combined
- In stands close to the selective structure with the presence of fir, trunk or group selective felling

9. CARE OF HIGH BEECH STANDS

The aim of the cultivation of stands is the selection and care of 60 to 80 (for poorer quality >80-100, >100-120) trees of the future of the target diameter per hectare, with a trunk of 8-10 m (for poorer quality 6-8m) clear of branches, with sufficiently developed crowns, which enables the production of high-quality technical wood of large dimensions, in the shortest possible period of time. Beech must grow in groups when young, because if it grows without lateral competition from neighbouring trees, it tends to form very branched trees of poor quality. A young beech stand in the early and late sapling phase should be kept at a high density, with strong mutual competition in order to best clean the beech trees of the lower branches and achieve the desired dimensions of the trunk free of branches.

Breeding situations

Breeding situation A1. Mature and maturing stands without undergrowth, preserved composition in which rejuvenation has not started, of satisfactory volume and growth close to or even greater than optimal. It is necessary to carry out fertilisation felling, marking in the first phase is done according to the principles of preparatory cut for fertilisation felling. This is the phase when natural renewal of the stand begins, when it is necessary to create conditions for natural renewal. The general rejuvenation period can be over 20 years (up to 50). The removal of trees should be tied to the seed germination, and if later in the process of restoration, smaller areas (groups, clearings) appear that have not been naturally restored, it is necessary to ensure on these surfaces (by introducing or naturally) the young of other species in beech stands (mountain maple, white ash, wild cherry, sessile oak, Hungarian oak, fir, spruce). The first measures involve the removal of trees which have reached the target diameter (40 to 60 cm depending on the conditions of the habitat, quality) and trees of poorer quality (III cultivation technical class) while monitoring the appearance of "kerns" depending on growth dynamics and age and accordingly correcting (increasing or reducing) target diameters, ensuring the natural rejuvenation of beech and other species in beech stands (mountain maple, white ash, wild cherry, sessile oak, fir, spruce), maximally reduce damages on saplings when performing renewal cuttings. Long-term breeding measures are based on various forms of Femmelschlag, protecting the understorey trees from damage during felling, removing damaged saplings and trees from the understorey immediately after felling (sapling care) and on parts of the stand where restoration has not completely succeeded (no saplings in sufficient numbers or damaged saplings), perform filling by groups of conifers (minimum group 0.1 ha, fir, spruce) and deciduous trees (minimum group 0.2 ha, maple, white ash, wild cherry, oak).

Breeding situation A2. Mature thinned stands without young trees or it is rare individual in smaller groups insufficient for the formation of future stand. Fellings were carried out earlier in the stand, which interrupted the composition, but it can be formed again, with rejuvenation that has actually started, but due to various reasons, natural renewal has not occurred. Volume and growth are reduced compared to the optimal amount. Remittance with marginal expansion of rejuvenation cores according to the principles of fertilisation cuttings. If we are dealing with strong beech habitats, where beech is biologically the strongest and where it will not mix with conifers in the years of beech harvest, it is necessary to prepare the soil for natural renewal in the core so that there is an occurrence of natural regeneration of beech from seed. In all other beech fields, conifers should be planted in places along with beech, first of all fir and then spruce. There is an effort to create group-like mixtures of beech and fir with spruce.

Breeding situation A3. Young stands in the stage of saplings and thickets with the remaining trees of the old stand (old seed-bearing trees). Stands in which previous felling ensured natural renewal,

young stand is of good quality, structure and vegetation, capable of forming a future stand. Care measures (illumination) are intensified with the goal to create conditions for undisturbed growth of beech trees in height, which makes this type of tree taller than the herbaceous vegetation, which in this phase, depending on the composition, can be threatening competition. The main goal is the removal of undergrowth, which endangers young stands and dense structure, so that the trees could naturally be cleared of lower branches. Negative selection is carried out and support provided to, in addition to beech trees, other desirable species of conifers and deciduous trees. Another goal is to regulate the composition of the stand, remove damaged, diseased and phenotypically poor individuals and undergrowth, and regulate the density and spatial distribution of trees and the introduction of pioneer fast-growing species. In young beech stands with residual seed-bearing trees, trees of larger dimensions need stronger interventions in the upper layer of residual seed-bearing trees, by choosing trees of the largest dimensions that most interfere with the development of the lower layer, removing trees of the largest dimensions and only those without sprouts, which should be taken into account that their extraction will predetermine the future core for forming groups. Time felling is at the height of 1-2 m of the saplings, which is about 10-15 years of age, and cultivation works include removal mature trees and negative ("mass") selection, removal of undergrowth or overly dominant trees (taller than a man) from the upper storey, and in the lower storey damaged and sick individuals, whereas the strength of the intervention must be about 10-15% according to the number of trees, in places where there is no natural youth, form groups with different types of trees (maple, ash, cherry, sessile oak, Hungarian oak, fir, spruce) at a surface of one acre, completing rejuvenation by introducing deciduous and coniferous trees to enrich the groups (minimum group circumference of 10 m for coniferous and 20 m for deciduous trees). In order to complete natural restoration, sciofita can be planted, under the assembly and in smaller groups with diameter greater than 10 m, and planting species that tolerate shade less, is done in groups with over 20 m in diameter.



Image 2. Mature successfully restored beech stand with residual seed-bearing trees – Dubička Gora (Photo Opačić, S. 2012)

Breeding situation A4. Two-storied stands with a well-developed understorey (early sampling) and delayed interventions in the upper storey of the stand (overmature trees), usually lack the final cut. It is necessary to remove the trees of the upper storey and carry out selective thinning choosing trees of the future.



Image 3. Two-storied beech stand with residual overmature trees in the upper storey – Dubička Gora, Section 105 (Photo Govedar Z., 2010)

Breeding situation A5. Medium-aged to maturing stands (from young pole to maturing stands) well compacted and of the same age, usually without residual seed-bearing trees. They were created after earlier fertilisation fellings, same age in terms of thickness and height structure. In these stands, one can find individual residual trees of the former undergrowth (due to the absence of care measures) and rarely with individual “seed-bearing trees”. It is the mid-term development phase in which the trees of the future are selected and marked.



Image 4. Middle-aged beech stand after thinning with selected trees of the future

In that phase, the dominant trees in the most productive habitats have reached a height of 17 m to 25 m and have a trunk clear of branches from 8 m to 10 m (dominant trees in habitats of good and moderate productivity reach a height of 14-17 m and have a trunk clear of branches 6-8 m). In this phase, it is necessary to carry out thinning of larger scope, with the aim of removing all competitors of the trees of the future. In principle, it is carried out by felling those trees that hinder the development of neighbouring better-quality trees, according to the principle of positive selection of trees. Primarily, we are talking about thinning cuttings when it comes to ways of caring for single-age stands. Depending on the production goal (which size and quality of trees we want at the end of the production period, and which species these are), we apply different methods of stand thinning. This means that these thinnings are for the purposes of care felling and use of stands. Some felling can be called thinning even within multi-age stands if it is carried out in groups, i.e. if the mixture of multi-age stands is extremely group-like. The minimum distance between future trees depends on the number of selected future trees and amounts to 12 m to 14 m (where the quality is lower, 10-12 m or 8-10 m). In the initial phase of middle-aged stands, as a rule, 3 to 5 strongest competitors of future trees are removed. Particular attention is paid to the degree of slenderness of the trees. If the degree of slenderness is high, then a maximum of 3 trees are removed, and if it is less than 100, then a maximum of 5 trees are removed. The critical degree of slenderness of young beech stands ranges between 180 and 220. The degree (coefficient) of slenderness at the height of dominant trees of 3-4 m must be below 200, in a middle-aged stand slightly above 100 and later below 100. The relative length of the crown in the young and early sapling stage must be about 0.6, that is, the crown must cover 60% of the tree's height, and later about 50%.

Breeding situation A6. The maturing stand is well assembled and of a single-age with clearly visible and well-developed trees of the future, which dominate over other trees. The intensity of cutting in this phase is reduced to the removal of 1 competitor tree per tree of the future.



Image 5. Clean maintained single-age beech stand in maturing phase without saplings

Breeding situation A7. Degraded stands in poorer habitats, mostly of protective character. The state of these stands is conditioned by poor habitat (shallow skeletal soil on steep sides or ridges), in which there is no interest in economic use. These are often medium-sized stands with trees of generative and vegetative origin at the same time. Tree selection is carried out with an emphasis on the sanitary and hygienic function of tree marking. The breeding goal is to improve the development of tree crowns in order to maintain the growth in thickness at the desired level and to improve the quality of the existing volume. Breeding measure to achieve these goals is the care of the stand by removing the main competitors with the trees of the future (at least 1 competitor) in the next one to two planting periods, with the scope of felling from 60 to 80% of overgrowth, removing damaged and the sick trees in order to improve the quality and vitality of the stand.



Image 6. Degraded beech stand

Breeding situation A8. Young stands of a complete assembly of preserved habitat with a tendency in the lower storey of mixed conifers and broad-leaved trees. It is necessary to carry out thinning of lower intensity in the lower storey of the stand. The breeding goal is the preservation and improvement of the health condition, the selection of future trees in mixed species (conifers, maple, ash, cherry), the preservation of a dense structure in order to better clean the potential trees of the future from lower branches, the regulation/preservation and support for the mix with other tree species, regulation of the mixture through the preservation of groups (conifers, maples, ash, cherry, oak), preservation and improvement of the state of health. Cultivation measures include cleaning measures with an impact scope of 10 to 20% from the overgrowth. In tall beech forests of secondary character, it is important from a breeding point of view to support conifers (fir and spruce). In this case, the breeding goal is to select 120-150/ha of trees of the future, distance between trees of the future 8 to 10 m, removal of 4 to 2 competing trees that have the highest vitality in relation to each tree of the future, carry out branch pruning of coniferous trees of the future to a height of 6-8 m.



Image 7. Middle-age beech stand of secondary character with fir under seed (Japra Budimlić)

10. NATURA 2000 AND BIODIVERSITY ISSUES

This issue will be elaborated in more detail during the implementation of the Natura 2000 in the forestry sector of in the Republic of Srpska. In relation to the issue of biodiversity, the following elements should be considered:

- Promote hollow trees to increase biological diversity preservation
- Keep dead trees in the stand
- Promote and protect rare and threatened species
- Protect nesting trees from logging

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1.8. Concept of guidelines for forest management on the example of one forest management type/ tree species – Serbia: High Mixed Beech Forests

Prof. Nenad Petrovic

GUIDELINES FOR MANAGEMENT OF HIGH MIXED BEECH FORESTS

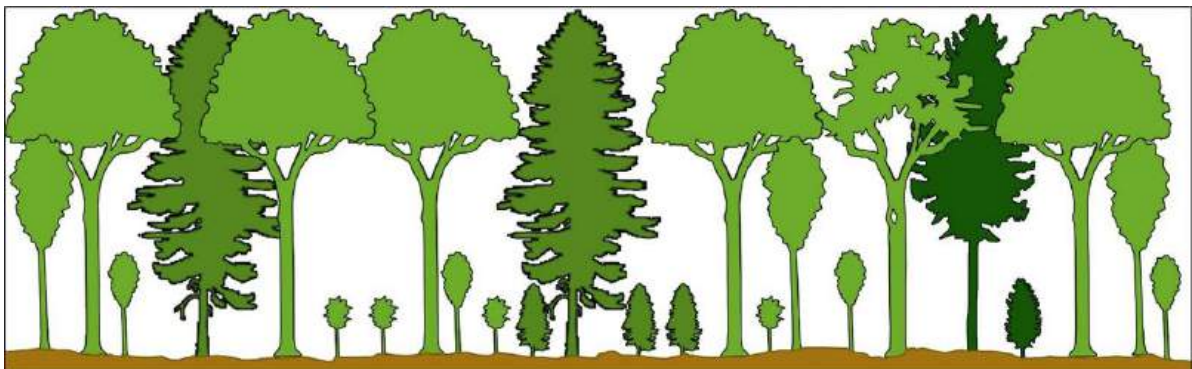
Management type (MT 21110): High mixed beech forests

Area: about 350,000 ha

1. General characteristics of the management type

Within high beech forests high quality stands can be found, substantially pure or in a particular mixture with fir, broadleaf species (sessile oak and different precious broadleaves, like maple, ash, elm, Norway maple, etc.). Stands have a wide vertical and horizontal distribution, from the lowest altitudes (70 m a.s.l. and even lower) up to the border of forest vegetation (above 1500-1600 m a.s.l.).

The basic characteristics of these forests, and at the same time the causes of reduced utilisation of site potential are rarefaction, weediness, slow and uncompleted process of natural regeneration, unfavourable structure (especially the quality, age and diameter structure), inhomogeneous origin, unfavourable mixture, disturbed health condition, unsatisfactory quality of forest infrastructure (low access with forest roads), etc. Even-aged forests occupy the greater part of high forests, compared to uneven-aged forests. A part of high beech forests is characterised by a selection structure or structure which is close-to-selection structure, with fir or fir and spruce. This management type includes the following **category** of forests: high even-aged and high uneven-aged beech forests.



2. Current situation

2.1 Distribution/area

Beech forests occupy a wide altitude zone, from the lowest altitudes to the highest mountain peaks (Željin, Stara Planina, etc.), as the final zone of forest vegetation. Beech in the lower altitude belts (500-600 m) creates stands of the submountainous belt with sessile oak or other broadleaved species, and on the northern colder expositions, pure stands as well. From 500 m to 900 m a.s.l., beech forests are climatogenic and beech is the dominant tree species. In the zone from 800 m to 1200 m a.s.l., beech creates pure or mixed stands, with fir or fir and spruce, forming even-aged, uneven-aged or group-selection stands, of high productivity and great economic value. In the subalpine zone above 1,200 m a.s.l. beech creates pure stands, in habitats with lower production potential and which, with increasing altitude, are characterised by a declining quality of produced wood. In general, predominantly beech creates pure stands with a small proportion of other tree species in the hilly and mountainous zone, formed as a result, above all, of its great competitiveness.

Regional distribution: Beech stands occupy all areas in Serbia, except for the area of lowland part of Vojvodina. The largest complexes of pure beech forests are located in eastern Serbia (Severni and Južni Kučaj, Jablanica, Timok, Rasina, and Južna Morava forest districts). In western Serbia, the Podrinje-Kolubara forest district has the largest area under beech forests. The largest area of mixed forests of beech and fir, and beech, fir and spruce are found on the mountains Goč, Tara, Golija, and Zlatar.

Climate: In the beech forest belt, the climate is from subhumid to humid (at lower altitudes) to per-humid (at high altitudes). Beech is very well adapted to the climate of mountainous regions, with an average annual temperature of 6-10°C, and an average temperature during the vegetation season of 13 to 17°C. The amount of precipitation below 300 mm during the vegetation period is not suitable for adequate growth of beech, reflecting on its assimilation ability and thus on the weakening of the competitive potential in relation to other tree species. Higher air temperature is conducive for beech in relation to fir and spruce.

Soils: Beech grows on alkaline, acidic, dry to fresh rendzina, humus carbonate or brown soils derived from limestone or dolomite. In principle, beech has a wide distribution in relation to the characteristics of the soil, and fresh and deep soils are the most appropriate. It does not tolerate dry soils and soils with high groundwater levels. Beech is not particularly demanding in terms of the appropriate content of nutrients in the soil.

3. History of forest management planning

In the past, beech forests were mainly virgin forests, and the beginning of their utilisation is most frequently related to the conversion of forest into agricultural land in lower areas, while in mountainous areas, the utilisation of beech forests is associated with the “pre-selection” management model, or the utilisation of timber in accordance with pre-defined products. The most common purpose of use of beech wood in this period was the use as firewood and for charcoal. Better quality trees with specific dimensions were used for the production of railway sleepers and quality sawn wood. Utilisation of beech virgin forests was carried out on accessible terrains, while beech forests on rugged terrain retained, to a certain extent, virgin forest characteristics. Felling types in the form of pre-selection can be characterised as very extensive management, which resulted in the creation of two-layer stands, where in the upper layer worse trees of the first layer remained, and in the lower layer a new generation of future beech stand emerged. The new stand is mainly with untended saplings and

young/old poles with a large number of pre-growth with lots of branches, not homogeneous in origin and of poor quality. Beech trees of better quality are removed before. The remaining trees are often too old and of poor quality with a large share of false heartwood.

After this period, the introduction of the shelterwood fellings occurs, with three or four cuts with a longer or shorter regeneration period (20 to 40 years), in order to mitigate the above-mentioned adverse effects of pre-selection fellings. For high beech forests, a rotation period of 120 years is introduced. In the period after the Second World War, there were concentrated clear cuts on large areas, and then a selective management system was briefly introduced. During the second half of the twentieth century, group management system was introduced, which defines the silvicultural groups according to homogeneity or silvicultural needs and not according to the size of the stand. Increment is one of the main indicators of the degree of utilisation and at the same time regulator of yield durability. Regeneration goes on in groups or depending on the development phase in which the particular silvicultural group is at the moment. The selective forest management system is used in various forest stands, with a defined felling diameter.

4. Environmental and production characteristics

Beech tends to form pure stands due to its pronounced competitive ability in relation to the basic growth factors (space for growth – light, nutrients, water, growth in the root system area), in comparison with other mixed tree species, except to a lesser extent with fir. Small groups of other broadleaves can be found primarily in the parts of habitats within beech stands or habitats that are more appropriate for species other than beech.

Mixed beech forests are extremely stable ecosystems. In the context of mixed beech stands, it is necessary to preserve and above all to actively protect species that are mixed, if one wants to improve biodiversity and enable the implementation of some of the most important principles of sustainable management. Different beech forests with precious broadleaves are of particular importance, which are recognised at European level as forests with the greatest diversity of tree species. Mixed forests of beech, fir and spruce, as well as beech and fir, and beech and spruce are of great production and ecological significance. Also, forests of beech and sessile oak are, from a production and ecological point of view, very valuable in our climate. Properly tended high beech stands in habitats with high production potential can have over 500 m³ of volume.

5. Forest functions

Pure and mixed forests of beech and other tree species play an important role on steep slopes for soil protection and water retention through interception, transpiration and infiltration. The following functions are especially important: (1) soil protection on steep slopes; (2) protection of settlements and infrastructure; (3) protection of water.

The function of soil protection is reduced in older development phases, when the increment of above-ground and underground mass has a tendency to develop a single-layer structure. Moreover, lack of mixture with other tree species reduces the effect of protection in comparison with the optimal mixed structure of beech forests with other conifers and broadleaved trees of this management type. Protection of soil from erosion and protection of water by beech stands is best provided in a mixture with coniferous tree species (fir, spruce, Douglas fir). Various forms of uneven-aged structure in the mixture with conifers provides a high level of interception (water retention), transpiration, in

particular in conifers, in the early spring months when broadleaves do not have formed leaves, as well as through infiltration or retention of water in the litter. Supporting of mixed stands of uneven-aged structure, with a favourable condition of the litter, provides a positive effect of this management type for the protection of soil from erosion, protection of infrastructure and protection of water, especially on steep slopes in mountain areas, as already mentioned.

6. Economic characteristics

Beech forests represent widespread forest communities which have great importance in the production of technical and firewood. In order to improve the economic value of this management type it is necessary to define (mark) an adequate number of potential crop trees which should be given to long-term care in the form of timely and by intensity moderate tending measures (lighting, cleaning, thinning) to ensure the adequate development of the crown, in order to intensify diameter increment. Adequate interventions based on height growth of dominant trees and adequately developed crowns, within the appropriate rotation periods, prevent the occurrence of false heartwood, the presence of which diminishes the value of wood assortments. The percentage of the mixture with fir, Douglas fir and other broadleaves (precious broadleaves, sessile oak) should be increased at the habitats which allow the creation of mixed stands of broadleaves and conifers with beech. Conifers should be supported in groups (nests) with a diameter of 20-30 meters, and for broadleaved trees 20-30 meters, in order to cope with the strong competition force of beech. The target diameter for selected potential crop trees (PCT), depending on the quality of the habitat, can be 50, 60 or 70 cm. Timely and by intensity adequate thinnings, based on clearly defined and marked potential crop trees, significantly increase the value of wood volume that remains in the form of potential crop trees at the end of the production process. Beech, fir and spruce forests as well as forests with various precious broadleaved trees can be identified as the most economically valuable.

7. Target long-term structure and composition

High beech forests often occur in small groups of all development phases, often vertically structured in small complexes of even-aged stands or more frequently in a higher number of more widespread complexes of uneven-aged forests. In the mixture with conifers they usually create groups of single-tree selection structure.

Regeneration begins when trees achieve target the diameter where all trees that have reached the target diameter are used gradually and repeatedly. During the removal of the last group that has reached the target diameter, the remaining trees of thinner dimensions are removed as well. In the mixture with conifers (fir, spruce, Douglas fir), conifer trees that have reached the target diameter are removed first, and then beech is further managed until the emerging of the trees with target diameter.

The long-term silvicultural goal in relation to mixture is defined as share of beech up to 70% and other tree species up to 30% (conifers, broadleaves).

The aim of tending of the stand is the selection and tending of 60 to 80 (in poorer habitats >80-100, >100-120) potential crop trees per hectare with branch-free trunk of 8-10 m (in poorer habitats 6-8m), with sufficiently developed crowns, which enables the production of high-quality technical wood of large dimensions, in the shortest possible time. In young phases, beech must be developed in groups, because if it grows without lateral competition from neighbouring trees, it tends to form very branchy trees of poor quality. Young beech stands in the phase of young pole and old pole should be

kept in high density, with strong competition among trees, so that beech trees are best cleaned from lower branches and achieve the desired dimensions of the branch-free trunk.

Table: 1.

Parameters ⁴	The most productive habitats	Habitats of good productivity	Habitats of medium productivity
Target diameter (beech:conifers:broadleaves), (cm)	>60-70-60	>50-60-50	>40-50-40
Distance between PCTs (m)	>12-14	>10-12	>8-10
Number of trees (N/ha)	>60-80	>80-100	>100-120
Production period (years)	110 to 130	110 to 130	110 to 130
Period needed for regeneration (years)	20 to 40	20 to 40	20 to 40
Height of dominant trees when selecting PCTs (m)	17-25	14-17	14-17
Length of branch free trunk (m)	8-10	6-8	6-8

8. Strategy of management treatments

8.1. Silvicultural treatment – general guidelines

GOAL: Production of 60 to 80 (on poorer habitats 80 to 100; 100 to 120) of the highest-quality trees above 60 cm (on poorer habitats 50 cm and 40 cm), per hectare in the shortest possible time.

Slightly steep terrain: Femmelschlag system (group shelterwood felling of the long regeneration period) (up to 0.5 ha) of the long regeneration period (20 to 40 years). In case if the conditions for natural regeneration are not optimal, it is necessary to apply additional measures for regeneration (soil preparation, additional sowing, weed removal, undergrowth removal etc.) of the longer regeneration period.

Medium steep terrain: the size of Femmelschlag (group) should be up to 0.3 ha.

In case the upper storey is of poor quality: shorten the length of the production process and reduce the target diameter. Accelerate the removal of low-quality trees and continue to support good-quality trees in the lower storey.

8.2. Treatment by development phases

GOAL: In relation to the quality of the habitat, to provide the optimal number of the best-quality trees of 60 to 80 (on poorer habitats 80-100; 100-120) of target diameter, at the end of the production process properly distributed over the surface (Table 1).



⁴ All the parameters listed here are only of an indicative and temporary character and should be the subject of further scientific and professional considerations.

Beech stand development phases are as follows:

- Sapling
- Young pole
- Old pole
- Middle-aged stand
- Maturing stand
- Mature stand

The primary goal in the first three development phases is to remove pre-growth, which endangers young stands, and support a dense canopy, in order to clean the trees from the lower branches naturally. Negative selection and support, in addition to beech, is carried out on other preferred species of conifers and broadleaves.

The middle-aged stand is the phase of selecting and marking potential crop trees. In this phase, the dominant trees in the most productive habitats have reached a height of 17m to 25m and have a branch-free trunk from 8 m to 10 m (dominant trees in habitats of good and medium productivity reach a height of 14-17 m and have a trunk clear of branches 6-8 m). In this phase, it is necessary to implement more intensive thinning in order to eliminate all competitors to potential crop trees. The minimum distance between potential crop trees depends on the number of selected potential crop trees and is from 12 m to 14 m (on poorer habitats 10-12 m; 8-10 m; Table 1). In the initial phase of middle-aged stands, 5 to 3 strongest competitors are removed from potential crop trees, as a rule.

The maturing stand is a phase of clearly visible and well-developed potential crop trees, which dominate other trees. The intensity of felling at this phase is reduced to the removal of 1 or 0.5 trees of the main competitors to potential crop trees.

Regeneration phase includes the beginning of the end of the production process when the removal of trees that have reached the target diameter and other trees of poor quality starts. Regeneration is carried out in 3 to 4 cuts, where parts of stands in which saplings are not present in a satisfactory number or quality are artificially planted with noble broadleaves or conifers (sycamore, white ash, wild cherry, sessile oak, Hungarian oak, fir, spruce, Douglas fir).

8.2.1. Sapling phase [H up to 3 m]

At this phase, sapling is the most numerous and dense. Tending measures (lighting) are intensified in order to create the conditions for smooth height growth of beech trees, whereby this tree species overgrows the green vegetation, which at this phase, depending on the composition, can significantly compete with the tree species.

Silvicultural goal:

- Preservation and improvement of health status
- Supporting the highest-quality sapling
- Supporting a dense canopy so that potential crop trees can be better cleaned from the lower branches
- Support the desired composition and mixture of species (sycamore, white ash, wild cherry, sessile oak, Hungarian oak, fir, spruce, Douglas fir)
- Removing pioneer fast-growing species (birch, aspen, goat willow)
- Regulation of origin

Measures to achieve the goals: tending of sapling – lighting

Silvicultural works:

- Additional establishment of the forest order
- Removal of weeds, pre-growth, damaged trees, pioneer trees
- In places where there is no natural sapling, form groups with different tree species (e.g. sycamore, white ash, wild cherry, sessile oak, Hungarian oak, fir, spruce, Douglas fir) at a minimum area of 100 m²
- Complete the sapling with the introduction of broadleaves and conifers to enrich groups (minimum diameter of the group of 10 m for conifers and 20 m for broadleaves)
- Planting of species that are susceptible to shade is carried out under the canopy and in smaller groups of diameters greater than 10 m
- Planting species that are less susceptible to shade is carried out in groups of diameters over 20 m

If necessary, in groups composed of conifers, the number of trees should be reduced.

8.2.2. Young pole phase [H >3-12 m]

At this phase of the most intensive differentiation there is no silvicultural treatment of greater proportions. Negative selection is carried out, through minimum intervention, in order to force natural clearing of trees from lower branches, natural differentiation and positioning of the best trees in the space in accordance with the required distance between them. Individuals struggle for space for growth and achieving a favourable biological position, i.e. dominant and co-dominant position. The tree species that need more light at this phase grow faster than trees of shadow species, and it is necessary to increase the competitive ability of beech trees or some other tree species of slower growth than beech.

Silvicultural goal:

- Preservation and improvement of health status
- Preservation of a thick canopy so that the potential crop trees can be better cleaned from lower branches
- Regulation/preservation and support of mixing with other tree species (sycamore, white ash, wild cherry, sessile oak, Hungarian oak, fir, spruce, Douglas fir)

Measures to achieve the goals:

- Tending of young poles – clearing

Silviculture works:

- Continuation of the removal of unwanted pre-growth
- Regulation of origin
- Control and regulation of the mixture
- Removal of dominant trees of poor quality
- Removal of pioneer fast-growing species (birch, aspen, goat willow)

8.2.3. Old pole phase [H >12-17 m]

The continuation of silvicultural treatments as in the previous development phase, the crown is largely folded and dying of the branches in the lower part of the trunk continues. Trees with a straight stem and branch-free stem hold the potential for creating the highest quality part of the stand. At this phase, individuals are further struggling for the biological position and availability of quality – upper light. Only when this phase is finished it is necessary to select PCTs (potential crop trees). The intensity of tree differentiation continues. In the old pole phase, minimum intervention is proposed in order to enhance natural clearing of trees from lower branches, natural differentiation and positioning of the best trees in space.

Silvicultural goal:

- Preservation and improvement of health status
- Selection of future trees within mixed species (conifers, maple, ash, cherry)
- Preservation of a thick canopy so that the potential crop trees can be better cleaned from the lower branches
- Regulation/preservation and support of mixing with other tree species (conifers, maple, ash, cherry)

Measures to achieve the goals:

- Tending of old pole – clearing

Silvicultural works:

- Preservation and improvement of health status
- Removing pre-dominant trees of poor quality (possible “ringing” of unwanted trees)
- Regulation and support of the mixture

Conifers (in mixture with beech):

Tending measures – highly selective thinning

Silvicultural works:

- Selection of 120-150 potential crop trees/ha
- Distance between potential crop trees 8 to 10 m
- Removal of 5 to 3 competing trees that have the highest vitality in relation to each PCT
- Felling intensity below the increment
- If necessary, perform artificial removal of branches of conifer PCTs up to a height of 6-8 m

8.2.4. Middle-age phase [H >17-25 m]

At this phase, the most important is the choice of optimal number of PCTs and the maintenance of free space for the growth of their crowns, by removing the strongest competitors (PCTs should grow without the shadow of the strongest competitors). During earlier interventions in the pole phase, PCTs were identified, and their first competitors were removed through clearing. In this way, the spatial distribution of future PCTs is already partly determined. At this phase, the final selection of PCTs corrects any errors (loss of dominant tree status, damage, irregular spatial distribution, etc.) that occurred during the selection of PCTs.

Silvicultural goal:

- Selection, marking and tending of PCTs for the development of crowns in order to maintain the desired diameter increment on certain level
- Intensifying diameter increment through timely thinnings of the corresponding intensity
- Achieving the appropriate dimensions of crowns of the highest quality trees (distance between PCTs 12-14 m; 10-12 m and 8-10 m, depending on the target diameter, see Table 1)
- Improving/maintaining the existing volume

Measures to achieve the goals:

- Tending of the stand/PCT – highly selective thinning.

Silvicultural works:

Beech, broadleaves:

- Final selection of **60-80** (in poorer habitats 80-100; 100-120) of potential crop trees/ha
- Distance between the potential crop trees 12 to 14 m (10-12 m; 8-10 m)
- In stands where good-quality trees (candidates for PCTs) are unevenly distributed over the area, it is possible to segregate PCTs into groups (2 to 4 trees at a minimum distance of 3-5 m), and if not, the most important/highest quality trees in the co-dominant storey should be chosen for PCTs
- Removal of main competitors to PCTs, removal of 5 to 3 competitors per each PCT
- Felling intensity 70 to 90% of the increment
- On steep terrain and locations where there is a threat of windbreaks, snow breaks, and slides, leave one competitor on the upper side or from the direction of the dominant wind in order to prevent unwanted consequences
- Interventions (thinnings) should be performed on the basis of the dynamics of height increment (increase of the upper heights by 3 m), in general, once in the poorest, and twice in better habitats during one management period

Conifers:

- Continue to remove most often 4-2 competitors per each PCT, and if necessary, in the next management period continue to remove at least 3-1 strongest competitors per each PCT
- Removal of damaged or deformed trees, starting from the largest diameter in order to systematically improve the quality of the existing stand

8.2.5. Maturing phase [H >25-30 m]

Guidelines for management in this development phase does not differ significantly from the management guidelines for middle-aged stands. The difference is that maturing stands have a smaller number of trees of all species per unit area and the intensity of the intervention is lower than in middle-aged stands, by the number of competitors.

Silvicultural goal:

- Continue tending of potential crop trees in order to develop tree crowns and to maintain the diameter increment at the desired level
- Improving/maintaining the existing volume

Measures to achieve the goals:

- Tending of the stand/PCT – highly selective thinning

Silvicultural works:

- Continue releasing PCTs by removing major competitors
- Removing at least 2-1 strongest competitors to PCTs, and if necessary, in the next management period, continue tending PCTs, by removing at least 1-0.5 of their strongest competitors
- Felling intensity from 60 to 80% of the increment
- Removal of damaged and diseased trees in order to improve the quality and vitality of the stands
- The beginning of the removal of the conifers that have reached the target diameter

8.2.6. Mature phase [H >30 m, D >=60 cm depending on target diameter]

This is the phase when the natural regeneration of the stand begins, where PCT begins to reach the target diameters (>60, >50, >40 cm). Regeneration is carried out so that in the period between 20 and 40 (30) years, PCTs that reach the target diameters and poor-quality trees are gradually removed. Removing the trees should be connected to fruiting of trees, and if there are smaller areas (groups, clearings) that are not naturally regenerated, on these surfaces it is necessary to provide (artificially or naturally) saplings of other species in the stands of beech trees (sycamore, white ash, wild cherry, sessile oak, Hungarian oak, fir, spruce, Douglas fir).

Goal:

- Prevent the occurrence of false heartwood, the presence of which diminishes the value of wood assortments
- Felling of trees that reached the target diameter and trees of lower quality
- Monitoring the occurrence of false heartwood depending on the dynamics of growth and age and accordingly correcting (increasing or decreasing) target diameters
- Ensure natural regeneration
- Secure (artificially or naturally) the sapling of other species in beech stands (sycamore, white ash, wild cherry, sessile oak, Hungarian oak, fir, spruce, Douglas fir)
- Minimise damage to sapling during the implementation of regeneration fellings

Measures to achieve the goals:

- The optimal system of natural rejuvenation (regeneration) is Femmelschlag with a long regeneration period
- If saplings of the new stand appear and are in waiting phase under poor-quality old trees, the process of regeneration should be accelerated, in order to obtain high-quality trees in the new stand

The most important interventions (works) at this phase are:

- The first intervention is the felling of trees that have reached the target diameter and trees of lower quality
- In the continuation of the regeneration, in addition to removing the trees with the target diameter, the regeneration is extended to considerably larger groups (Femmelschlag)
- Protecting the standing trees from damage during felling
- Removing damaged sapling and trees from the bottom layer immediately after felling (tending of sapling)
- On the parts of the stands where the regeneration has not been completely successful (saplings are not present in a sufficient number or saplings are damaged), additional planting in groups with conifers (minimum group of 0.1 ha – fir, spruce, Douglas fir) and broadleaves (minimal group 0.2 ha – maple, white ash, wild cherry, sessile oak, Hungarian oak)
- If the stand is well regenerated, and the concentration of the net annual cut is over 150 m³/ha, the final cut is carried out twice in the same management period

For mature or overmatured even-aged beech forests in which the regeneration process is not completed, which are thinned, of poorer quality and health condition, with accumulated volume and surface in the last age class, reduced productivity, unfinished regeneration process, partially weeded, with sapling of different ages, quality and numbers, additional guidelines are given in Annex 1 to this document.

9. Management treatments in stands with pronounced slope – protective function

In addition to production, the most important functions for this management type are:

- Soil protection on steep slopes
- Protection of settlements and infrastructure
- Water protection

Beech stands in mountainous areas are most often found on expressed slopes. Forests in these habitats protect the soil, but also roads and other infrastructure, from erosion. In addition, beech stands in these areas play an important role in the protection of mountain watercourses.

In order to ensure the protective functions of these forests, it is essential that the soil is permanently covered with trees or saplings. This management type is the optimal solution for soil protection. On the slopes of 40-60%, a higher target diameter compared to the slopes above 60% is recommended, and if there are objects with the basic purpose of protecting soil from erosion, it is necessary to go towards a smaller target diameter in order to avoid the appearance of landslides.

On slopes above 50% single tree management approach is applied.

On slopes above 50%, the optimum way of skidding timber assortments is the use of cable yarders.

In forests with the purpose to protect soil from erosion, all working procedures, forestry machinery and in general preparation in the forest must be adapted to the following requirements of the protective function:

- As the inclination increases, the target diameter decreases, the number of trees per hectare increases, the area where the regeneration is carried out decreases – the final cut, and shifts from group to single tree management method
- Exclusion and banning of clear cuts, large-surface forms of cuts as a method of regeneration
- Consider the possibility of using a cable yarder
- The formation of mixed stands with other conifers and broadleaves through multi-layered structural forms
- Excluding the technology of production of long (heavy) timber assortments
- In the production technology of wood assortments, mandatory cutting of branches and leaving them in the stand after cutting
- Prohibit the skidding of trees along the line of the largest inclination in order to prevent the formation of erosion fissures
- In the process of designing and constructing forest communications, especially tractor roads, maximally adjust them to the configuration of the terrain (by contour line)

10. Measures in case of disasters

Such harmful consequences can be significantly reduced by the implementation of adequate silvicultural and management measures, in accordance with the state of forests and biological laws within the habitat. In this way, the desired vitality, health condition and stability of trees and forest as a whole is maintained. Whenever possible, regenerate the stand in a natural way.

10.1 In case of clearing >0.2 ha afforestation is necessary

Silvicultural goal:

- Rehabilitation of endangered or damaged areas

Silvicultural measures:

- Afforestation on barren areas caused by natural disasters (fire, wind, snow, ice, etc.)
- Afforestation on areas where regeneration and afforestation has failed
- Afforestation on areas where devastation has been carried out – illegal harvesting, etc.

Type of treatments/works:

- Measure and present damaged areas for rehabilitation on maps
- Measure and record damaged trees by category of damage (breaks, slides, drying, fires and other), tree species and assortment structure (technical, firewood and other)

- Prepare a sanitary plan
- Urgent removal of damaged trees
- Complete preparation of terrain for afforestation (clearings – larger groups)
- Afforestation of clearings – larger groups – by adequate selection, above all, of fast-growing tree species and other tree species, of adequate age, of the type of seedlings and the number (planting distance), taking into account habitat conditions for a particular object
- Preserve natural sapling with adequate silvicultural measures, where possible, in order to enable its competitiveness in relation to artificially introduced species

10.2. In case of damage on a smaller area (group of trees) – afforestation is not necessary

Type of treatments/works:

- To measure and record damaged trees by category of damage (breaks, slides, drying, fires and other), tree species and assortment structure (technical, firewood and rest)
- Urgent removal of damaged trees
- Establishment of forest order

11. Stands of poorer quality

Those are the stands of poor quality that are located on the soil of poorer quality (shallow and skeletal with higher slopes) or which are the result of the inappropriate way of management (large interventions - felling, over-utilisation of quality) in which there is not enough potential crop trees of good quality.

Goal:

- Selecting an adequate number of trees with lower target diameters.

Measures to achieve the goal:

- Tending selected trees (promoted trees/PCTs)

Type of treatment/works:

- Selection of 20-40 (50) trees of the best quality per hectare
- Selection of trees can also be done per groups where 2 to 4 trees can form a group
- Tending a stand when it is economically justified
- Early beginnings of regeneration
- Artificial introduction of genetically suitable seedlings or seedlings of other tree species
- Change of the main future tree species in case of failure of the regeneration mentioned in the previous paragraph

12. Guidelines for the implementation of works on forest utilisation

- Priority guidelines for quality implementation of works on forest utilisation (felling, production and skidding/removal of wood assortments) are the following:
- Maximum protection of saplings and standing trees
- Determine felling directions
- Directed felling of trees
- Design and construct tractor roads and mark skidding directions
- Means of transport for skidding wood assortments can only be moved along the marked directions and constructed roads, and parts of stand where there are no saplings
- Align the size (diameter, length and volume) of wood assortments of maximum dimensions with the power of the vehicle on F-II
- In parts of the stand that is well regenerated, apply trunk method of producing wood assortments (the length of the trunk is not longer than 6 to 8 m), and produce stacked wood as firewood from lateral branches of thinner dimensions
- Remove the remains of thin branches from saplings and place them on the part of the stand where there are no saplings, or on stumps, along the direction of wood assortments skidding
- Preferably, design a transport scheme – use a winch uphill, and means of transport downhill
- Create work maps with a vertical representation of the terrain in the scale 1:2,500, 5,000, with mapped forest infrastructure (truck roads, tractor roads, skidding directions, temporary warehouses)

13. Natura 2000 and biodiversity issues

This chapter will be completed during the implementation of Natura 2000 in the forestry sector of Serbia.

Regarding biodiversity issue the following elements should be taken in consideration:

- Hollow trees should be promoted for increase of biodiversity preservation
- Dead trees should be kept in the stand
- Rare and endangered tree species should be promoted and preserved
- Nest trees should be protected against harvesting operations

14. Annexes

Annex No. 1. Guidelines for the management of existing mature even-aged beech forests in which the regeneration process is not completed, which are thinned, of poorer quality and health condition, with accumulated volume and surface in the last age class, of reduced productivity, unfinished regeneration process, partially weeded, with saplings of different ages, quality and number

1. General characteristics

Within high beech forests, a significant area is occupied by mature forests (forests of the last age class). High even-aged beech forests that have reached the phase of regeneration (maturity) are often rarefied, of poorer quality and health condition, with accumulated volume and surface in the last age class, reduced productivity, unfinished regeneration process, partially weeded, with saplings of different ages, quality and numbers, etc. In the previous period, quality was often undertaken, i.e. the trees of the best quality were removed, and other trees of poorer quality remained, the regeneration was not completed on time.

High mature even-aged forests do not have a typical even-aged structure, but are loaded with a larger number of depressed trees, smaller in size (10-20-30 cm, underlying layer).



2. Current situation

Mature even-aged beech forests that have reached the regeneration maturity phase due to a long regeneration period (often >20, 30 and more years), are:

- Rarefied
- Poor quality and health
- In the process of regeneration
- Partially weeded
- Saplings occur in smaller or larger groups, of different ages and distribution on the surface of the stand

2.1 Distribution/area

The largest areas of mature beech forests are located in eastern and southern Serbia (Severno-Kučajsko, Južno-Kučajsko, Timočko, Jablaničko, Topličko, Južnomoravsko, Rasinsko forest districts). The total area of state-owned beech forests is about 370,000.00 ha, where high forests occupy about 260,000 ha. In terms of structure, high beech forests are dominated by even-aged forests with a share of more than 90% (about 180,000.00 ha in state ownership).

3. Economic characteristics

In mature beech forests, due to the unfinished and long regeneration period, insufficient soil potential is used, the trees are of poorer quality (appearance of false heartwood, rot, branchiness), which significantly reduces productivity and economic effects.

4. Target long-term structure and composition

Short-term goal: complete the natural regeneration of mature and over-mature beech forests in the shortest possible time.

Long-term goal: create young quality stands that will be managed according to the Guidelines for the Management of High Beech Forests (MANAGEMENT TYPE MT 2110)

Optimal structure (mixture) of young regenerated beech forests includes the shares of up to 70-80% of beech and up to 30-20% of other species (precious broadleaves and conifers)

Table 1.

Parameters	Values
Rotation (years)	120
Regeneration period (years)	10/20
• In rarefied stands	up to 10
• In stands of full canopy	up to 20
Regeneration period (years)	
• In rarefied stands	up to 10
• In stands of full canopy	up to 15 /20/
Number of cuts	3/2
• In rarefied stands	2
• In stands of full canopy	3
Management system	Stand management
Method of calculation of the annual felling	Moderate stand management

5. Strategy of management treatments

5.1. Silviculture treatment-general guidelines

GOAL: In mature thinned stands of poorer quality, in which the process of natural regeneration has begun (saplings are in smaller or larger groups or on the whole surface) to complete the process of natural regeneration in the shortest possible time, and in stands of good quality with a sufficient number of trees, where there is no danger of large share of false heartwood, keep 60 to 80 (100) of the best trees until they reach the desired diameters (60, 50 cm). In stands where it is not possible to perform natural regeneration on the entire surface of the stand, regenerate the stand with supplementary measures (habitat preparation, sowing filling). After the regeneration is completed, continue with tending the young stand (saplings).

5.2. Treatment by development phases

GOAL: These guidelines refer only to the phase of overmatured even-aged beech forests in which the regeneration process is not completed, which are rarefied, of poorer quality and health condition, with accumulated volume and surface in the last age class, reduced productivity, unfinished regeneration process, partially weeded, with saplings of different ages, quality and numbers, etc. In the previous period, quality cutting was often undertaken, i.e. the trees of the best quality were removed, and other trees of poorer quality remained, the regeneration was not completed on time.

Treatments in other phases (sapling, old pole and late pole, middle-aged and maturing forests) are

implemented according to the Guidelines for the Management of High Beech Forests (MANAGEMENT TYPE MT 2110)

5.2.1. Mature forest phase

High even-aged beech forests that have entered the regeneration phase are thinned, of poorer quality and health condition, with irregular age structure, with accumulated volume and area in the last age class, reduced productivity, unfinished regeneration process, unfavourable age structure, partially weeded and with saplings of different age, quality and number, unsatisfactory quality of forest infrastructure (low openness with forest truck roads), etc. In the previous period, quality cutting was often undertaken, i.e. the trees of the best quality were removed, and other trees of poorer quality remained, the regeneration was not completed on time.

Silvicultural goal:

- In the shortest possible time, perform regeneration of stands, i.e. remove the trees of the old stand and form quality young stands
- On the part of the surface where natural regeneration failed saplings of other species should be secured (artificially or naturally) in beech stands (sycamore, white ash, wild cherry, sessile oak, Hungarian oak, fir, spruce, Douglas fir)
- Monitor the occurrence of false heartwood depending on the dynamics of growth and age and accordingly correct (increase or decrease) target diameters
- Minimise damage to saplings during the implementation of regeneration fellings

Measures to achieve the goals:

Silvicultural measures:

- Management system: stand management
- Method of regeneration: shelterwood felling of short regeneration period (regeneration by natural means and, if necessary, by a combination of natural and artificial methods)
- Type of felling: shelterwood felling – through preparatory, establishment, (additional) and final cut and a combination of these cuts

Management measures:

- Length of rotation period: 120 years
- Length of regeneration period: 10 (20) years
- Time required for regeneration of mature beech forests: 5 to 15 years

Method of calculating the annual cut:

- Method of moderate stand management, which is a combination of age class methods and stand management methods (Spider's moderate understanding)
- Mandatory preparation of a temporary felling plan
- A prerequisite for the safe application of this method is accurate and detailed data collected from the field (description of the stand and habitat, especially the description of the sapling)

Silvicultural works:

- Conducting preparatory establishment cut
- Implementation of the final cut
- If necessary, soil preparation immediately before abundant fruiting (weed and undergrowth removal, soil loosening)
- Sowing, supplementary planting-afforestation (sowing seeds, planting seedlings) of areas that have not been naturally regenerated
- Protection and tending of young regenerated stands (in the sapling phase)
- Establishment of forest order

Method of implementation of shelterwood felling of the short regeneration period

Shelterwood felling of the short regeneration period

- It is planned and implemented through three basic cuts: preparatory, establishment and final, and in some circumstances through additional cut and a combination of aforementioned cuts.

Preparatory cut:

Objective of the preparatory cut:

- To create optimal conditions for insemination and seed germination in the stand
- Create favourable habitat and stand conditions for natural regeneration

Silvicultural works:

- Preparatory cut is planned by the plan of regeneration fellings, based on habitat and stand conditions, and is carried out immediately or several years before the abundant fruiting of trees of the main species
- Preparatory cut is planned and implemented in stands with a large number of trees
- In stands where there is a danger of weeding (stands on deep, fresh soil, coves, etc.), preparatory cut is not carried out, but is combined with establishment cut (preparatory establishment cut), and if it is planned due to a large number of trees, by preparatory cut the underlying layer (storey) is not removed, but trees of poorer health and quality and trees with lighter seeds from the upper storey are removed
- The preparatory cut removes primarily undesirable species – competitive species, light seed species, poor quality and health status, hereditary and genetic traits, trees of V and VI biological class, etc.
- The intensity of the intervention in relation to the volume when planning the preparatory cut is usually 20-30% of the volume and above the increment
- Conducted throughout the year

Establishment cut:

Establishment cut is performed in the year (autumn, winter) of full seed yield or the following year (winter).

It is very important to determine the quality of seeds when performing establishment cut within abundant seed yield, because beech seed/acorn can often be of poor quality.

If the establishment cut is carried out one or two years after the abundant seed yield, it is necessary to check the germination of beech seeds, i.e. whether there is a germination on the entire surface of the stand we are regenerating and whether it is in a satisfactory number per m^2 (optimally 3 to 5 pieces/ m^2).

Objective of the establishment cut is:

- To fertilise the entire stand area with quality seeds
- To provide the best stand conditions in terms of light, heat and moisture for seed germination
- To provide the best conditions for seedlings and saplings, and at the same time protection from the negative effects of climatic factors (extremely high and low temperatures)

Silvicultural works:

- Establishment cut primarily removes trees of competitive species, light seed species, poor health, hereditary genetic traits and trees of poor quality and those with a well-developed crown
- Undergrowth – underlying layer must be removed
- Carried out during vegetation dormancy in autumn/winter, in the year of full seed yield and the next two years
- Canopy is reduced to about 0.5 (0.5-0.6)
- The optimal number of trees of the main species that remain after the establishment cut is 60-80 (100)/ha, evenly distributed over the surface
- When the surface is regenerated by at least 80% and the sapling reaches a height of about 0.5 m, the final cut is carried out (3 to 5 years after the establishment cut)
- Felling intensity in relation to the volume when planning the establishment cut is usually about 40-50% of the volume and above the increment

It is necessary to monitor the condition of the regeneration of the stand, and if the stand is regenerated on more than 80% of the surface and the saplings are about 0.5 m tall, the final cut and tending the sapling (lighting) should be implemented.

Preparatory establishment cut:

Preparatory establishment cut is planned and carried out as one intervention in mature, rarefied stands, with a smaller number of trees per ha, on deep and fresh soils, where there is a danger of weeding (usually blackberry).

Considering the condition of mature forests (rarefied, partially regenerated and weeded, etc.), this is the cut with which, in most cases, natural regeneration of high mature beech forests should begin.

If the establishment cut is carried out one or two years after the abundant seed yield, it is necessary to check the germination of beech seeds, i.e. whether there is germination on the entire surface of the stand regenerating and whether it is in a satisfactory number per m^2 (optimally 3 to 5 pieces/ m^2).

Objective of the preparatory establishment cut is:

- Fertilise the entire stand area with quality seeds
- Provide the best stand conditions in terms of light, heat and moisture for seed germination
- Provide the best conditions for seedlings and sapling, and at the same time protection from the negative effects of climatic factors (extremely high and low temperatures)

Silvicultural works:

- Preparatory establishment cut is carried out during the vegetation dormancy autumn/winter in the year of full seed yield and the next two years
- Preparatory establishment cut primarily removes trees of competitive species, light seed species, poor health and hereditary genetic traits and trees of poor quality and those with a well-developed crown
- Undergrowth – underlying layer must be removed
- Removal of the underlying layer and dry trees can also be done during vegetation before the seeding of the main species and has the character of a preparatory cut, and removal of trees from the upper layer that has the character of an establishment cut is done during vegetation dormancy (autumn/winter)
- Canopy is reduced to about 0.5 (0.5-0.6)
- Optimal number of trees of the main species that remain after the preparatory establishment cut is 60-80 (100)/ha
- Interval between the preparatory establishment cut and the final cut is 3-5 years, and when the surface is regenerated by at least 80% and the sapling reaches a height of about 0.5 m, then the final cut is implemented
- Felling intensity in relation to the volume when planning the preparatory establishment cut is usually about 40-50% (60) of the volume and above the increment

It is necessary to monitor the condition of the regeneration of the stand, and if the stand is regenerated on more than 80% of the surface and the sapling is about 0.5 m tall, the final cut and tending of the sapling (lighting) should be implemented.



Image 1. Stand for the implementation of a preparatory establishment cut
Foto: Stajić

Final establishment cut**Silvicultural goal:**

- Complete the natural regeneration of the entire surface of the stand

Silvicultural works:

- Planned and implemented in mature stands that are not regenerated on the entire surface, but the sapling of good quality is unevenly distributed over the surface of the stand in smaller and larger groups (30-60% of the stand area)
- The final cut is carried out on a part of the surface of the stand that is well regenerated, with saplings of good quality and number
- Establishment cut is performed in the year (autumn, winter) of full seed yield and the next two years (during the dormancy of vegetation) on the surface where there are no saplings
- The intensity of the intervention depends on the share of the area in which the final cut is carried out, but as a rule it is above 50% of the volume and above the increment

Additional cut**Silvicultural goal:**

- Complete the natural regeneration of the entire surface of the stand
- Protect the sapling

Silvicultural works:

- Planned and implemented depending on habitat and stand conditions, usually between the establishment and final cut, in order to protect the sapling (from extremely high and low temperatures) or additional restoration of part of the stand surface that is not sufficiently regenerated
- Intensity of the intervention in relation to the main tree species in the planning of the additional cut, depending on the habitat and stand conditions, is around half of the remaining growing stock, and above the increment
- Carried out during vegetation dormancy – autumn/winter.

Final cut**Silvicultural goal:**

- Complete the natural regeneration of the stand

Silvicultural works:

- Planned and implemented when at least 70-(80)% of the stand area is regenerated by saplings of good quality and number, height about 0.5 m, age 3 to 5 years, capable of independent development
- Carried out during the dormancy of vegetation, late autumn/winter
- It is obligatory to carry out tending measures – lighting of saplings immediately after the completion of works on forest utilisation
- Establish forest order
- If there are smaller areas that are not naturally regenerated, fill/plant them with seedlings of precious broadleaves, wild fruit trees, conifers



Image 2 & 3. Stands where the final cut is planned and implemented
Foto: Kaurin (2012)

Final cut on two occasions

- Complete the natural regeneration of the entire surface of the stand
- Protect saplings

Silvicultural works:

- It is planned and implemented in a stand or part of a stand with a large number of trees, which have been regenerated by over 70% (80%) in the form of seedlings and saplings that are not old enough, 1-2 years old, up to ten centimetres high. The interval between the two interventions ranges from 3 to 5 years, but it depends on habitat conditions, terrain conditions, climatic conditions – extremely high and low temperatures, etc.
- The final cut is implemented on two occasions in stands with a larger wood volume, where the net annual felling is $<150 \text{ m}^3/\text{ha}$, where there is danger of greater damage to saplings due to the concentration of net annual felling per ha
- It is obligatory to carry out tending measures – lighting of saplings immediately after the completion of the works on forest utilisation
- Establish the forest order
- If there are smaller areas that are not naturally regenerated, fill/plant them with seedlings of precious broadleaves, wild fruit trees, conifers



Image 4 and 5. Stands where the final cut is planned and implemented on two occasions
Foto: Kaurin (2012)

6. Management treatments in stands with a protective function – stands with a pronounced slope

Implement Guidelines for the Management of High Beech Forests (MT 2110)

7. Measures in case of disasters

Implement Guidelines for the Management of High Beech Forests (MT 2110)

8. Specificity of regeneration in relation to the characteristics of present stand situation

8.1 Mature rarefied and weeded stands

- If there is a sufficient number of trees per ha (at least 60, 80, 100/ha) with developed crowns, capable of fruiting in the year of full fruiting, immediately before the fall of the seed (autumn/winter), prepare the soil by removing weeds, shrubs and the lower layer, and poor quality trees from the upper layer (preparatory-establishment cut).
- If the stand is very rarefied and with trees of poor quality and poor health condition, with reduced and rarefied crown and without the ability to enable the regeneration of the stand in a natural way, implement the preparation of the surface, as in the first case, and implement regeneration on the artificial way by sowing seeds or planting seedlings (beech with a combination of precious broadleaves, wild fruit trees, conifers). If climatic conditions (danger of extreme temperatures) and terrain conditions (very steep terrain) at a given location are rather unfavourable, the additional sowing of seeds and afforestation must be carried out before removing the trees of the old stand and remove the old stand (final cut) only when saplings are capable of independent growth (3-5 years old, height above 30 cm).



Image 6 and 7
Foto: Kaurin (2012)

8.2. Mature rarefied stands, in which the process of natural regeneration has started, but with unsatisfactory saplings in terms of number, quality and surface (saplings occur individually or in smaller groups up to one-third of the area of the stand), and the larger part of the stand surface is weeded

- Finish regeneration by combination of natural and artificial methods.
- On areas where there is a sufficient number of saplings of good quality and capable to continue to grow and develop independently, it is necessary to complete regeneration by implementing the final cut and to implement tending measures – lighting of the sapling on those areas after the utilisation of forests.
- In the part of the stand where saplings are not in sufficient quantity, it is necessary to prepare the surface by removing weeds and undergrowth in the year of full fruiting.
- In case the number of trees for fruiting and natural regeneration is not sufficient, it is necessary to prepare the soil by removing weeds and undergrowth and sow beech seeds or plant seedlings in combination with precious broadleaves, wild fruit trees and conifers.
- If climatic conditions (danger of extreme temperatures) and terrain conditions (very steep terrain) at a given location are rather unfavourable, the additional sowing of seeds and afforestation must be carried out before removing the trees of the old stand and the old stand removed (final cut) only when saplings are capable of independent growth (3-5 years old, height above 30 cm).



Image 7 and 8
Foto: Kaurin (2012)

8.3. Mature rarefied stands, where the process of natural regeneration progressed (sapling occurs individually or in smaller groups on one to two thirds of the area of the stand), and the other part of the stand is not regenerated

- Finish the regeneration by combination of natural and artificial methods.
- On areas where there is a sufficient number of saplings of good quality capable to continue to grow and develop independently, it is necessary to complete the regeneration by implementing the final cut and to implement tending measures – lighting saplings on those areas after utilisation of forests.
- In the part of the stand where saplings are not in sufficient quantity, it is necessary to prepare the surface by removing weeds and undergrowth, in the year of full fruiting.
- In case when there is no sufficient number of trees for fruiting and natural regeneration, it is nec-

essary to prepare the soil by removing weeds and undergrowth and sow seeds or plant seedlings of beech in combination with precious broadleaves, wild fruit trees, conifers.

- If climatic conditions (danger of extreme temperatures) and terrain conditions (very steep terrain) at a given location are rather unfavourable, additional sowing of seeds and afforestation must be carried out before removing the trees of the old stand and the old stand removed (final cut) only when saplings are capable of independent growth (3-5 years old, height above 30 cm).



Image 9 and 10
Foto: Baković (2015)

8.4 Mature rarefied well-regenerated stands, saplings of good quality evenly distributed, (saplings appear on the whole surface or on a surface of more than two-thirds of the stand of different ages and a height of 0.5 m up to over 2.0 m, and at the age of 3 up to 10 years)

- Complete natural regeneration by the implementation of a final cut.
- It is obligatory to carry out tending measures – lighting of saplings immediately after the completion of works on forest utilisation.
- Establish forest order.
- If there are smaller areas that are not naturally regenerated, fill/plant them with seedlings of beech, precious broadleaves, wild fruit trees, and conifers.

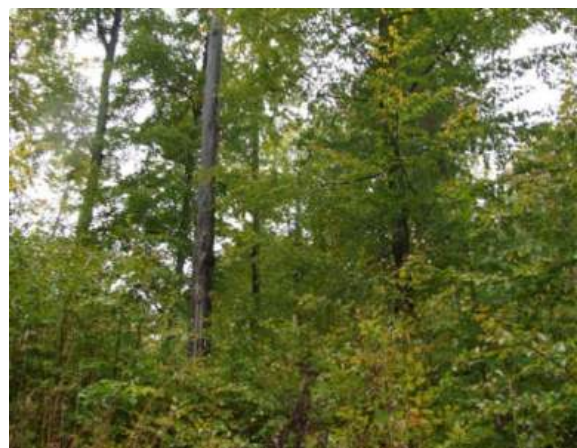


Image 11 and 12
Foto: Kaurin (2012)

8.5 Stands in which the lower layer is formed in the phase of a young pole, with the remaining trees of the old stand

- If the lower layer is evident, with trees of good quality and number, it should be kept as a base stand, and the trees of the upper layer should be gradually removed taking into account the possible damage on the trees of the lower layer (a number of trees of the old stand can be left if their removal would cause excessive damage to the trees of the lower layer).
- If the trees of the lower layer are of poor quality and insufficient number, in order to form a newly established stand for further management, the lower layer should be removed immediately before the abundant seed yield or gradually removed, with sowing seeds or planting seedlings.



Image 13 and 14
Foto: Kaurin (2012)

8.6 Mature stands of complete canopy 0.7

- Complete natural regeneration by the implementation of a final cut.
- Implement regeneration by classical shelterwood felling in three cuts (preparatory, establishment and final cut) and, if necessary, perform an additional cut.
- It is obligatory to carry out tending measures – lighting of saplings immediately after the completion of the works on forest utilisation.
- Establish forest order.
- If there are smaller areas that are not naturally regenerated, fill/plant them with seedlings of beech, precious broadleaves, wild fruit trees, and conifers.

9. Stands of poorer quality

9.1 Regenerated stands of poorer quality

These are thinned stands of poor quality and health condition, (where trees are of poor quality with a large share of false heartwood and rot), which were created by a long regeneration period, by over-utilisation of quality, harm of natural disasters, and regenerated with good quality saplings.

Goal: Complete the regeneration and create a young stand in the shortest period of time

Measures to achieve the goals: Shelterwood felling of short regeneration period

Silvicultural works:

- Final cut of shelterwood felling
- Additional planting of non-regenerated parts of the stand
- Tending saplings
- Minimise damage to saplings during the implementation of regeneration fellings
- It is obligatory to carry out tending measures – lighting of saplings immediately after the completion of the works on forest utilisation
- Establish forest order

9.2 Stands of poorer quality in good habitats, without saplings

Mature, thinned stands of poor quality and health, in good habitats emerged by wrong way of management or effects of natural disasters (drought, disease, windbreaks, snow breaks), where there are not enough quality trees for natural regeneration, and stands are not regenerated.

Goal: Complete artificial regeneration and establish the young stand in the shortest possible time

Measures to achieve the goal: direct conversion

Silvicultural works:

- Clear cut
- Preparation of terrain for afforestation
- Removal of weeds, shoots from stump etc.
- Afforestation (sowing under the canopy of the old stand)
- Additional planting/filling
- Tending saplings

9.3 Stands of poor quality in poor habitats without saplings

Mature, thinned stands of poor quality and health, in poor habitats, emerged by wrong way of management or effects of natural disasters (drought, disease, windbreaks, snow breaks), where there are not enough quality trees for natural regeneration, and stands are not regenerated.

Goal: Complete the artificial regeneration of the stand, by replacing the species and establishing the young stand in the shortest possible time,.

Measures to achieve the goal: direct conversion – replacing species.

Silvicultural works:

- Clear cut
- Preparation of surface for afforestation
- Removal of weeds, shoots from stump, etc.
- Afforestation (sowing) by replacing the species adapted to habitat conditions
- Additional planting/filling
- Tending saplings

10. Maturing stands in the process of regeneration

10.1 Maturing thinned stands with saplings under the main stand

As a result of inadequate measures (interventions of higher intensity, over-utilisation in quantity and quality, natural disasters (fire, snow-breaks, etc.), these stands are characterised by increased thinning, fewer number of trees, of poorer quality and health with a reduced crowns. In such thinned stands, there was an unplanned regeneration of the stand by sapling in smaller or larger groups, unevenly distributed over the surface of the stand, of different age, height, number per m².

Goal: Complete natural regeneration and create a young quality stand

Measures to achieve the goals:

- Regeneration of the stand - shelterwood felling of a short regeneration period

Silvicultural works:

- Complete the natural regeneration of the stand in the shortest possible time, by a combination of preparatory establishment and final cuts
- In the first intervention, remove poorer quality trees, trees and groups of trees that hinder the development of saplings, and leave the best trees evenly distributed over the area (80, 100, 120 per ha)
- When the stand is regenerated 70% (80%) of the surface with good quality saplings, remove the remaining trees (final cut)
- Artificially implement additional planting/filling of the parts of the stand where natural regeneration has failed (sycamore, white ash, wild cherry, sessile oak, Hungarian oak, fir, spruce, Douglas fir)
- Minimise damage to saplings during the implementation of regeneration felling
- Tending saplings

10.2 Maturing stands thinned and weeded without sapling

As a result of inadequate measures (interventions of higher intensity, over-utilisation in quantity and quality, or the effects of natural disasters (fire, snow breaks, windbreaks, etc.), these stands are characterised by increased thinning, fewer number of trees of poorer quality and health with a reduced crowns, insufficient number of quality trees (less than 60/ha). In such thinned stands, weeding of habitats (most often blackberries) and formation of the lower layer (elder, hornbeam, etc.) occurs, and saplings are absent or appear in patches, insufficient for natural regeneration of the stand.

Goal:

- Produce trees of lower target diameters

Measures to achieve the goals:

- Tending selected trees

Silvicultural works:

- Selection of 30-50/ha trees of the best quality
- Selection of trees can be done in groups, where 2 to 4 trees can form a group
- Tending stands when it is economically justified, by removing competitors to selected single trees

- Earlier start of regeneration
- Artificial introduction of genetically suitable seedlings or seedlings of other tree species
- Change of future main tree species

10.3 Maturing stands thinned and weeded with insufficiently represented saplings or without saplings, without the possibility of selecting trees of better quality (promoted trees)

- Stands in which there is no possibility to select a small number of quality trees (30-50 per ha), thinned, of poor quality, weeded, without saplings.
- It is not economically justified to keep the stand further.

Goal: Complete regeneration and create a young quality stand

Measures to achieve the goal: direct conversion

Silvicultural works:

- Clear cut
- Preparation of surface for afforestation
- Removal of weeds, shoots from stump, etc.
- Afforestation (sowing) by replacing the species adapted to habitat conditions
- Additional planting/filling
- Tending saplings

11. Guidelines for the implementation of works on forest utilisation in mature even-aged beech forests

Priority guidelines for quality implementation of works on forest utilisation (felling, production and skidding/removal of wood assortments) are:

- Maximum protection of saplings and standing trees
- Determining felling directions
- Directed felling of trees
- Design and construction of tractor roads and marking the directions of assortment skidding
- Means of transport for skidding wood assortments can only be moved along the marked directions and constructed roads, and parts of the stand where there are no saplings
- Aligning the size (diameter, length and volume) of the wood assortment of maximum dimensions with the power of the vehicle on F-II
- In parts of the stand that are well regenerated, apply trunk method of producing wood assortments (the length of the trunk is not longer than 8 to 10 m), and from lateral branches of thinner dimensions stacked wood as firewood is produced
- Remove the remains of thin branches from saplings and place them on the part of the stand where there are no saplings, or on stumps, along the direction of wood assortments skidding
- If possible, design a transport scheme – skidding with a winch uphill, and skidding with a means of transport downhill
- To create work maps with a vertical representation of the terrain in the scale 1:2,500, 5,000, with mapped forest infrastructure (truck roads, tractor roads, skidding directions, temporary warehouses)

12. Guidelines for establishing the forest order

In young, regenerated stand, after the final cut, it is necessary to establish the forest order, which consists of the following treatments/works:

- Remove branches from saplings and arrange them in smaller piles where there are no saplings or on the stumps of felled trees
- Cut down and remove pre-growing trees of the main species and competing species from saplings
- Cut down and remove trees that were damaged during the implementation of works on forest utilisation



Image 15 and 16. Establishing the forest order
Foto: Kaurin (2012)

Overview of the stand before the final cut (Image 17-19)



Image 17. Foto: Kaurin (2011)



Image 18. Foto: Kaurin (2011)



Image 19. Foto Kaurin (2011)

Overview of a young regenerated stand (appearance of the stand after the completion of natural regeneration) – Images 20-25





Images 20-25. Foto: Kaurin (2010/12)

Presentation of a mature stand in which a combination of a preparatory establishment cut is planned and implemented (Image 26)



Image 26
Foto: Stajić (2009)

Presentation of a mature thinned stand of poor quality, regenerated by saplings of good quality (Image 27 and 28)



Image 27 and 28
Foto: Kaurin (2012)

Annex 2. Images of specific silvicultural groups in beech stands



Image 29. Saplings (under the canopy). Foto: Petrović (2017)



Image 30. Young pole. Foto: Petrović (2017)



Image 31. Old pole. Foto: Petrović (2017)



Image 32. Middle-aged stand (the beginning of the selection of PCTs)
Foto: Petrović (2017)



Image 33. Middle-aged stand
Foto: Krstić (2017)



Image 34. Maturing stand
Foto: Stajić (2016)



Image 35. Mature stand
Foto: Stajić (2009)

Annex 3. An example of vital, quality, previously selected potential crop trees

Image 36. PCT selected in 1997, which in the previous period grew under a stronger influence of the crowns of competing trees, ready for the next thinning
(Foto: Stajić 2017)



Image 37. PCT selected in 1997, which was previously adequately released from the influence of competing trees, ready for the next thinning
(Foto: Stajić 2017)

Annex 4. Stands of poor quality



Image 38. High beech forest of poor quality

2. Analysis of forestry policy issues in Western Balkan countries/territories

Prof. Nenad Petrovic

National experts have provided insight regarding forest policy processes and priorities that need to be in focus in the near future. Some countries have created national forest strategies, while others have roadmaps, whereas in the next period forest development strategies should shape a future common vision of the forestry sector in each of the WB countries/territories. In the chapter below, several cross-cutting forest policy issues have been identified, three topics have been particularly highlighted as common topics that have high cross-cutting potential and importance at the national level, as potential topics for future cooperation among partners in the WB region. Closer-to-Nature Forest Management (CNFM) could be used as a leading concept in achieving SFM in the region. Cooperation in the region should be strengthened by further implementation of Forest Management Guidelines (FMGs) for other tree species or further explanation and better implementation of FMGs developed by this project (high or coppice beech forests). A second topic that could be used for future cooperation potential is the development and implementation of forest biodiversity assessment into forest management planning in the WB region. For both these concepts, training materials should be created and further update of demo plots should follow. These two topics should be used as the main input for the implementation of the third forest policy cross-cutting issue, which is continuous education in the forestry sector. This topic should be the key topic in future cooperation, as this instrument of forest policy does not exist or is in under development stage with huge potential for creating forest experts capable for coping with climate change challenges in the future. Better understanding of forestry practices should secure the creation of resilient and vital forest ecosystems by promoting natural regeneration, forest mixture, unevenly aged structures, clear management targets, integrated pest management by guiding forest practice on how to achieve these objectives using clear and numerical management instructions.

Continuous education as an instrument of the implementation of strategic goals in forest management needs to be created in the forthcoming period. Long-term continuous education strategy, including an institutional setup needs to be established as instrument for securing sustainable forest management in the WB region in the future, and such organisation could create cooperation and exchange patterns among the countries/territories. Long-term research and demonstration plots should be created as an institutional setup at the national level and could be used for practical training activities within continuous education approaches in each WB country/territory. National concept of the life-long learning concept could create the precondition for creating a regional training exchange platform and secure additional knowledge and capacity building in the region and beyond.

2.1. Cross-cutting forestry policy issues in the Western Balkan region

Based on the reports by national experts, this chapter presents the main cross-cutting issues in the Western Balkans region, regarding forestry policy. The main cross-cutting issues are presented in the following text.

Forestry policy needs reform related to the climate change challenges. Strategic and legislative framework needs to be improved in almost all WB countries/territories, based on the needs of forestry and related sectors toward changing climate conditions. Strategic and legislative frameworks need to be adaptable due to a fast-changing environment. Laws and by-laws should have general norms described, but most technical elements should be in the form of technical guidelines that could be quickly updated or changed.

Forest information systems are also some of the preconditions for CNFM, considering the fact that different databases are available, in different forms and different data sets, and in different institutions. They should be further developed/upgraded. In addition to this, the creation of a new system of early warning based on new technology should be an important mitigation instrument during dry and rainless summers, especially in pure coniferous stands.

The use and development of forest management guidelines as a tool for implementation of CNFM in forestry practices, is also one of the cross-cutting issues. The creation of guidelines on forest management for forestry practitioners, which clearly explain management throughout the entire production period, is of importance for adapting the management strategy in a climate changed environment in the future. Intensive training activities need to be conducted in the whole region in order to introduce the ideas of CNFM into practical understanding and their implementation into regular forest management practice.

Development of sustainable lifelong learning system for forestry practitioners is a need in the forestry sectors in the WB region. Continuous education and the system of lifelong learning implies a permanent transfer of knowledge and the development of professional abilities and skills of employees in the forestry sector, which should be achieved through mandatory and optional educational programmes, throughout the professional career. The institutional setup for lifelong learning is missing in almost all WB countries/territories. The establishment of a sustainable knowledge transfer from science to praxis is of essential importance for SFM in the future. The establishment of an institutional setup for long-term research and demonstration plots is an important precondition for the training of people in the field and for demonstrating the effects of different management strategies aimed at the achievement of different management goals. The results of long-term research could be used for the adaptation of the existing objectives and demonstration plots could be an important instrument of lifelong learning using practical examples in the field. Capacity building in remote sensing technologies is essential for the monitoring of large-scale areas in a short timeframe.

Sustainable Forest Management of private forests is a great challenge especially in a changed socio/economic environment and depopulation of rural areas in the WB aiming to increase the resilience of forests through the adoption of most climate and biodiversity-friendly forest management practices. An action should be directed toward encouraging the formation of forest owner associations for future SFM challenges.

The aspect of biodiversity is not well-integrated into forest management planning. The lack of permanent monitoring of the implementation of forest strategies and their effect on forest biodiversity is missing. The creation of a methodology for biodiversity assessment is missing in almost all WB countries as well as management practices for the maintenance and improvement of forest biodiversity. Integrating biodiversity into sectoral policies and practices in order to create assessments and long-term monitoring of forest biodiversity, should be one of the key topics.

Forestry legislation needs to create a clear connection towards rural development and EU accession initiatives for supporting rural development. The forestry sector should recognise and use the opportunity from EU rural development instruments as it was done by the agricultural sector several years ago in all countries/territories in the WB.

Insufficient human resources are a challenge present in all WB countries. In the first place, appropriate human resources are lacking in the state administration, as well as experts for forest management and skilled forestry workers. The lack of labour force is evident during afforestation, silvicultural works and mainly in forest utilisation, due to migration from rural to urban areas, as well as to foreign countries.

Continuous education and the system of lifelong learning implies a permanent transfer of knowledge and the development of professional abilities and skills of employees in the forestry sector, which should be achieved through mandatory and optional educational programmes, throughout the professional career. The institutional setup for lifelong learning is missing in almost all WB countries/territories. The establishment of a sustainable knowledge transfer from science into practice is of essential importance for SFM in the future.

Development of forest land restoration policy as contribution towards land degradation neutrality is obligation for forestry sectors derived from international commitments of WB countries/territories. Having in mind that almost all WB countries/territories are in the process of EU accession, Green Agenda for the Western Balkans imposes obligations to forestry sectors related to forest land restoration.

The nature protection sector and designation of protected areas have a specific impact on the forestry sector and SFM. In addition to this, NATURA 2000 and its integration into forest management planning is missing. Capacity building for the integration of NATURA 2000 into forest management planning is of essential importance in order to avoid management conflicts in the future.

Visibility and communication in the forestry sector is an issue that requires action. Almost all countries (except Serbia and North Macedonia) have a forest cover ratio that is higher than 40% and having this in mind foresters need to be more proactive in communication and publicly more visible. Therefore, there is a need for a clear communication strategy of the forestry sector in WB countries/territories.

2.2 Policy Analysis Document: Country Report Albania

Prof. Leonidha Peri

I. Abbreviations

ALFIS	A lbanian F orest I nformation S ystem
ANFI	A lbanian N ational F orest I nventory
EU	European Union
FLR	Forest Landscape Restoration
MTE	Ministry of Tourism and Environment
NAPA	National Agency for Protected Areas
NFA	National Forestry Agency
SFM	Sustainable Forest Management
WB	World Bank
GAWB	Green Agenda for the Western Balkans

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Chapter I. Introduction

Forests represent one of the major natural resources of Albania. According to ANFI 2018, 45.6% of Albania, an area of approximately 1.31 million ha is covered with forests. Forests (46.5%) and pastures in total cover around 65% of the country area, or around 0.65 ha/capita.

Due to their natural and diverse structure, as well as extensive natural regeneration, they represent crucial resources for further development of Albania.

The country itself is geographically excellently positioned in terms of diverse climatic influences: the coastal lowlands have a typically Mediterranean climate while the highlands have a continental climate. In both the lowlands and the interior, the weather varies markedly from north to south, west to east and is home to over one hundred tree species.

The main purpose of this forestry sector policy analysis document is to identify which segment/area/beneficiary should be targeted within the forestry sector through future project interventions based on a GAP analysis.

Today, Albania has already opened formal negotiations for accession to EU membership.

In line with the EU ambition to become climate-neutral by 2050, the region has also committed to achieve carbon neutrality by 2050, and to align with the European Green Deal's key elements by endorsing the Green Agenda for the Western Balkans (GAWB) at the Summit in Sofia in 2020, and subsequently the GAWB Action Plan, at the Brdo Summit in October 2021. GAWB is seen a New Growth Strategy for the Western Balkans, leaping from a traditional economic model to a sustainable economy, in line with the European Green Deal and its supporting documents, such as the 2030 EU Biodiversity strategy, 2030 EU Forest Strategy, and related processes to implement concepts like Closer-to-Nature Forest Management and Forest Landscape Restoration.

It is expected that in the near future the possibility of EU support for the forestry sector will increase, taking into account the importance of this sector in the development of rural areas in Albania.

On the other hand, the products of EU processes related to climate change, biodiversity, forests, mentioned above, have, and will have an even greater impact on the Albanian forestry policy.

Chapter II.

SWOT and GAP analyses of the forestry sector

In the last 60 years, forest resources in Albania have been under a great pressure. A considerable loss, not only in area but also standing volume already took place during the communist regime period, mainly because of government decisions at the time to clear up forest areas in favour of expanding the arable land area and overusing these resources.

The fundamental aspects of the policy and legal reform on forests and pastures during the last 30 years have been: (i) orientation of the forestry sector towards a market economy, (ii) the restitution of forests to former owners and transfer of user rights on forests to rural communities, (iii) decentralisation of the administration of forest areas from the government to municipalities.

All Albanian governments of the last 25 years have undertaken several reforms in the forestry sector, with a strong focus on decentralisation processes. Decentralisation reforms in the forestry sector are seen today as a policy option to tackle the unsustainable management of natural resources including forest resources. Policies fostering devolution processes in the forestry sector follow mainly three objectives: (i) **empower local “forest communities” to sustainably manage forests**, (ii) **improve the condition of degraded forest areas** and (iii) **reduce/alleviate the poverty of these communities**.

However, this entire process has not been flawless and other measures need to be taken to face the ever-increasing challenges for the environment and forests. Despite experiences and positive developments, problems persist in the forests, such as illegal logging, massive damage from forest fires, overgrazing and erosion, leading towards further degradation of forests.

Albanian forests have recently undergone changing demands in terms of contributing more to protecting and enhancing all important forest functions, ranging from economic viability to social responsibility and environmental and ecological sustainability. In general, the forestry sector has faced significant structural changes in the last 5 years but needs further modernisation and improvements.

SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis is an instrument of strategic planning which scans internal strengths and weaknesses of a sector and identifies the opportunities and threats of the sector environment. Furthermore, SWOT provides a framework for deriving strategies based on promising combinations of found strengths, weaknesses, opportunities, or threats.

The analysis of the forestry sector is focused on those areas where the highest negative impact on the sector deterioration is currently noted, where the country is seriously deficient, and where in the medium term, expected actions have great potential to improve the sector conditions and contribute to a sustainable economy with the greatest positive impact on the population and nature protection.

Table 1. SWOT analysis of the forestry sector

STRENGTHS	WEAKNESSES
Relatively large forest cover (45% of country area) New National Forest Inventory (ANFI 2021) Rich biodiversity (over 20% of the forest area under protected status) Important source of income for the rural population (fuelwood production, NWFP, forage production) Use of wood biomass as a renewable energy source Employment of the local population in forest management activities Forest recreation/ecotourism development	Forest land tenure conflicts Low standing volume and productivity Organisation of the sector still incomplete Insufficient investments in the forestry sector Forest management planning and implementation system underfunded Low level of use of new technologies in forest management Outdated and uncontrolled forest mapping system Limited information/knowledge on forest resources Lack of functional information and monitoring systems in the forestry sector Insufficient human resources capacities Insufficient law enforcement Limited forest accessibility infrastructure Lack of forest certification schemes
OPPORTUNITIES	THREATS
Increased environmental awareness on sustainable forest management issues New forest information system (ALFIS) Increasing support for biodiversity conservation/ protection Increasing support to rural population employment and income generation Innovative financing schemes (PES) Decreasing pressure on forests because of demographic changes in rural areas (grazing, use of fuelwood) Forest stands in young age classes with high CO sequestration potential Starting of the EU integration process, access to EU funds Available funding for capacity-building programmes in the sector from national and international sources Available new technologies for sustainable forest management	Climate change impacts on forests (wildfires, diseases, insects, erosion) Governance in the forestry sector is focused on traditional systems/approaches Illegal activities and rural poverty level Forestry not in the leading policy agenda Still high and unsustainable demand for firewood Economic activities in the forest fund (mining, hydropower development, intensive tourism) Reinvestment of forestry-generated income Lack of capacities for EU standard implementation (EUTR) Lack of cross-sectoral communication and strategy harmonisation Demographic changes, decrease of population and emigration Resistance to change from within and outside the forest sector

The analysis of the forest sector reveals a multitude of aspects to be potentially addressed by future interventions. In the next section, the most important priority thematic areas for the Albanian forest sector are identified.

Chapter III.

Priority thematic areas in the forestry sector

In summary, the priority thematic areas listed below need to be addressed in the future. The priorities for actions related to specific areas will be described for some of them. The topics below represent some of the problems that cause gaps in sustainable management of forest resources in Albania.

a. Institutional and legislative context of the sector

The second strategic goal of the main strategic policy document in the forestry sector is aimed to establish, put into operation, and strengthen an efficient and effective institutional organisational system, which operates according to the best standards and practices, ... and with modern infrastructure, technology, and innovation.

Consolidation of the organisational structure of NFA through the establishment of the organisational structures of NFA in 4 regions. The organisational structure of NFA should be improved in accordance with its responsibilities as well as challenges of the forestry sector in the near and distant future.

It is a necessity the increase NFA staff and infrastructure capacities and in fields like IT, remote sensing and mapping, to enable NFA to better perform its National Forest Inventory and ALFIS responsibilities.

Municipalities have designated structures or persons responsible for forests, but there is a variety of forms or names for these structures, such as: Agency, Directorate, Department, etc. Often the responsible unit for forests is attached to the responsible structures for agriculture, environment, waters, water basins, etc. There is no clear orientation and organisation of the structures responsible for forests in the country's municipalities.

Further consolidation of the decentralisation process in the forestry sector is required, through the standardisation of structures responsible for forests at the municipal level and the completion of the forest registration process in all municipalities as two important elements towards a sustainable governance of forests by communities.

Priority topics/fields of action

- ii. Complete the vertical structural organisation on the territory of the National Forest Agency
- iii. Standardise the structural organisation of the municipality administration responsible for forests and complement these structures with trained human capacities
- iv. Establish in all municipalities control/inspection structures responsible for forestry, separated from the management structures, and support the implementation of the forest inspection system from the central (NFA) to the local level (municipalities)

b. Integrated governance system in the forestry sector

To achieve the main forestry policy objective of "... sustainable contribution of forests to a better life for society today and future generations" and considering the European Green Deal – the roadmap for **making the EU's economy sustainable** by turning climate and environmental challenges into opportunities across all policy areas and making the transition just and inclusive for all, the sector needs an integrated governance system. This system, among other things, should include the consolidation of the forest planning system, the planning and financing of the implementation of planting plans (operational plans), the infrastructure of protection from diseases and pests, the infrastructure of forest protection from fire.

The EU Forest Strategy for 2030 foresees forest management plans as the main strategic planning document in the forestry sector and new concepts, such as closer-to-nature forest management or forest landscape restoration, aiming to increase the resilience of the forestry sector facing climate change impacts.

The forest management plan is the basic document for the sustainable governance of a forest economy, which contains the analysis of the state of forests, defined objectives that must be achieved regarding their status, as well as measures for their treatment and interventions for the next 10 years.

The technical governance of the forest and pasture sector is done based on the implementation of forest management plans and the development of a forest management plan is a legal obligation for forest owners. Among a total of 417 forest economies in the country, only 42 forest economies are covered with management plans and other 32 management plans are in the process of development. Less than 20% of forest economies have a management plan.

The lack of forest management plans is a very big problem for sustainable management of forests, standardisation of activities and operations in the forestry sector, establishment of the new forest cadastre register, and the updating of the forest information system (ALFIS). Forest management plans are a prerequisite for the municipalities and rural communities to get support from the IPARD III Programme.

In the last 5 years, the level of impact and damage to coniferous forests in Albania has reached its peak. The sector lacks a system for monitoring and combating diseases and pests in forests.

Monitoring the health status of forests is not a priority and new pests have been identified. The protection of forests is today a problem that crosses borders because fire and forest pests spread knowing no borders. A regional or integrative approach is necessary in setting up these systems.

Forest fires are the main cause of damage in forests, mainly due to human causes, but with greater intensity and degree of damage as a result of the impact of climate change.

Regardless of the concentration of responsibility for fighting forest fires at the central level of government, the coordination of local and central structures is still insufficient, as is the fighting infrastructure.

Priority topics/fields of action

- i. Ensure financial support for municipalities from the government or international partners for the design of forest management plans for all forest economies.
- ii. Revise and improve the Forest Management Plan Guidelines based on closer-to-nature forest management. Include in the guidelines practical closer-to-nature silvicultural measures to be implemented in the different development stages of forest stands.
- iii. Build separate capacities for forest management planning at all levels (NFA and municipalities) in order to develop and maintain forest management plans and increase their capacities continuously through a network of training sites.
- iv. Ensure financial support for municipalities from the government or international partners to establish permanent processes and capacities for the design and implementation of forest operational plans.
- v. Establish a permanent and functional forest protection system for monitoring and combating diseases and forest pests based on the examples of animal and plant protection.

c. *Digitalisation of the forest sector*

Strengthen the capacity of NFA for environmental/forest monitoring and information management in Albania by establishing an operational environmental information management and monitoring system as Albanian Forest Information System (ALFIS). The system is in place but is not yet fully functional.

The need for a Forest Information and Monitoring System that is integrated throughout relevant government institutions and that uses international monitoring standards for indicator development, data collection, analysis, and policymaking should be addressed.

Increase the existing technical and institutional capacities in NFA to align its management and monitoring efforts with global monitoring and reporting priorities of the ministry responsible for the environment.

Increased human and infrastructural capacities in this area will improve reporting to the Rio Conventions, European Environmental Agency, EU and lay the groundwork for sustainable development of forest resources through better-informed forest and environmental policy. Without these systems, it will be impossible to fully implement the future responsibilities of Albania for EUTR.

The evaluation of the progress towards SFM needs a system of monitoring and evaluation criteria and indicators on SFM.

Through digitisation, it is also possible to introduce new technologies in forest governance, such as remote sensing technologies, the field of use of which in the forestry sector is very large.

Priority topics/fields of action

- i. Make ALFIS fully functional from the infrastructural point of view and increase NFA capacities to operate and maintain it
- ii. Finish the consolidation of forest property registration process in all municipalities to open the way to establish a digital forest cadastre
- iii. Establish a digital forest cadastre within ALFIS and increase the capacities of NFA and municipality forest staff to develop the necessary procedures
- iv. Make fully functional the module of Forest Europe Criteria and Indicators (C&I) Monitoring module within ALFIS, and increase the capacities of NFA and municipality forestry staff to develop the necessary Forest Monitoring Programme within the National Environmental Monitoring Programme
- v. Start the 2nd cycle of the National Forest Inventory and support NFA to increase the infrastructural and human capacities of a dedicated structure for implementing ANFI in a rotation cycle of 8 years
- vi. Establish within NFA in cooperation with the Faculty of Forestry Sciences a forest mapping facility with the necessary infrastructure and provide necessary training for the personnel

d. *Investment programmes in the forestry sector*

Albania's forest resources are today at a stage that requires increased care to place their development on the path of a sustainable governance.

Regardless of some initiatives in recent years to increase forested areas, a national afforestation programme is needed for a period of at least 10 years. The drafting of this programme requires the pro-

vision of funding sources years in advance, as well as initial investments in large nurseries that will support the realisation of this programme.

This programme should be designed on the approach of forest landscape restoration, as a recommended approach in the framework of the EU Forest Strategy for 2030.

Albanian forests have an uneven structure of area and standing volume per age classes, dominated by young forests. More than two-thirds of the area and 50% of the standing volume of high forests are younger than 80 years old and nearly all coppice forests are younger than 40 years old, which represents an important challenge for the future of sustainable management of Albanian forests.

Under the European Green Deal, the EU Biodiversity Strategy for 2030 sets a path for the recovery of Europe's biodiversity, including its forest biodiversity. The Biodiversity Strategy for 2030 highlights the importance of sustainably managing forests as a nature-based solution in the fight against climate change, and it calls for biodiversity-friendly forestry practices to continue and to be further developed. The EU Forest Strategy for 2030 echoes this commitment and defines closer-to-nature forest management as a set of practices to ensure multifunctional forests by combining biodiversity goals, carbon stock preservation and timber-related revenues. Without the implementation of the necessary silvicultural interventions in young forests, it will be difficult to promote biodiversity-friendly and adaptive forest management as part of a common framework for closer-to-nature forest management.

In this context, the forests of Albania today have an urgent need to be served and taken care of, such as silvicultural interventions (afforestation, reforestation, clearing, thinning, etc.)

Priority topics/fields of action

- i. Support the establishment of at least 2-3 public forest nurseries as a basis for a long term afforestation and reforestation programme
- ii. Revise and support the funding of the existing forest afforestation programme prepared by NFA in collaboration with municipalities
- iii. Establish a forest seed testing laboratory at the Faculty of Forestry Sciences to ensure the quality of forest seeds and seedlings to be planted
- iv. Draft a 10-year programme of silvicultural interventions in young forest stands based on forest management plans. The IPARD III Programme can be a powerful tool of support for the implementation of this programme

e. Education, research and training in the forestry sector

SFM is accepted as the primary approach in the development of the forestry and pasture sector in Albania. This concept is sanctioned in all the main forest policy documents in the country, including the Law on Forests.

The practical implementation of this concept leaves much to be desired for many reasons. A clear orientation of education, scientific research and innovation in forests in support of solving problems on the way to SFM is necessary.

During the discussion on the implementation of a Closer-to-nature Forest Management with forestry experts, lack of local studies regarding the development of high forest stands came up, but other silvicultural systems should also be considered.

This lack can be one of the possible obstacles for implementing a forest governance system based on the concept of closer-to-nature forest management.

On the other hand, the implementation of this concept makes it necessary to undertake intensive studies on the impact of silvicultural interventions on the development of forest stands in different stationary conditions and treated under different silvicultural regimes.

The concept of border diameter, despite being known by forestry professionals, has not been implemented so far in the practice of forest management.

All this, among other things, makes it necessary to adapt the study programmes for forestry specialists and their orientation towards the transfer of knowledge on new concepts of forest cultivation with the aim of mitigating the effects of climate change.

Likewise, basic or applied forestry research should be intensified to seek nature-based solutions for the above-mentioned problems.

Both of these aspects of education and scientific research in forests require a relatively long time to be implemented and these processes have already started. The Agricultural University of Tirana will sign a 5-year cooperation agreement with the University of Life Sciences (BOKU) in Vienna in a few weeks.

Under this framework, the three pillars of higher education will be restructured, such as education, research and services to society and innovation following the example of BOKU.

Forest experience from countries such as Austria and Germany have shown us that the implementation of a sustainable governance of forests based on nature requires continuous training of forestry professionals.

Priority topics/fields of action

- i. Establish a National Professional Training Centre in the forestry sector in collaboration between the Faculty of Forestry Sciences and the National Forestry Agency, as a responsible structure for the coordination of professional training activities in forests. The centre will operate based on a yearly professional training programme in the forestry sector.
- ii. Establish a career system in the forestry sector based on continuous training and revise the respective legislation in collaboration between the Faculty of Forestry Sciences and the National Forestry Agency.
- iii. Establish a network of experimental areas for the purpose of research and training in the forestry sector. Such a network within the former Forest Research Institute no longer exists.
- iv. Revise forestry expert legislation and connect licensing with continuous professional training activities.

Chapter IV. Recommendations

Regardless of the importance of all topics, we recommend an intervention in the form of a project with a focus on the following:

- (i) Revise the forest management plan guidelines following the concept of closer-to-nature forest management and include in it a manual for silvicultural interventions.
- (ii) Establish a network of sample plots (one is already established in a high beech forest stand) on the example of Integrate+, for the purposes of training forestry staff that will deal with forest management and support the training activities of this staff.
- (iii) Make the Forest Information System (ALFIS) functional in terms of software and hardware, including all its modules (planting plans, digital forest cadastre, forest monitoring and reporting system).
- (iv) Raise the capacities of NFA and municipalities for the operation and maintenance of ALFIS and on remote sensing techniques, supporting the implementation of the National Forest Inventory, design of forest management plans, and the forest monitoring programme.

Support in these priorities will ensure and facilitate the establishment of an integrated system of governance of forest resources based on the digitisation of the forestry sector, thus responding to the challenges of the sector in relation to human capacities and insufficient financing.

The review of the forest planning system as well as of the forest information system are some of the current topics in the focus of the Albanian Government and the National Forestry Agency.

2.3. Draft Policy Analysis Document: Country Report Federation of Bosnia And Herzegovina

Prof. Bruno Maric

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Abbreviations

B&H	Bosnia and Herzegovina
CCA	Climate Change Adaptation
CBD	Convention on Biological Diversity
EU	European Union
FAO	Food and Agriculture Organisation
FB&H	Federation of Bosnia and Herzegovina
FMAWMF	Federal Ministry of Agriculture, Water Management and Forestry
FP FB&H	Forest Programme of the Federation of Bosnia and Herzegovina
GIS	Geographic Information System
MOFTER	Ministry of Foreign Trade and Economic Relations
NGOs	Non-governmental organisation
RS	Republic of Srpska
SFM	Sustainable forest management
SDG	Sustainable Development Goals
UNFCCC	United Nations Framework Convention on Climate Change

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1. Introduction

Forests within Bosnia and Herzegovina (B&H) stand as invaluable natural assets, encompassing a wide array of forest habitats that host a rich and diverse flora and fauna (Anon, 2010). The predominant forest type comprises high forests with natural regeneration, accounting for 51% of the total, followed by low or coppice forests at 38%. This distribution reflects the overarching emphasis on a closer-to-nature approach to forestry and forest management, as well as the concerted efforts made to bolster the industrial raw material base during the late socialist era. Forests in B&H exhibit an extensive diversity of forest types, spanning from coastal Mediterranean woodlands to mountainous forests in central B&H. These forests are among the nation's paramount natural resources. Their inherent natural and diverse structure, coupled with widespread natural regeneration, render them pivotal resources for B&H's ongoing development. The primary tree species encountered include fir, spruce, Scots and European pine, beech, various oak species, and a modest presence of noble broadleaved trees such as maple, elm and ash, alongside fruit-bearing trees like cherry, apple and pear. Approximately 80% of these forests are publicly owned, with the remaining 20% under private ownership (FAO, 2015).

With obvious significance of forest resources for B&H, it is important to mention international processes that have a significant impact on the Federation of Bosnia and Herzegovina's (FB&H) forest management policies.

- United Nations Framework Convention on Climate Change (UNFCCC): an international treaty designed to address the global issue of climate change. It sets out to reduce greenhouse gas emissions and enhance climate resilience to combat the adverse effects of a changing climate. Forests are crucial within this framework because they act as a sink for carbon dioxide (carbon sequestration). They absorb carbon dioxide from the atmosphere, helping to mitigate climate change. Additionally, well-managed forests are essential for climate adaptation as they can provide protection against natural disasters and changes in temperature and precipitation. The UNFCCC influences B&H's forest policies by emphasizing the need to manage forests sustainably, ensuring their capacity to sequester carbon. It also underscores the importance of adapting forest management practices to changing climate conditions.
- United Nations Sustainable Development Goals (SDGs): are a set of global objectives aimed at addressing a wide range of social, economic, and environmental challenges to achieve a more sustainable and equitable world. Goal 15 specifically pertains to terrestrial ecosystems and underscores the importance of protecting, restoring, and sustainably using terrestrial ecosystems, including forests. It promotes responsible forest practices to maintain biodiversity and ecosystem services. SDG 15 exerts an influence on B&H's forest management practices by emphasising the need for sustainability, biodiversity conservation, and responsible forest management. It encourages the integration of environmental and social considerations into forest policies.
- EU Integration: B&H is pursuing integration into the European Union (EU). This process involves harmonising its national policies and regulations with EU standards and requirements. The EU has a comprehensive forest strategy that outlines guidelines for sustainable forest management, biodiversity conservation, and climate adaptation. It also contains regulations and standards for timber and forest-based products. As B&H seeks EU integration, it must align its forest management policies with EU standards. This alignment influences forest practices and governance to meet EU expectations, fostering sustainable forest management and the responsible trade of forest products.

The purpose of this document is to assess the state of forest policy in the FB&H and its alignment with international and EU processes. It aims to identify gaps in achieving sustainable forest management, particularly in the context of climate change, and provide recommendations for addressing these gaps.

2. SWOT analysis of the B&H, FB&H forestry sector

STRENGTHS S	WEAKNESSES W
Rich Forest Resources: B&H has substantial forest resources FSC certified, and there is untapped potential for a renewable natural resource strategy.	Lack of Legal Framework: The absence of a comprehensive legal framework, such as a Law on Forests in FB&H, is a significant weakness, hampering forestry sector regulation and management.
FSC Certification: The introduction of Forest Stewardship Council (FSC) certification has led to an improvement in forest management practices, particularly with respect to high conservation value forests.	Ineffective Public Forestry Administration: The current organisation of the public forestry administration has proven ineffective, and there is a need for reorganisation and a more functional model.
Biodiversity and Environmental Role: Forests in B&H play a major role in biodiversity conservation, water provision and environmental protection. B&H's diverse forest ecosystem needs to be more effectively incorporated into forest management planning.	Institutional Gaps: Weak institutional platforms for strategic forest policymaking and a lack of capacities and resources among private forest owners hinder sustainable forest management.
Cross-Sectoral Strategies: The forestry sector can benefit from cross-sectoral strategies and regulations related to rural development, energy policies, spatial planning, environmental policies, and rural development strategies.	Inadequate Education and Training: Education and training in the forestry sector are insufficient, both in terms of practical training and addressing socio-political and economic aspects of natural resource management.
Close-to-Nature Management Practices: The application of closer-to-nature forest management principles within the forestry sector enhances ecosystem services and biodiversity conservation.	Law Enforcement and Corruption: Challenges such as insufficient law enforcement, political instability, complex inter-entity dialogue, corruption, and illegal activities, like illegal logging, are barriers to attracting private investments.
OPPORTUNITIES O	THREATS T
Renewable Resource Strategy: The potential for a stronger role in a renewable natural resource strategy exists, especially if new forest inventory data is published.	Legal and Regulatory Challenges: Overcoming political and administrative obstacles, as well as the absence of a comprehensive legal framework, may pose significant threats to the development of the forestry sector.
Use of Unproductive Areas: Making unproductive and inaccessible areas productive offers a substantial opportunity to increase forest resource utilisation.	Climate Change: The forestry sector is vulnerable to climate change, and the absence of a monitoring system may hinder effective adaptation and strategic decision-making.
Incorporating Biodiversity into Management: Properly incorporating the rich biodiversity in B&H's forests into forest management planning can enhance conservation efforts and potentially create opportunities in eco-tourism and other areas.	Biodiversity Loss: The lack of data on biodiversity and ecosystem status, as well as insufficient conservation measures, pose a threat to biodiversity.
Inter-Sectoral Collaboration: The alignment of forest sector activities with other sectors such as rural development, energy, and environmental policies presents an opportunity for more coherent and integrated planning.	Land Mine Contamination: Areas still mined are not effectively utilised, impacting land management and limiting access to forest resources.
Diversification of forest products is a significant strength of the forest sector because it offers several advantages, contributing to the sector's resilience and economic viability.	Lack of Capacity and Education: A lack of capacity and insufficient education in socio-political and economic aspects of natural resource management may continue to hinder development and modernisation.

The forestry sector in B&H and FB&H is rich in resources and has the potential for further growth. However, it faces significant challenges related to legal frameworks, forest administration, education, and cross-sectoral cooperation. Addressing these weaknesses and seizing opportunities, such as incorporating biodiversity into management and expanding the role of forests in renewable resource strategies is vital for the sector's sustainable development. Additionally, overcoming threats such as complex administrative organisation, political obstacles, climate change and land mine contamination is essential for the sector's long-term success.

3. Gaps in Sustainable Forest Management under Climate Change Challenges

The sustainable management of forests plays an important role in the global fight against climate change, while forests serve as a natural and renewable resource that sequesters carbon, maintains biodiversity, and safeguards vital ecosystems. B&H as a country endowed with rich and diverse forest resources, faces a multitude of challenges in achieving sustainable forest management (SFM), especially in the context of climate change. The Forestry Programme of the FB&H recognised climate change as an important challenge and it was conceived in such a way that it includes 9 thematic areas:

1. Jurisdiction, legislation and organisation of the forestry sector
2. Sustainable management of forest ecosystems
3. Socio-economic aspects of forest resource management
4. Relations between forestry and the wood-processing industry
5. Non-timber forest products and services
6. Environmental protection and spatial planning
7. Forests and climate change
8. Education, research and development in forestry
9. Information, communication and public relations

While forests possess the potential to contribute significantly to environmental preservation, economic development, and societal well-being, there are gaps in SFM in FB&H that jeopardise these aspirations.

- Absence of a comprehensive law on forests: The lack of a comprehensive Law on Forests at the federal level in FB&H hinders the establishment of a unified regulatory framework for sustainable forest management. This legal gap needs to be addressed to provide clear guidelines and principles for forest management.
- Lack of climate adaptation strategies: Insufficient emphasis on adapting forest management practices to the changing climate, which includes addressing the increased risk of forest fires, pest infestations, and drought.
- Lifelong learning system: A consistent lifelong learning programme for forestry professionals is missing. Enhancing education and training programmes is crucial for developing the skills and knowledge needed to address contemporary challenges in the forestry sector.

- **Ineffective public forest administration:** The current organisation of public forest administration in FB&H is deemed ineffective. Reorganising and developing a more functional model is necessary to enhance the efficiency of forest management and bridge the gap between forest ownership and management functions.
- **Lack of inter-institutional cooperation:** There is a need for better cooperation between various institutions in the forestry sector and related fields such as water management, agriculture, environment, tourism, and energy. Harmonising regulatory instruments, policies and strategies among these sectors is crucial for integrated and sustainable forest management.
- **Inter-entity cooperation:** The forest sector in B&H is regulated separately by entity laws, resulting in a lack of coordination and harmonisation of policies and practices between entities. Bridging this gap and ensuring inter-entity cooperation are essential for consistent and sustainable forest management.
- **Climate change monitoring:** There is a lack of an adequate monitoring system and central database for tracking climate change impacts on forest ecosystems in FB&H. Continuous monitoring is essential for making informed decisions and addressing climate change challenges.
- **Inadequate stakeholder engagement:** Limited involvement of local communities and other relevant stakeholders in forest management decisions.
- **Communication and information sharing:** Communication capacities within the forestry sector are underdeveloped. Strengthening communication, securing budget resources, and implementing a communication strategy can bridge this gap and facilitate information sharing among sector stakeholders.
- **Diversification and marketing:** Diversification in the forest sector beyond wood products requires support for marketing platforms, branding, and promotion of non-wood forest products (NWFP) and end-manufactured wood products.
- **Training and capacity building:** Investment in capacity building through training programmes is essential for modernising forest operation, meeting EU standards, and fostering an understanding of socio-political and economic aspects of natural resource management.
- **Coppice forests:** Specific attention should be given to addressing the role of coppice forests, particularly in biodiversity conservation and biomass production.
- **Private forest owners:** The capacities and resources of private forest owners are insufficient for proper forest management. Encouraging the formation of forest owner associations can help address this gap.
- **Investment needs and challenges:** Investments are required in various aspects, including infrastructure, technology, human resources, and legal and political frameworks. Overcoming law enforcement issues, political instability and corruption is essential for attracting private investments.

4. Adoption of the Law on Forests in FB&H

The regulatory framework in Bosnia and Herzegovina (B&H) presents a significant challenge in achieving adaptive and participatory forest management. The complexity of this framework is particularly evident given the decentralised nature of the forestry sector, with organisation occurring at the entity level. To provide some context, the Law on Forests (Official Gazette of the FB&H, No. 20/02, 29/03 and 37/04) ceased to be in effect on 27 November 2009, following a decision by the Constitutional Court of the FB&H on 14 April 2009 (Official Gazette of the FB&H, No. 36/09). In lieu of a new forest law, the Government of the FB&H introduced a Regulation on Forests (Official Gazette of the FB&H, No. 83/09, 26/10, 33/10, and 38/10) as a temporary measure. The Constitutional Court of the FB&H, in its Decision No. U-28/10 dated 23 March 2011 (Official Gazette of the FB&H, No. 34/11), stipulated that the Regulation on Forests would remain in effect until 6 December 2011. However, after 6 December 2011, the Regulation on Forests lost its legal standing, and no new law on forests has been passed yet. This legal void has left the forestry sector in the FB&H without a clear regulatory framework (FAO, 2015).

In 2017, during the 110th session, the Government of the FB&H reviewed and forwarded the Draft Law on Forests, prepared by the Forest Management and Advisory Working Group, to the parliamentary procedure. Subsequently, in 2018, 2019, 2020, and 2021, the Government of the FB&H made urgent requests to the House of Representatives and the House of Peoples of the Parliament of the FB&H to include the Draft Law on Forests in their agendas. Unfortunately, to this day, the proposed law has not been considered in either house of the Parliament of the FB&H. One consequential outcome of the failure to enact a federal regulation on forestry is that nine cantons within the FB&H have enacted their own regulations concerning forestry. This decentralised approach compromises the competencies defined in the Constitution of the FB&H, leading to varying regulations on forest management, ownership, and allocation of financial resources for forest use, protection, and enhancement. This fragmentation is inconsistent with constitutional provisions (FMAWMF, 2019, 2021, 2022).

Preparing and adopting an umbrella law on forests at the federal level, with a focus on sustainable forest management, ownership and allocation of financial resources, is a complex and time-demanding process that requires careful planning and coordination. It is necessary to undertake the following steps:

- **Stakeholder engagement:** At the outset, the government of FB&H and relevant authorities engage with a broad spectrum of stakeholders. This includes representatives of the public forest administration, public forest companies, forest experts, environmental organisations, local communities, and non-governmental organisations. Their expertise and input are considered essential for drafting a comprehensive and balanced law.
- **Legal and policy analysis:** Ensure alignment with international agreements and conventions on forestry, such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD) and other relevant international processes and strategic documents, with special focus on EU requirements and standards. A thorough review of existing forestry laws and regulations at both the FB&H and cantonal levels should be undertaken. This analysis seeks to understand the current strengths and weaknesses of the legal framework and identifies areas that require improvement or alignment.
- **Drafting an umbrella law on forests in FB&H:** Clear objectives are established for the umbrella law. These objectives include the promotion of sustainable forest management, defining the compe-

tences, rights and obligations of all levels of government in matters of ownership and management of forest resources. Principles of sustainable forest management, such as conservation, restoration, and responsible resource utilisation are outlined in the draft law. Ownership and access rights are defined, considering the interests and needs of local communities, NGOs and private forest owners. A framework for allocating financial resources for forest use, protection, and enhancement is established.

- **Public consultation:** A critical part of the process involves public consultations. The government solicits input and feedback from stakeholders, including local communities and relevant organisations, to ensure that the law reflects their concerns and perspectives.
- **Legislative process:** The draft law should be submitted to the federal parliament for review. Throughout this stage, close engagement with parliamentarians is maintained to build support for the legislation. Relevant parliamentary committees, such as those overseeing the environment, agriculture and forestry, review the draft law.
- **Monitoring and evaluation:** Systems for monitoring and evaluating the impact of the law on forest management and conservation are established. The law should be adaptable, with provisions for making the necessary adjustments based on ongoing assessments and changing circumstances.
- **Enforcement and compliance:** The law specifies enforcement mechanisms and penalties for violations to ensure compliance and adherence.
- **Review and adaptation:** Regular reviews of the law are scheduled to ensure it remains effective and up-to-date. As circumstances change and new challenges arise, the law may need to be adapted accordingly.
- **Legal harmonisation:** The FB&H law on forests should be designed in a way that allows coordination with existing cantonal laws. This ensures that federal regulations provide a framework that can be adapted and complemented by cantonal laws, while maintaining consistency and conformity with provisions of the federal law.
- **Adoption and implementation:** Advocacy for the adoption of the law in the federal parliament is necessary and essential, as well as provision of support for its effective implementation across the FB&H.

Recommendation: It is imperative that the authorities in the FB&H expedite the development and adoption of an umbrella law on forests, developed with respect to the principles of forestry science and profession, participation, transparency and consensus, while overcoming political and administrative restrictions and precisely defining the competences, rights and obligations of all levels of government in matters of ownership and management of forest resources. It is necessary to carry out a comprehensive analysis of the existing constitutional and legal solutions regarding the competence, rights and obligations of all levels (FB&H) of legislative and executive power (federal, cantonal and municipal) in the context of ownership, management and management of forest resources. The umbrella law on forests in FB&H needs to be developed and adopted on the principles of forestry science and profession, and the process of its creation, adoption and implementation should be based on the principle of participation of all interested parties, transparency of the process itself and consensus of stakeholders.

5. Development and Adoption of Climate Adaptation Strategies

The lack of climate adaptation strategies in B&H FB&H poses a significant challenge, especially regarding the urgent need to adjust forest management practices in response to a changing climate. This encompasses a heightened risk of forest fires, pest infestations, and prolonged periods of drought. B&H is notably vulnerable to climate change due to its geographical location, the substantial economic importance of agriculture and forestry and its limited capacity to adapt. Over recent decades, certain regions have experienced a noteworthy rise in summer temperatures, reaching up to 1.2°C. Concurrently, rainfall patterns have undergone significant alterations. Climate models predict that the average annual temperatures will increase by 2° to 4°C throughout the remainder of the century, with summer temperatures potentially soaring by as much as 4.8°C. These projections necessitate fundamental changes in agricultural, forestry, and land management practices.

Climate change could have a profound impact on B&H's forests, leading to long-term transformations in forest ecosystems and altering their distribution and composition. Some forest reserves exhibit greater resilience to climate change, but potential impacts still loom. Even resilient beech forests could be susceptible to pathogens, diseases, and an increased risk of fire, particularly in low-rainfall areas in the northeast. Low-altitude oak forests and high-mountain forests face similar risks. Coniferous forests, in particular, are susceptible to pest outbreaks in warmer temperatures, including beetle infestations, and increased fire risks. Simulations based on a 2°C average temperature rise predict adverse consequences for the distribution of dark coniferous forests. Fir trees are also at risk due to rising temperatures, while other species expand their range to higher altitudes. Many tree species, especially broadleaves, experience stress from drought, potentially impacting numerous forest species. Climate change may lead to multiple stresses, where changes in soil moisture, rainfall, temperature, and pathogens create a hostile environment, resulting in high tree mortality. Species located in the central part of their distribution range tend to be more climate-resilient than those on the periphery.

The vulnerability of ecosystems to the impacts of climate change has intensified due to their degradation, fragmentation, and various human-induced influences. The national reports from Bosnia and Herzegovina on climate change and biodiversity protection highlight climate change as a major factor disrupting biodiversity. Climate change effects on different ecosystems manifest through a wide range of complex interactions, often working in synergy with other factors. When interacting with other elements, climate change significantly influences the timing and duration of specific seasons. This, in turn, has a profound impact on the length of the growing period and the timing of critical phenophases. These effects are initially noticeable in changes to plant phenophases, but they also extend to all facets of biodiversity, leading to alterations in the distribution of populations and species and affecting ecosystem functioning. According to the First National Communication of Bosnia and Herzegovina (2009), the following vulnerable areas are under significant pressure from the changing climate: high mountain ecosystems, mountain ecosystems, sub-Mediterranean forests and shrub ecosystems, karst cave ecosystems, valley and abyss ecosystems, hilly area ecosystems, peri-Pannonian area ecosystems, and Pannonian ecosystems.

To establish an effective mechanism for seamless horizontal and vertical communication and facilitate unrestricted exchange of information in the domain of monitoring measures and Climate Change Adaptation (CCA) activities within the forestry sector, several key factors must be considered. Primarily, the complex constitutional arrangement of B&H necessitates careful consideration. Additionally, it is essential to respect the legally defined responsibilities of institutions at various levels, including

the national level of B&H, the entity levels of RS and the FB&H (while also acknowledging the roles of the Cantons within the FB&H), and at the level of the Brčko District of B&H. To effectively adapt to climate change, it is essential to enhance or establish suitable institutional frameworks for climate change governance within the forestry sector, with particular attention to multilevel coordination among diverse stakeholders. Recognising the significant role of the forestry sector in climate change governance within the FB&H is imperative. While the FB&H forestry sector has yet to take tangible actions to incorporate and implement adaptive forest management practices in response to the evolving climate conditions, which encompass the need to mitigate heightened threats such as forest fires, pest infestations and drought, it is imperative to initiate specific adaptation measures in close coordination with all administrative levels within B&H and collaborate with scientific institutions. The proposed measures for forestry and biodiversity are outlined in the Bosnia and Herzegovina National Adaptation Plan as follows:

Table 1. Measures for biodiversity and forestry

Measure	Responsible institutions	Time frame
Making a study into the impact of climate change on biodiversity and forestry	MOFTER – coordination, Government of RS, Government of FB&H, Government of BD, Environmental Protection and Energy Efficiency Fund of RS, Environmental Fund of the FB&H; scientific institutions	2021-2024
GIS mapping of forest areas	MOFTER— coordination, Government of RS, Government of FB&H, Government of BD, Environmental Protection and Energy Efficiency Fund of RS, Environmental Fund of the FB&H; scientific institutions	2021-2024
Afforestation with native and fast-growing species	MOFTER— coordination, Government of RS, Government of FB&H, Government of BD, Environmental Protection and Energy Efficiency Fund of RS, Environmental Fund of the FB&H; scientific institutions	2021-2030
Tree health survey and replacement of damaged trees in urban areas	MOFTER— coordination, Government of RS, Government of FB&H, Government of BD, Environmental Protection and Energy Efficiency Fund of RS, Environmental Fund of the FB&H; Scientific institutions	2021-2030
Development of a system to monitor the impact of climate change on biodiversity	MOFTER— coordination, Government of RS, Government of FB&H, Government of BD, Environmental Protection and Energy Efficiency Fund of RS, Environmental Fund of the FB&H; scientific institutions	2021-2025
Revision of Red Lists with field research	MOFTER— coordination, Government of RS, Government of FB&H, Government of BD, Environmental Protection and Energy Efficiency Fund of RS, Environmental Fund of the FB&H; scientific institutions	2021-2025
Examining the impact of climate change on mountain lakes and ecosystems	MOFTER— coordination, Government of RS, Government of FB&H, Government of BD, Environmental Protection and Energy Efficiency Fund of RS, Environmental Fund of the FB&H; Scientific institutions	2021-2025
Increasing the percentage of protected areas	MOFTER— coordination, Government of RS, Government of FB&H, Government of BD, Environmental Protection and Energy Efficiency Fund of RS, Environmental Fund of the FB&H; scientific institutions	2021-2025
Examining the impact of climate change on the endemic fauna of karst areas	MOFTER— coordination, Government of RS, Government of FB&H, Government of BD, Environmental Protection and Energy Efficiency Fund of RS, Environmental Fund of the FB&H; scientific institutions	2022-2025

Measure	Responsible institutions	Time frame
Development of pilot studies and installation of “green roofs”	MOFTER— coordination, Government of RS, Government of FB&H, Government of BD, Environmental Protection and Energy Efficiency Fund of RS, Environmental Fund of the FB&H; scientific institutions	2021-2030
Making a study into forest fires and mapping of burned areas in B&H	MOFTER— coordination, Government of RS, Government of FB&H, Government of BD, Environmental Protection and Energy Efficiency Fund of RS, Environmental Fund of the FB&H; scientific institutions	2021-2024

Source: Bosnia and Herzegovina National Adaptation Plan, 2021

Recommendation: Develop and implement a comprehensive climate adaptation strategy for the forestry sector in B&H, FB&H focusing on sustainable forest management, capacity building, multilevel governance, early warning systems, research, and collaboration with all administrative levels and scientific institutions to address the specific challenges posed by climate change and enhance the resilience of the forests and ecosystems.

6. Lifelong Learning System in the FB&H forestry sector

There are several significant challenges evident in the forestry sector of the FB&H concerning lifelong learning and scientific research projects. It is evident that both institutions and employees in the forestry sector approach lifelong learning differently after formal education. The absence of a formal lifelong learning policy leaves this aspect largely to individual interests and needs. To foster lifelong learning, it is crucial to recognise it as a collective responsibility involving employers and the broader social community. This recognition should be based on the specific requirements and needs of business entities, public forestry administration, and the non-governmental sector.

The concept of lifelong learning entails the ongoing acquisition and refinement of knowledge, as well as the development of professional competencies among employees in the forestry sector. This process is realised through a combination of compulsory and elective educational programmes that span one’s entire career. In alignment with global development trends and aspirations to integrate into the European knowledge society, it becomes imperative to craft a comprehensive lifelong learning programme. Such a programme should encompass a thorough needs assessment, the creation of relevant educational materials, and the establishment of the necessary organisational framework to facilitate its implementation. Furthermore, it is crucial to institute a credible and legally grounded licensing system that governs the performance of specific roles and tasks within the forestry sector.

Table 2. Measures for establishment of lifelong learning program in the FB&H forestry sector

Measure	Responsible institution	Tim frame	
Development of lifelong learning programmes	Determination of needs based on the analysis of the current situation in the FB&H forestry sector	Ministry of Agriculture, Water Management and Forestry of the FB&H, Faculty of Forestry	2024-2025
	Development of educational content for target groups outside the regular education system	Faculty of Forestry	2024-2025
	Development of organisational frameworks for the implementation of lifelong learning programs	Faculty of Forestry	2024-2025
Establishment of a licensing system	Legal regulation of the licensing system in forestry (depends on the adoption of the Law on Forests FB&H)	Ministry of Agriculture, Water Management and Forestry of the FB&H	2024-
	Establishment of a professional licensing body	Ministry of Agriculture, Water Management and Forestry of the FB&H and Professional Forestry Association	2024-2025

Source: Study Education, Research and Development in Forestry, 2011

The establishment of lifelong learning programmes in the FB&H forestry sector hinges on a well-structured approach, including:

- **Needs assessment:** The initial step involves a thorough needs assessment, primarily based on a comprehensive analysis of the current state of affairs within the FB&H forestry sector.
- **Educational content development:** Following the needs assessment, the development of targeted educational content for individuals who are outside the traditional educational system is essential. This content should cater to the specific requirements of the forestry sector.
- **Organisational frameworks:** To ensure the seamless implementation of lifelong learning programmes, it is imperative to create a professional organisational structure that can effectively coordinate and administer these initiatives.

In addition to the above, licensing for forestry work plays a critical role in maintaining the requisite quality of personnel across all levels and for various specialised tasks within the sector. To this end, it is vital to establish a legal framework for the licensing system in forestry, and concurrently, the formation of a specialised body with expertise to oversee and administer these licenses becomes imperative. This ensures that the forestry sector maintains high standards of competence and professionalism.

Recommendation: Establish a dedicated professional organisation for licensing in forestry FB&H, comprising representatives from government, educational institutions, forestry businesses, and non-governmental organisations with the aim of formulating and implementing a comprehensive lifelong learning policy for the forestry sector in FB&H. This entity should work collaboratively to define the specific needs, objectives, and standards for lifelong learning in forestry, fostering a collective approach to lifelong learning and ensuring its alignment with the diverse requirements of business entities, public forestry administration, and the non-governmental sector.

7. Literature

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2.4. Policy Analysis Document: Country Report Kosovo*

Prof. Faruk Bojaxhi

Legislation

Forestry activities are carried out according to Law No. 08/L-137 on Forests (09.03.2023)⁵.

In 2012, the Ministry of Environment, Spatial Planning and Infrastructure (MESPI) approved two laws related to forests: Law No. 04/L-087 on the Sharr National Park ⁶ and Law No. 04/L-086 on national park Bjeshkët e Nemuna⁷.

Based on the results of the survey carried out as part of the study on establishing starting points and indicators for the legality of forest use, most institutions think that the Law on Forests, even though it has been redrafted, is not clear enough.

Kosovo* has made significant efforts over the past years to participate in regional and international initiatives and conventions related to biodiversity and environmental protection, but this process has been constantly burdened by political problems. Kosovo* has become a cooperating member country of the European Environment Agency (EEA) together with the other five economies of SEE that are not members of the EU. For political reasons, Kosovo* has not yet ratified any of the international agreements in the field of biodiversity and/or the environment.

There are 46 by-laws (administrative instructions) related to forestry and hunting in different Ministries, and some of them have been amended and supplemented once or twice. In addition to the Constitution and the Law on Forests, there are about 13 laws that are directly or indirectly related to forests.

Policies and Strategies

With the support of the project GCP/KOS/007/SWE implemented by FAO, the Ministry of Agriculture, Forestry and Rural Development (MAFDR), has drafted and approved the Forestry Development Strategy (FDS) and Action Plan (AP) 2021-2030. Members of the working groups and sub-groups were the representatives of the main ministries and organisations, which had direct or indirect connections with the forestry sector. The FDS is an important effort to build capacities to address adverse conditions and cease current unsustainable practices.

The Forestry Development Strategy 2021-2030 was prepared in accordance with the EU Forestry Strategy 2021, to protect Kosovo's forest resources and promote their sustainable management. The 2021-2030 FDS is structured according to SMF criteria and approach agreed by Forest Europe. It takes into consideration the future political and socio-economic scenario of Kosovo*, as well as the generation of a theory of change that describes the steps and their connections that will lead to the planned outcome.

The action plan provides a detailed description of the strategic activities that will take place over the 10-year period. In this plan, implementation periods for projects, institutions responsible for the implementation of projects, the financial cost of each activity, and the sources of financing for each activity are defined.

5 LIGJI_NR08_L-137_PËR_PYJET_231023_192432 (1).pdf

6 LAW NO. 04/L-087 ON THE NATIONAL PARK SHARR (rks-gov.net)

7 LAW NO. 04/L-086 ON THE NATIONAL PARK BJESHKËT E NEMUNA (rks-gov.net)

SWOT ANALYSIS FOR THE FORESTRY SECTOR

STRENGTHS	WEAKNESSES
Strategic importance of forests (national resources) Existence of strategic and legal framework and administrative and management structures National Afforestation and Reforestation Programme 2018-2027 National Forest Vitality Programme Rich biodiversity Existence of Forestry Institute in Peja Good percentage of forest land in private ownership Forest under national parks represent areas of great importance for development and improvement of scientific research activities Use of wood biomass as a renewable energy source Considerable number of young experts graduated from the Faculty of Forestry and Environment	High quantity of technical wood is used as firewood Lack of public and political support to the forestry sector Low (modest) budget for the sector Unsatisfactory success of afforestation Weak legal framework on lease and change of use of forest land Ongoing irregular logging in forests and damage of forest land Poor forest infrastructure and lack of maintenance Limited private sector capacity for provision of professional forestry services Non-inclusion of the forestry sector in support measures (subsidies and grants, measure 202 and forest protection through IPARD) Lack of wild animal inventory and update of aromatic and medicinal plants inventory Insufficient funds for education about and research of environmental issues Non-functioning of the laboratory at the institute (lack of professional staff for applied forestry research) Lack of forest cadastre Underdeveloped wood industry, and lack of coordination between primary production and the wood processing industry No new forestry experts employed in public institutions
OPPORTUNITIES	RISKS
Increased economic, social and environmental value through multi-purpose forest management Increased employment Increased contribution to GDP Reproductive material, seeds and seedlings provided by forests of autochthonous origin Increased regular logging and meeting of local population needs Development of rural areas through multi-purpose use of forest resources Expansion of forest area through afforestation Improved situation in degraded forests (reforestation)	Continuous damage to forests by illegal logging, biotic and abiotic factors Application of non-professional logging according to forest types Impact of climate change Damage to forest lands, landscape, causing erosion, Pollution of air, water resources and water courses Pollution of forest ecosystems by waste dumping Annexation of forests and forest lands Continued use/exploitation of private forests without management plans

Kosovo* is in the process of developing the new National Development Strategy (NDS). The existing NDS (2016-2021) was a new approach to development policies. NDS charged the forestry sector to ensure sustainable use of Kosovo's forests, as well as to prevent their degradation. The NDS clearly indicated that deforestation could bring significant negative economic and social impacts in addition to ecosystem damage.

NDS has also identified, the lack of appropriate forest management plans, as well as insufficient capacities of institutions for the sustainable management of forest resources as the main obstacles.

The Government programme of the Republic of Kosovo* 2020-2023 (still active) foresees the afforestation of bare forest lands, damaged forest surfaces and degraded forests and requires preventive measures and legal and institutional changes that enable the rational use of forests and strengthen the capacities of the Forestry Agency of Kosovo*.

The Medium-Term Expenditure Framework (MTEF) prioritises the protection of forest resources and emphasises the urgency of afforestation in new areas. KASH underlines that for environmental, economic and social purposes, a suitable environment must be created through the review and amendment of the existing legislation on forestry.

There is the National Forestry and Reforestation Programme of Kosovo* (NFRP) 2018-2027 and the National Forest Health Programme (NFHP) 2018-2027. The NFRP aims to increase Kosovo's forests by 5%, but it has been evaluated as overly ambitious and difficult to implement. Meanwhile, the NFHP aims the improving forest health, but its implementation remains a challenge for the responsible institutions of forest administration and management due to the lack of human capacities and financial means.

The Strategy for Climate Change (SCC) 2019-2028 emphasizes that, the use of natural resources, high population density, uncontrolled construction on agricultural land, uncontrolled use of forests, illegal logging, economic and industrial activities, exploitation of minerals (quarries), and the processing industry are the main causes of environmental degradation.

The Plan for Agriculture and Rural Development (PARD), within Measure 5 of Chapter 4, the development of forestry and afforestation, is mentioned as an alternative to the use of agricultural land. The plan states that forestry is an important economic activity in mountain areas and can provide long-term employment opportunities. Private forestry is highlighted as underdeveloped.

A redesign of the National Action Plan for Renewable Energy (NAPRE, 2011-2020) is underway, referred to in the Forestry Development Strategy (FDS, 2021-2000), which says that especially in rural areas, wood remains the most important source of energy for heating. The strategy defines special measures for promoting the use of energy from biomass. This plan estimates that 120 GW/h of energy can be produced annually from biomass (forest waste), simultaneously expressing concern that the realisation of such projects is hindered primarily because of their cost.

Acknowledgment, protection, preservation and active management of heritage values,- natural environment ensuring the preservation of biological diversity (biodiversity), and public welfare are welcome and traditional missions of national parks. In addition, the specifics of both parks in Kosovo* allow leading the development of a number of original activities, which have the purpose of preserving natural, cultural and landscape values. It is ambitious, mainly based on guaranteed interactive activities, positive (synergistic) and friendly, e.g. in the middle of open areas agricultural – herbal and forest environment, etc.

Management Plan – the 10-year management strategy 2014-2023 of the Sharr National Park provides a reasoned strategic framework for the long-term management of Sharr National Park, and also a detailed action plan for the management of the national park over the next five years.

2.5. Policy Analysis Document: Country Report Montenegro

Mr. Ranko Kankaras

Montenegro forestry sector policy analysis and policy recommendations regarding Sustainable Forest Management under climate change challenges

Montenegro's level of alignment with the EU on **climate change** remains limited. Montenegro has a Climate Change Strategy in place but has to intensify its work to ensure consistency with the EU 2030 climate and energy policy framework. It also needs to ensure that its strategy is integrated into all relevant sectoral policies and strategies. In July 2020, the government adopted the third national climate change report in the UN Framework Convention on Climate Change. In June 2021, the government adopted a report preparing the updated nationally determined contributions (NDC) in the frame of the Paris Agreement. The revision of the NDC sets as new target to reduce by 35% Montenegro's greenhouse gas emissions by 2030.

Previous Revised Forestry Development Strategy for the period 2018-2023, through the operational objective "Protection of biodiversity and other ecosystem services of forests", recognizes as a way of combating climate change the strengthening of resilience of forests to the negative effects of climate change and other threats. Also, declaratively suggests that forest development plans and forest management plans should include adaptation measures to climate change in terms of increasing the resilience of forest ecosystems and their protection from forest fires and other threats. That strategy noted that one of the preventive measures should be the maintenance of existing open areas in forest areas by mowing meadows.

Unlike the previous one, the new Forestry Development Strategy (2024-2029) recognises, at a strategic level, the importance of forestry in combating climate change and defines Preserving and strengthening the capacity of forests for adaptation and resilience to climate change, including fire prevention and other solutions as a strategic goal. Adoption of the new Forestry Development Strategy for the period 2024-2029 is expected in the first quarter of 2024, and thus the realisation of the aforementioned strategic goal in the next five years.

The defined strategic goal was further elaborated, so the operational goal Protection of forests, preservation and improvement of their health status was defined, which further recognises the following activities:

- Monitoring the harmful impact of climate change on forest ecosystems
- Creation of a forest protection plan (against fire) and implementation of preventive and repressive protection measures
- Protection of forests from biotic and abiotic harmful effects (risk factors)
- Adaptive planning and forest management
- Application of the concept of closer-to-nature forest management
- Strengthening knowledge about forests and changes in forests and
- Implementation of the national forest inventory in Montenegro

For all the mentioned measures, an explanation was given, followed by the recommended method of implementation, deadlines, defined preconditions for realisation, and the main activity bearers, and target groups.

Due to the above, it can be concluded that the new Forestry Development Strategy represents a significant step forward in relation to the previous strategy, and that it fully corresponds with the measures from the EU Strategy on Forests, regarding the prevention of negative impacts of climate change on forests.

In the context of the negative impact of climate change, forest fires are becoming a growing threat to forests globally, especially in Mediterranean countries, such as Montenegro.

Another negative trend characterises the Mediterranean countries, including Montenegro, where in the last three decades there has been a very pronounced trend of rural areas depopulation, which is accompanied by the absence of traditional agricultural activities and the reduction of forestry activities.

These changes have resulted in the afforestation of agricultural land into forests and bushes, as well as a higher density of forest biomass. From the aspect of the risk of forest fires, it can be defined as a high accumulation of combustible wood biomass in a given area and an increased connection of combustible substances, with risks for the occurrence and development of forest fires. The combined impact of the accumulation of flammable substances in the area with weather conditions favourable for the creation of fires, with the additional impact of climate change, creates very favourable conditions for the occurrence of extremely intense fires. Such forest fires, known as “sixth generation fires”, lead to significant degradation of Mediterranean forests and their natural, cultural and economic values, which is recorded by the JRC of the European Commission.

It is clear that such unfavourable trends must cause special attention of the forestry profession and a new conceptual framework must be provided, which will integrally consider the issues of forest protection from forest fire degradation. Increasing landscape fire resilience requires understanding the complex interactions within the landscape. One new approach, the concept of Fire-Smart Landscape (FSL) land management to reduce fire risk while promoting environmental and socio-economic benefits, is one of the main trends of current European policies in this area, at least when it comes to Mediterranean countries. It is based on finding the root causes of the occurrence of forest fires in the area and then searching through an integrated approach for solutions to increase the resilience of forest landscapes. Such an innovative approach is based on regulating the spatial distribution of fire and its harmful consequences, improving the efficiency of fire suppression, but also achieving benefits in terms of ecosystem services and local economic development. The benefit of this concept is not only the reduction of the risk of fire on such an area, but, more broadly, FSL contributes to reducing the vulnerability of local communities in the event of forest fires, thereby minimising total losses and damages. Also, this integrated and proactive approach not only focuses on issues related to immediate fire risks, but also promotes sustainable practices in harmony with the natural environment.

It is also very clear that the focus must be on prevention measures, and that the concept of closer-to-nature management must be deeply rooted in practice in order for prevention measures to be successfully implemented.

After reviewing all Montenegro’s strategic documents that deal with the risks of forest fires, it can be concluded that there is a functional administrative capacity for managing the risk of forest fires and fires in open space (existence of laws, strategies, institutions). However, the lack of a state enterprise for forest management, which could be a key factor for the operational application of closer-to-nature management, is noted as a key weakness, both in terms of prevention, risk reduction for the ignition and development of forest fires, fire extinguishing, and finally the choice of measures for the restoration of forests degraded by forest fires, where the focus is on creating mixed stands of high stability and good vitality.

In essence, it is necessary to make a link between the goals given by the new Forestry Development Strategy and their implementation at the operational level, which is therefore only possible by establishing a company for forest management, as is the practice of almost all countries in the region and Europe. From such a situation, the technical equipment of the sector can be achieved, and the nec-

essary financial resources can be obtained, which can in general contribute to a better management of forest fires.

What is undoubtably clear from the experience of Montenegro, is that the concessionaires are not interested in these topics, but almost exclusively in making a quick profit in the field of forest exploitation. Given that the implementation of forest protection measures requires investments in equipment and training, and that the financial benefits of preventive measures can only be seen after a long period of time, their intentions to avoid investments in forests are clear. As biological investments are a prerequisite for improving the stability and resistance of forests to climate change, the concession model of forest use has shown all its weaknesses in Montenegro.

Gap analysis of the Montenegro forestry sector including recommendations for action and steps towards bridging the gaps

Gap analysis of forestry sustainability in Montenegro

Montenegro is one of the most forest covered countries in Europe, and this situation is maintained despite the fact that during the last two decades, some part of the forests have been destroyed or degraded by forest fires, illegal logging or in other ways. The reason is the fact that in recent decades, some pastures and other agricultural areas have grown into forests due to spontaneous natural processes (reforestation), abandonment of traditional agriculture and depopulation of villages. These are mostly new areas of maquis, low and coppice forests, which have a very important protective role. Also, we have observed the growth of areas into high natural coniferous forests in the north of Montenegro. These data are based on the results of the National Forest Inventory, as well as parameters for monitoring changes in land use through LU/LUCF.

The ratio of high and coppice forests in Montenegro is characterised by a large share of coppice forests in the area. Although there are many areas with poor soil and unfavourable conditions for the development of forests, also there are significant areas of forest land of lower quality in relation to soil production capabilities. Wood volume and volume growth, as basic indicators of productivity, in most forested areas are below the production potential of the habitat, which especially applies to newly forested areas.

In relation to indicators of sustainability, the degree of mixed forest in Montenegro can be considered insufficient, and in relation to bioecological stability, unfavourable. Management measures that increase the degree of mixed forest stands are still not extended through the planning system, especially when it comes to increasing the participation of deciduous trees in coniferous forests.

In relation to the structural characteristics of the forests in Montenegro, there is a fragmented variety of age, where, according to NFI data, even-age stands cover 33.8%, stands with two levels of age cover 47.2%, and uneven forest stands in which there is a significant presence of selective forests cover 19.0%.

One of the principles and imperatives of closer-to-nature management is actively forced and maintained diversity on small areas of forests, depending on the forest management system. In relation to the situation with forests in Montenegro shown above, this means either that there are no forest cultivation measures that produce a diversity of stands, or that the wrong forest restoration measures are being applied. Closer-to-nature management is a trend that has recently been actively promoted in EU countries, through the EU Forest Strategy and other binding documents or agreements on a voluntary basis.

Forestry guidelines have been developed and are being applied in the practice of a number of European countries, and we could see an example of application through this project in Serbia as well. When it comes to Montenegro, through earlier development projects, work was done on defining guidelines for forest silviculture, as well as on training for their application, however, the application of these guidelines is almost completely absent, especially when it comes to interventions in even-age forests.

Finally, it is characteristic of Montenegro that the quality of forests is strongly related to ownership. Unlike the high-value forests in the north of Montenegro, which are mostly state-owned, private forests are concentrated in the karst region in the central part of Montenegro and in the coastal region. These forests are mostly coppice, young, poorly cared for or uncared for, or degraded.

Gaps in the organisation of forestry

The current organisation of the forestry sector in Montenegro is such that it is the only country in the region that does not have a state-owned company for forest management, and that sells state-owned forests in standing volume.

For the last 15 years, Montenegro has been facing unsustainable forest management practices. This period coincides with the period of use of forests by concession, which showed weaknesses both for the preservation and protection of forests, as well as for the industry based on this resource. Although the establishment of the concession system was aimed at the development of the wood processing sector, based on the fact that wood processors acquired long-term rights to wood raw material from state forests through concession contracts, the products of the wood industry in Montenegro are still within the category of primary products, sawn timber and pellets. On the other hand, semi-final products, construction carpentry and panels are imported. This means that the goals of introducing concessions in forestry were not achieved, and on the other hand, the condition of the forests was not improved, on the contrary, in most cases there were no measures for the protection and cultivation of forests in concession areas.

At the moment, there are also no investments in the modernisation of semi-final and final wood production, so the important natural resource that Montenegro has at its disposal is poorly valorised, the products of the wood industry have little added value with a significant consumption of wood raw materials.

Financial gaps

The existing system of financing the forestry sector of Montenegro, given that there is no state enterprise that would finance forest management measures from its own revenues, is based on budget allocations for financing the implementation of planning documents in forestry. Those financial resources are based on Budget revenues from concessions and other fees from the use of forests.

However, according to the Law on Financing of Local Administrations in Montenegro, 70% of the income from fees for the use of forests belongs to local administrations, which do not have any responsibilities in terms of forest management by law. This situation has led to the income in the Budget based on the use of forest resources being less than the expenditures required for sustainable forest management.

Final conclusions and recommendations on the possibilities for the implementation of Sustainable Forest Management/Closer-to-Nature Forest Management in the forestry sector

The pillar on which the improvement of the sustainability of forest management and the application of the concept of closer-to-nature management is based is the new Forestry Development Strategy.

However, the key prerequisite for the implementation of the Strategy is the reorganisation of the sector and the establishment of a state enterprise for forest management. The reorganisation establishes a new financing framework for the forestry sector, which enables the generation of real income for sustainable forest management.

In order to carry out the reorganisation, it is necessary to change the Law on Forests, which is adopted in order to abandon the concession model of forest use and achieve goals for obtaining sustainability of forest management in accordance with the Sustainable Development Strategy of Montenegro until 2030, as well as the new Forestry Development Strategy for the next five-year period. The law therefore creates prerequisites for the establishment of a state enterprise for forest management that will carry out forest management activities, which are in the public interest, in a sustainable manner and in accordance with planning documents in forestry.

The process of reorganisation of the forestry sector is underway. A new Law on Forests is in the form of a proposal and in the final phase of alignment with the Ministry of Finance, after which it will be sent to the European Commission for an opinion. Through the FAO project, titled Development of Forestry Sector in Montenegro and the GEF VII project Integrating Biodiversity into Sectoral Policies and Practices in Order to Strengthen the Key Points of Biodiversity in Montenegro related to forestry, it is planned to revise the existing forest inventory methodology (currently in private forests) and create forestry management plans. These projects have just started and will be implemented during the next two years.

A very important thing for the forestry sector at the moment is the establishment of the forest information system and the creation of forest databases in digital form. Through the IPA III instrument, Montenegro agreed with the EU on the implementation of the project Establishment of an Information System in Forestry in Montenegro, the implementation of which is expected to start.

The use and development of forest management guidelines in Montenegrin forestry according to the methodology used in Germany and Serbia at the moment would be a process compatible with the implementation of the new Montenegro's Forestry Development Strategy. Guidelines are also an important tool for the implementation of Sustainable Forest Management/Closer-to-Nature Forest Management in the forestry sector.

2.6. Draft Policy Analysis Document: Country Report NORTH MACEDONIA

Prof. Nikolco Velkovski

Abbreviations

EU	European Union
EUTR	European Union Timber Regulation
Eco-DRR	Ecological Disaster Risk Reduction
FAO – FRA	Food and Agriculture Organisation – Forest Resources Assessment
FLEGT	Combating Illegal Logging through Forest Law Enforcement, Governance and Trade
ICF	Institute of Chartered Foresters
IUCN	International Union for Conservation of Nature
LDN TSP	Land Degradation Neutrality Target Setting Programme
MAFWE	The Ministry of Agriculture, Forestry and Water Economy
MoEPP	The Ministry of Environment and Physical Planning
NC_EU	National Convention for the European Union in the Republic of North Macedonia
NPCC	National Plan on Climate Change
NWFP	Non-wood forest products
PENF	Public Enterprise National Forests
SSO	State Statistical Office
SFM	Sustainable Forest Management
UKIM – HEF	Ss. Cyril and Methodius University in Skopje, Hans Em Faculty of Forest Sciences, Landscape Architecture and Eco-Engineering in Skopje
UNFCCC	United Nations Framework Convention on Climate Change
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
VAT	Value Added Tax

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1. Introduction

According to the data from FAO – FRA, PE National Forests, the Ministry of Agriculture, Forestry and Water Economy (MAFWE) and the State Statistical Office (SSO), in the Republic of North Macedonia, over the years, the forest areas have been constantly increasing. Chronologically speaking, in 1938 we had 615,261 ha, and in 2020 1,042,321 ha, with 111,737 ha additionally classified as other forest land (SSO), which is an increase of 63% that reflects afforestation, regrowth of abandoned agricultural land and appropriate forestry activity in the past.

According to ownership, 87.4%, are state owned while 13.6% are private forests. Oak forests cover almost 50% of the forest area, whereas beech forests have 50% of the total wood mass. Pure coniferous forests cover 6% and various mixed forests cover 30%.

The above-ground biomass is 71.64 t/ha (total carbon 33.67 t/ha), and the underground biomass 19.32 t/ha and total carbon 9.08 t/ha) (IV NCCC, 2023). According to the origin distribution, it is as follows: high forests – 30.48%, cultures (0.67%), coppices (61.75%), shrubs (7.1%).

According to data from the State Statistical Office (SSO, 2020), the total forest reserves are 93,454,576 m³, or 104.7 m³/ha (the European average is 163 m³/ha). The total annual growth is 1,800,153 m³, or 2.02 m³/ha. The permitted cut rate is 75% of the increase, but the realisation is no more than 70%, or 55% of the total increase, which enables an increase in the wood mass and all ecosystem services from the forests.

In the Republic of North Macedonia, there are 0.54 ha of forest and forest land per capita, an average that is close to European, but given the geographical location and natural, the quality of the forest is among the lowest in Europe.

At least 120,000 ha of the whole forest area is in protected area according to IUCN categorisation. PE National Forests manages the most state-owned forests except those in national parks, special reserves and some forests (park-forest etc.) under the management of local municipalities.

According to historical data, beginning from 1913 up to now around 250,000 ha of bare land/erosive land area has been afforested, but there is no exact data about the success (expert judgment is 60-70%).

Forestry contributes 0.4-0.5% in the State Budget.

North Macedonia has already opened formal negotiations for accession to EU membership. It is expected that in the near future the possibility of EU support for the forestry sector will increase, taking into account the importance of this sector in the development of rural areas and especially the improvement of the environment in North Macedonia.

1.1. Impact of climate change

According to Gurgevic V. (2020), North Macedonia will face a warmer and drier climate in the future.

- The amplitude of this change will primarily be related to the future concentration of greenhouse gases.
- Associated with a warmer climate in the future, an increase in warm extreme events and a decrease in cold extreme events are expected.
- Although this dry condition is expected on average, the analysis reveals a potential increase in daily extreme precipitation that will cause a greater risk of flash flooding.

- On the other hand, the expected decrease in summer precipitation and the extension of the duration of consecutive dry days will increase the risk of drought.
- Finally, as a result of warmer weather conditions, the length of the growing season will increase on average.

In nature, it is normal for changes to occur when habitat conditions change. Also, by changing some socio-economic activities (especially abandonment of agricultural land including pastures) positive change and expansion of the forest may occur.

In terms of the vulnerability of forest ecosystems to climate change, there can be both positive and negative changes, and some are assessed as neutral.

According to research by Melovski et al in 2017, the types of forest ecosystems where positive changes are expected, i.e. their expansion are:

- Xerothermophilic pine forests,
- Thermophilic forests of pubescent oak and hornbeam
- Thermophilic forests with Greek juniper
- Podgorica and mountain beech forest
- Subalpine Macedonian pine forest
- Subalpine mountain pine forest

Types of forest ecosystems where negative changes are expected, i.e.. their restriction are:

- Riparian forests of willow, poplar, alder and tamarisk
- Thermo-mesophilic forest of Turkey oak and Hungarian oak
- Mesophilic forest of sessile oak
- Subalpine spruce forest

For the subalpine beech forest as well as the subalpine fir and white pine forest, the assessment is that they may be neutral or there may be a positive change.

According to Nikolov N., (NPCC, 2023), the main sources of impact of climate change on the forestry sector can be divided into several components:

- The nature of climate change – temperature, precipitation and wind patterns and their variability, which can affect a wide range of forest values;
- Uncertainty in forest management
- Global changes such as nitrogen deposition, socioeconomic and market trends, land use changes
- Impact on other forest values – NWFP, habitats of wild animals, biodiversity

The impact of climate change in the forestry sector can be positive or negative. It is important to understand the opportunities that might exist to reduce their negative impacts on forests.

According to Nikolov (Nikolov et al. NPCC 2023), the main impacts of climate change on forest ecosystems in the country are:

- Impact on the health condition of forests
- Transparency of the canopy

- Availability of water
- Forest fires
- Impact on forest ecosystem services
- Productivity
- Carbon storage and sequestration and
- Impact on forest management

With an increase in temperature, it is possible to have changes such as an increase in the working season, a longer period of vegetation. On the other hand, with an increase in the number of extreme events (floods, droughts), there are real threats to infrastructure, life, residents, and socio-economic aspects. With the increase in forest fire activities, they will pose a serious threat to infrastructure, decrease the supply of wood, increase greenhouse gas emissions, and reduce greenhouse gases absorption. Then, with the increased occurrence of insects and diseases, it will cause corresponding changes manifested through a reduction in the supply of wood, reduce growth and yield. Changes in forest productivity will affect wood supply as well as carbon sequestration. Changes in species composition will cause changes in technology and market and recreational values.

All these negative changes on forests and forestry would reduce the land cover, and with the forecast increase of the frequency of intense rainfall, leading to increased erosion, sediment production and the frequency of flash floods, which would increase the region's vulnerability to desertification.

2. Policy aspects

2.1. Environment and climate change

Environmental protection and issues related to the fight against climate change are becoming increasingly important among the general public and a priority of political elites. Environmental risks dominate the World Economic Forum 2022 Global Risks Report – in the short and long term.

The process of integration in the European Union is a driver for harmonising national strategies and legislation with European directives, standards and criteria, as well as for fulfilling the obligations that the state has in relation to the ratification of international conventions in these areas. In recent years, exceptional efforts have been made to align strategic orientations in the fields of environment, climate change and natural habitats with sectoral policies, especially when it comes to climate change. Many laws and by-laws have been adopted, or prepared and awaiting adoption (the Law on Nature, the Law on Inspection, the Law on Climate Action, and others). However, while progress has been made regarding Chapter 27 (Environment), there is still much work to be done on the way to fully transposing European legislation in North Macedonian laws in this area.

The European Commission report on the progress of the Republic of North Macedonia in this area notes that the harmonisation of the legal framework with EU law remains low, while human and financial resources are very limited. The Law On Climate Action has been prepared, but it has not yet been adopted. The Strategic Framework for Climate Change at the national level is defined in two documents that were adopted in 2021: the Long-Term Strategy for Climate Action with Action Plan (by 2050) and the Revised National Determined Contributions to Climate Change (by 2030). A platform for monitoring, reporting and verification is being prepared (NC_EU, 2023).

For wider application of efficient and low-carbon technologies, support for renewable energy sources in the heating and cooling sector (households or enterprises) is necessary. The use of high-efficiency heat pumps, district heating systems (natural gas cogeneration plants, biomass and/or biogas heaters, including waste biomass and other by-products), as well as the inclusion of renewable energy sources in district heating systems, should be stimulated. It is necessary to stimulate new connections to the central heating system by reducing VAT. At the same time, substitution of the current inefficient use of biomass (inefficient stoves as well as the use of firewood) with other fuels is needed (NC-EU, 2023).

2.2. Biodiversity

In December 1997, the Republic of North Macedonia ratified the Convention on Biological Diversity, thereby committing and pledging to implement the undertaken obligations. The first Study on the State of Biological Diversity in the Republic of Macedonia was prepared in 2003, and the first National Strategy for Biological Diversity with Action Plan of the Republic of North Macedonia was adopted in 2004.

The main goal of the first National Biodiversity Strategy with Action Plan adopted in 2004 was aimed at “protecting biological diversity and ensuring its sustainable use for the sake of people’s well-being, taking into account the unique natural values and rich tradition of the Republic of Macedonia”. This is an attempt to combine global goals with country-specific goals that should be set at the national level.

The environmental aspect is expressed throughout the sustainable development agenda, and the preservation of biological diversity is mostly related to goal 15, i.e. “to protect, restore and promote the sustainable use of terrestrial ecosystems, sustainable forest management, combating desertification, to prevent and restore land degradation, and to halt the loss of biological diversity”.

In 2015, within the framework of the project Support of the Republic of Macedonia for the Revision of the National Strategy for Biological Diversity with Action Plan and the Preparation of the Fifth National Report to the Convention on Biological Diversity, the National Strategy for Biological Diversity with Action Plan for the period 2018-2023 was adopted in the Republic of North Macedonia. In it, forestry is identified as one of the key sectors affecting biological diversity. With this Strategy, 19 national goals have been identified for biological diversity, which are grouped into the following 4 strategic goals:

- (1) Overcoming the basic causes of biodiversity loss by integrating it into the whole society
- (2) Reduction of direct and indirect pressures on the biological variety
- (3) Improving the status of biological diversity through the conservation of ecosystems, species and genetic diversity in order to increase the benefits of biodiversity and ecosystem services and
- (4) Improving knowledge and availability of all relevant information regarding biological diversity

So far, the Republic of North Macedonia has produced six national reports to the Convention on Biological Diversity, as well as several thematic reports.

However, despite the great strategic importance of these documents, insufficient attention is paid to biological diversity.

2.3. Climate change and forestry

According to the IV National Plan on Climate Change (2023), mitigation activities defined for the forestry sub-sector aim to achieve a reduction in greenhouse gas emissions. Mitigation activities defined by North Macedonia until 2030 include

- (i) Integrated forest fire management (aim: decrease of mean annual burned area and further negative effects)
- (ii) Afforestation (on 5,000 ha with the aim to obtain all the benefits from new forests)
- (iii) Conversion of field crops on slopes above 15% to forests (main aim – reduction of erosion)

Adaptation measures include:

Upgrade of future forest management planning with issues related to climate change

Adaptation of harvesting techniques and equipment as well as construction and maintenance of forest roads

Improve and intensify monitoring of health condition of forests

Implementation of new silvicultural concepts

2.4. Forestry

Forest management in the Republic of North Macedonia is based on a separate legislative framework.

Despite the fact that the concept of Sustainable Forest Management was promoted in 1992 (at the United Nations Conference on Environment and Development in Rio de Janeiro), for the first time in the legislation of the Republic of Macedonia it was accepted in two strategic documents: with the Spatial Plan of the Republic of Macedonia for the period 2000-2020 and with the Strategy for Sustainable Development of Forestry from 2006.

In 2004, the Parliament of North Macedonia adopted the Spatial Plan of the Republic of North Macedonia with projections for the development of forestry until 2020. In this document, the main objectives refer to the increase of the areas under forests in accordance with the general rezoning and categorisation of space, the improvement of the quality of forests through an improvement of species composition, the conversion of coppices into high forests, the reconstruction of degraded forests and thickets, undertaking breeding measures in all development phases of forests, the introduction of more modern techniques and technology in the use of forest products, the increase of the openness of forests, as well as the timely taking of protective measures. In terms of forest management, this document also foresees sustainable development as a way to promote forests and improve the forest fund.

With the Strategy on the Sustainable Development of Forestry, adopted in 2006 (for the period 2006-2026), it is planned to implement the concept of sustainable forest management, as well as to direct activities towards the public functions of forests, as well as towards the protection and care for nature and the environment. With the vision presented within the Strategy on the Sustainable Development of Forestry, a constant increase in the areas under forests is foreseen through afforestation with quality plant material, with an advantage given to autochthonous (domestic) species in relation to allochthons, as well as a more appropriate regulation of management with other forest species, products and modernisation of this activity. In addition, the cultivation and protection of the newly planted forests, as well as the revitalisation of the degraded forest ecosystems, are foreseen. With this, biologically and economically quality forests should be achieved, and degraded forests and thickets should be intensively transformed into a higher cultivation form, that is, towards higher-quality forests.

Other national documents also have an impact on the forestry sector, such as those related to sustainable development, climate change, biodiversity, desertification, fire protection, etc.

The competent government institution is the Ministry of Agriculture, Forestry and Water Economy

(MAFWE), while, on the other hand, the Ministry of Environment and Physical Planning (MoEPP) is also responsible for forests in protected areas.

State-owned forests are managed by entities appointed by the Government of the Republic of North Macedonia: PE National Forests, as well as the public institutions for managing protected areas: PINP Pelister, PINP Mavrovo, PINP Galichica, PINP Shar Planina, PEMPMA Jasen and by some local government units (Skopje, Vevchani, Vinica, Novo Selo). Private forests are managed by owners – natural or legal persons, and some of them are organised in the National Association of Private Forest Owners.

The model of centralised operation in practice in PE National Forests faces many problems and difficulties in functioning, forests are divided into forest management units (more than 200), and a 10-year plan is drawn up for each forest management unit. After revision, the 10-year plan is approved by the Minister of Agriculture, Forestry and Water Management. The State Inspectorate for Forestry and Hunting is responsible for controlling forest activities such as reforestation, cultivation, use, construction of forest roads, protection (from diseases, pests, and fires) in accordance with the management plan.

National parks have in common that they still make the biggest income from the sale of wood, except NP Galichica and NP Pelister, which started a project with PONT and focus on the protection and conservation of nature. PE National Forests, on the other hand, generates almost all its income from timber products (>95% of revenue).

The Republic of North Macedonia is a signatory and has accepted several international agreements and conventions related to forestry and environmental protection. As a candidate country for membership in the European Union, it also has an obligation to monitor and implement all regulations and policies relating to forest management and environmental protection.

UN Framework Convention on Climate Change (UNFCCC). The Republic of North Macedonia has prepared several national documents and other related documents that highlight this issue. Forests and forestry have a significant place in the mitigation of this problem, and the national documents include various goals and measures related to forestry, above all the reduction of deforestation, especially from fires.

UN Convention on Biodiversity. The Republic of North Macedonia is working on biodiversity-related issues and has produced 2 strategies with action plans and other related national documents, however, in the forestry sector, this issue is in the initial phase.

UN Convention to Combat Desertification (including LDN – Land Degradation Neutrality Target Setting Programme until 2030). Forests are one of the key components of this LDN process. The Republic of North Macedonia has prepared a National Action Plan for Combating Desertification (in the process of adoption), and the so-called programme with LDN targets and appropriate measures where sustainable forestry, afforestation, and fire protection have their proper place. The problem of desertification does not affect many Central, Western and Northern European countries, so there is no common EU document, as is the case with the other two conventions.

The EU Timber Regulation (EUTR) came into force on 3 March 2013 and prohibits operators in Europe from placing illegally cut timber and products derived from illegal timber in EU markets. “Legal” timber is defined as timber produced in accordance with the laws of the country from where it originates or is cut. The current Law on Forests is largely in accordance with the EUTR, in certain parts it is even stricter than the requirements of the EUTR, but still there are parts that need to be

specified; that is, to be further edited, but some are also related to our membership in the EU.

EU Forest Strategy 2030 notes that there has been some change in the discourse related to the concept of sustainable forest management (SFM). There has also been a shift in the focus of policy discussions, where climate change and biodiversity loss have been given greater priority.

EU Biodiversity Strategy 2030 is a comprehensive, ambitious, and long-term plan to protect nature and restore/reduce ecosystem degradation. The main objective is to put Europe's biodiversity on the road to recovery by 2030 and contains many specific actions and commitments.

EU Bioeconomy Strategy 2030, by which the EU wants to achieve:

- a) Ensuring safety of food and nutrition
- b) Sustainable management of natural resources
- c) Reducing dependence on non-renewable resources
- Climate change mitigation and adaptation and
- e) Strengthening European competitiveness and job creation

EU Green Deal refers to the member states of the European Union. It clearly emphasises the ambitions for climate change until 2030 and 2050, through:

- a) Supply of clean, affordable, and reliable energy
- b) Mobilizing the industry for a clean and circular economy
- c) Using an efficient and ecological way of energy and resources

The Green Agenda for the Western Balkans represents what the Green Deal is for the EU, only at the regional level (Western Balkans). The vision of the Green Agenda is a carbon-neutral Western Balkans by 2050. To reach a carbon neutral Balkans, the Green Agenda contains the following components that should help to that end:

- a) Climate action, including decarbonisation
- b) Energy and mobility
- c) Circular economy
- d) Biodiversity
- e) Reduction of pollution and
- f) Sustainable food production systems

EU Strategy on Deforestation: The integration includes incorporating measures that contribute to EU commitments to halt deforestation by promoting sustainable land use, combating illegal logging and improving the traceability of timber and non-timber forest products. Emphasis should be placed on encouraging partnerships with third countries, supporting sustainable supply chains and supporting initiatives that promote responsible consumption and production.

In addition to this, the Sendai-Eco-DRR frame, the framework for ecologically-based reduction of natural disasters in the 2015-2030 period, is also a significant document. This changes the previous instrument, where a relative approach was taken, into a new proactive approach. Forestry plays an important role in solving this problem. The Republic of North Macedonia is a signatory of this instrument, but the implementation is in the initial phase. In addition to other activities, this one is also related to sustainable forestry.

2.4.1. Sustainable forest management

Due to the established principle for permanent forest management of forests, many of the requirements provided by the criteria and indicators are fulfilled in our country.

Criterion 1: Maintaining and adequately increasing forest resources and their contribution to the global carbon cycle.

The activities envisaged by this criterion are fulfilled almost entirely; it is the result of the corresponding forestry activities throughout the historical period, and mostly of the afforestation of bare places. It should be noted that from 1914 to 2020, about 250,000 ha of bare places and heavily eroded lands were reforested, thereby increasing forest resources and their contribution to the carbon cycle.

Criterion 2: Maintaining the health and vitality of forest ecosystems.

The health status of the forests is constantly monitored. It is the responsibility of the manager of the forestry management unit, who is obliged to note any changes in the 'forest chronicle' section of the plan. In addition, in the event of a mass outbreak of a pest or disease, the MAFWE is informed, as well as the Reporting and Diagnostic Service (RDS), while appropriate measures are taken.

Criterion 3: Maintenance and improvement of the productive functions of forests (wood and non-wood products).

The maintenance and improvement of forest production functions for timber products have been placed in the plans and practiced for a long time. Because there are many degraded forests and wooded areas in the Republic of North Macedonia, it is necessary to intensify activities for their revitalisation and melioration. The openness of forests with forest transport infrastructure is low (8.41 km/km²), so this should also be worked on in the future. On the other hand, non-wood products are neglected in commercial forests and not enough attention is paid to them. Only in protected areas is the maintenance and improvement of non-wooden products planned.

Criterion 4: Maintaining, protecting, and enhancing the biodiversity of forest ecosystems.

Considerable work is needed to meet the requirements for this criterion. Biodiversity has generally been maintained so far. There used to be a trend of introduction of allochthonous species, mainly coniferous, due to the needs and demands of the wood industry. In addition, large bare fields are forested with allochthonous pioneer species for several reasons, primarily due to engineering requirements (ability to bind soil to the root system and protection against erosion), but also financial (low cost of production and reforestation, that is, the most optimal cost-benefit). After one rotation is completed (about 100 years) and when, above all, the conditions at the place of growth improve, it is possible to think about the reconstruction of the plantations and the introduction of indigenous species, such as contemporary trends.

Criterion 5: Maintaining and improving the protective functions of forests (especially soil and water).

Until the 1998 Law on Forestry and the establishment of PE National Forests, there were officially 17,617 hectares of protective forests in the country (for the purpose of protection against erosion and sedimentation in the reservoirs), managed by local water supply and irrigation companies. With the integration of these forests into the existing economic units and the transfer under the authority of the PE National Forests, they lost that status, but three years ago, the process of delineation of protected forests has begun and would continue for the next 7-8 years until the completion of the cycle of the development of all special plans.

The global average is about 10%, while the European average is about 32%. For different types of forest protection (whether for water production, erosion protection, protection from natural disasters, etc.), different specific forestry measures are applied, which requires additional training of engineers.

Criterion 6: Maintaining socioeconomic functions and conditions.

If we look at the indicators for Criterion 6, we can say that some are respected, while others are not. Regarding ownership, what is missing is data on private companies that are related to forestry (supply, logging and transport of timber varieties, warehouses for sale of wood, companies working with non-wood forest products, sawmills, etc.). The actual share of forestry in GDP is unknown (it is estimated at 0.4-0.5%). Workforce data, as well as occupational safety data, are fragmented and incomplete. Data on consumption, timber trade and energy from timber are also lacking.

Regarding recreational resources, there is still no data on the number and frequency of people using the forest for recreational purposes. Objects and locations that have cultural and spiritual values are not included in the plans at all, so their number and location are not known.

3. SWOT and GAP analysis of the forestry sector

Taking into account that 40% of the country's territory is under forests and that different types of forests are found in different habitats and with different quality, the potentials for development and improvement of the conditions in forests and forestry are great. It is necessary to work on a larger scale and with greater expertise to valorise the natural values of forests, forest diversity, their productivity, ecosystem services, modernise and improve some key pillars in forest management and follow modern European trends in forestry.

Strengths	Weakness
- Large territorial representation - Exclusive access to natural resources of high quality - Sources of clean water - Cultural and recreational locations, landscapes - Additional income for the rural population - Wealth with VAT - Good conditions for beekeeping - A long tradition in forest management (first afforestation in 1914, first plan in 1932) - Trained staff - Partially conducted staff trainings on various aspects of sustainable forest management - Good landscape types - Diverse amount and quality of food and availability of water - Good natural conditions - Global trends and principles: climate change and the great importance of forest ecosystems, deforestation, nature-based solutions for disaster risk reduction, desertification	- Still traditional forestry - Deficiency in the process of afforestation (collecting seeds from unrecognised seed crops due to lack of equipment, etc. - Unplanned production of planting material and often the seedlings get too old and are unusable - Inappropriate handling of classic seedlings during transport and immediately before planting - Afforestation also by untrained persons (private companies); - Low degree of afforestation and increase of the area under forests in recent years - Social responsibility - Lack of official afforestation area (officially cadastral class pastures although degraded) - The management of the protective forests is the responsibility of PENF, although the users of services from these forests are different (water management, LMAs, energy, etc.) - Lack of amelioration activities - Lack of a real picture of the state of forests (no census since 1979 and limited public data) - Insufficient use of forests (poor realisation of the possible state (60%), realistically low quality of wood mass and % of technical wood, administrative bureaucracy (tenders) and lack of workforce - Outdated technology and facilities - Poor quality of private forests - Insufficient and inappropriate openness - Entry of pellets, briquettes into the wood market - The return on investments (invested funds) is a long period of time - Frequent fires, as well as damage from insects, pathogens and other abiotic factors - Economic value (underestimated participation of forestry in the national GDP - Ecosystem services from forests are not valorised - Adverse impact of the public - Illegal activities (non-functional monitoring system but also problem with the court system) - Illegal cutting; illegal hunting; unlawful collection of VAT; inability to apply legislation - Low implementation of the Action Plan for the Strategy on the Sustainable Development of Forestry; - Non-existence of a general forest management plan - Non-existence of publicly available data; - No data for analysis (different sources have different data) - Lack of advisory services for private owners - Weak capacity of the state forest institutions (SSHL, SP, ISH and JPNSH) to implement the basic institutional obligations, be it financial, professional and ecological/biological aspects; - Lack of experts in state institutions with the capacity to monitor international policies and trends in forestry, to process data and prepare reports to international institutions - A large share of forests with poor quality and low productivity (around 70% of the forest fund in the RSM is of offshoot origin), which means weak raw material base for the development of the industry - Outdated concept of planning in forestry, which does not include ecological plans

Opportunities	Threats
- Management reorganisation (new organisational setup) - Political will to develop the sector - Creation of a fund for ecosystem services - New standards in planning - Training courses for planners, but also engineers in practice for sustainable forest management - Application of principles and criteria for closer-to-nature principles - Increasing the area under protective forests, as well as real compensation for their maintenance - Establishing new nurseries and improving the method of seed collection - Planned afforestation to be able to produce and use suitable planting material - Melioration of degraded forests and thickets - Construction of forest infrastructure - New technologies and new products - Additional revenues from VAT - Improvement of the fire protection system - Increasing the share of forestry in GDP through valorisation and payment for ecosystem services for the management of protective forests; forests with significant biodiversity and other special purpose forests - Increased interest in forests globally as carbon storage pools - Construction of recreational facilities - New sources of energy, circular economy - The price of wood should not be established by a Regulatory Commission - Raising public awareness of the importance of forests - New technologies and new products - Improvement of education and science about new trends in forestry in the world - Reduction of illegal activities in forestry - Employment of persons with necessary professional qualifications and provision/initiation of professional further training of employees - Capacity building for finding additional ways of financing in forestry (funds, grants, programmes, collection of ecosystem services/utility functions of the forest, etc.) - Establishing greater inter-sectoral and international cooperation of the forestry sector with the aim of using experiences in order to achieve a more modern approach in forest management - The transformation of coppice and degraded forests in the long term can provide greater stability of forests, greater production of wood mass, greater biodiversity, greater amount of carbon sequestration, greater utility and protective functions, etc.	- Bureaucracy - Non-adjustment of the product to market demand - Increased demand for competitive products - Recession of the economy - Unfavourable demographic changes - Lack of workforce for services in forestry - Insufficient knowledge and experience of PE employees for the application of the national forest policy in relation to sustainable forest management (application of criteria and indicators for OSH) - Lack of knowledge on assessing the impacts on forests from climate change - Threats from natural disasters - Threats from insects, pathogens and other abiotic factors - Fire threats - Insufficient funds for the preparation of studies in various fields - Lack of raw material - Adverse climate change scenarios - Weak results of the forest and state police and the forestry inspectorate in the fight against organised crime in the field of forestry - Insufficient care in forest management to fully comply with legal regulations, environmental protection and the protection of endangered and protected species, property rights and the interests of the wider social community

4. Current activities in forest policy

In 2006, a Strategy for Sustainable Forestry Development was adopted, which envisaged the implementation of the concept of sustainable forest management, yet in practice this concept has not yet been adequately implemented, and its revision is launched.

The 2006 Strategy was updated in 2023 and harmonised with new global trends, i.e. with the European Forest Strategy (2021-2030), European Green Deal, the Green Agenda for the Western Balkans, FLEGT, ICF and other various world policies related to forestry (UNFCCC, UNCBD, UNCCD, Eco-DRR, etc.).

The new Law on Forests, which foresees the transformation of the public enterprise and following of new European trends in forestry, is now in Governmental procedure. The

The goal of the Government of the Republic of North Macedonia is, through sustainable forest management, to increase the contribution of the forestry sector to the national economy and rural development, providing renewable resources and protection of the local and global environment, thus ensuring an improvement in the quality of life of all citizens.

The goals and priorities for forestry development are described in the Strategy on the Sustainable Development of Forestry in North Macedonia.

The main guidelines of the National Policy are:

1. Expansion, improvement of the quality and protection of the forest fund in accordance with the Spatial Plan of the Republic of North Macedonia
2. Multifunctional forest management and sustainable development of economically viable forestry, in accordance with the Forestry Strategy of the European Commission (European Commission, Forestry Strategy, 1998).
3. Overall valorisation of the ecosystem services as an integral part of the overall assessment of the sectoral development strategy.
4. Determination of the conditions for finding national and international funds to support the development of the sector.
5. Harmonisation of forestry legislation with national interests and international obligations.

The general objectives of the forestry sector are:

1. To ensure an increase in the area under forests and their production potential, improving the stability and quality of forests, increasing the openness of forests and improving the health of forest ecosystems and their vitality
2. To ensure that forest production functions (timber and non-timber), including economic efficiency are enhanced in a sustainable manner
3. To ensure that ecological and social forest functions or ecosystem services, including the conservation of forest biodiversity and landscape diversity, are maintained and enhanced
4. To contribute to mitigating climate change by adapting the composition and structure of forests and increasing their resistance to climate change

In order to achieve the goal and general objectives of the strategy, the forestry sector should:

1. Introduce multifunctional, closer-to-nature and economically sustainable management systems in all forests
2. Intensify forest management in a sustainable way, based on significantly increased investments in forests as well as the volume of felling, with a simultaneous reduction of illegal felling and wood trade
3. Introduction of simultaneous maintenance and improvement of forest functions or ecosystem services through sustainable management of forests and striving for their comprehensive valuation
4. Gradual transition from short-term to long-term use of wood forest products
5. Adaptation and improvement of the organisational set-up and functioning of state forest institutions/organisations, based on the division of state/public and commercial functions and improvement of efficiency in the management of state forests
6. Introduction and development of the system of state/public financing of forest activities and measures of public interest and ensuring the intended use of funds
7. Raising political and public awareness of the key role of forests and their ecosystem services, including biodiversity conservation and climate change mitigation
8. Attracting national and international funding for protection, conservation, restoration and closer-to-nature development of forests and for sustainable development of the forestry sector
9. Harmonisation of forestry legislation with national needs, international and EU obligations.

Crucial document that should be prepared is the *NATIONAL PLAN FOR SUSTAINABLE DEVELOPMENT OF FORESTRY IN THE REPUBLIC OF NORTH MACEDONIA.*

2.5. Closer-to-nature forestry

Measures for Education

- Improve and support education and training related to sustainable and closer-to-nature forest management, including forest biodiversity conservation and climate change mitigation, environmental quality improvement and economically sound and socially responsible forest management and development of the forestry sector
- Adaptation and/or expansion of existing programmes for the education at the forestry faculty with modern contents, especially with multifunctional forestry, the conservation of biological diversity, forest functions and ecosystem services, management of forests closer-to-nature, climate change mitigation and adaptation, multifunctional assessment of the forest, ecological economy and commercialisation of forestry activities in a sustainable way

CNF and climate change mitigation and adaptation

- To adopt guidelines for closer-to-nature-forestry practices

5. Recommendations

1. The Ministry of Agriculture, Forestry and Water Economy (MAFWE) should take more significant initiatives to develop and implement the concept of holistic forest ecosystem management that will replace the current linear (fossil) economy with a circular bioeconomy in accordance with European (international) forestry policies.
2. The government should initiate strengthening of the capacities of PE National Forests (PENF) in the direction of professionalisation of employees, as well as in the improvement of the material and financial basis for appropriate implementation of the activities on sustainable forest management.
3. MAFWE should consider the possibility of changes in the approach to the valorisation of the role of forests (considering their comprehensive multifunctional utility role) by introducing the PES approach – payment for ecosystem services.
4. MAFWE should initiate the creation (adoption) of by-laws for the adaptation and effective implementation of the criteria and indicators for monitoring the results of sustainable forest management.
5. Competent institutions (MAFWE and the Ministry of Environment and Physical Planning, MEPP) should initiate changes in the legislative framework to provide dedicated financial means (compensation) for the costs of sustainable forest management (afforestation, cultivation, protection), thus fulfilling the obligations assumed by the various ratified conventions and other agreements (CO₂ credits, green tax – financial instruments).
6. MAFWE should prepare a by-law for specifying the methodology for the delineation and categorisation of protected forests, as well as appropriate engineering measures for each special type and category, as well as a recognised method for the financial sustainability of protected forests.
7. Strengthening the capacities of civil associations, as well as motivating other associations to get involved with activities in the field of sustainable forestry to help establish monitoring, lobbying, and other types of assistance for the efficient implementation of public policies.
8. Improvement of inter-institutional cooperation and collaboration with the civil sector among MAFWE and MEPP, and PENF.
9. The Parliament should initiate a supervisory hearing to discuss illegal logging, the corruption that dominates in the forestry sector and other criminal activities (primarily causing fires). Such a debate, in the long term, would contribute to reducing crime and corruption.
10. The system for electronic monitoring of the wood pulp should be implemented.
11. The competent institutions should initiate and conduct appropriate investigative proceedings for the perpetrators of violations and crimes.
12. Increasing the capacities and knowledge of inspectors through professional training to eliminate weaknesses and improve their financial and technical resources to perform their work. The integration of the Forestry Inspectorate in the future AS should improve their functioning.
13. Investments in a gradual conversion of outgrowths and degraded forests into highly productive forests of generative (seed) origin in order to improve their structure, stability, productivity, naturalness and fulfilment of other ecological, socio-economic and protective functions.
14. Improvement of forest planning, which should be aimed at permanent maintenance and preservation of areas under forest and forest land, as well as promotion of ecological, economic, cultural and social values of the forest, including land and water protection.

15. To implement the concept of sustainable forest management and the concept of growing forests closer-to-nature to prevent activities that lead to forest degradation.

16. To reduce the use of clear cutting, especially on large forest areas, and to take measures for the revitalisation of degraded forest ecosystems.

17. To carry out forest certification, which will provide evidence of sustainable forest management and the application of forest practices that provide assurance that wood and non-wood products from the forest are produced in compliance with the highest environmental, social and ethical standards.

Establish a new institution in the state's forestry sector, the Forestry Agency, responsible for monitoring EU policies, strategies, regulations and standards, and for implementing national strategic and legal frameworks in forestry.

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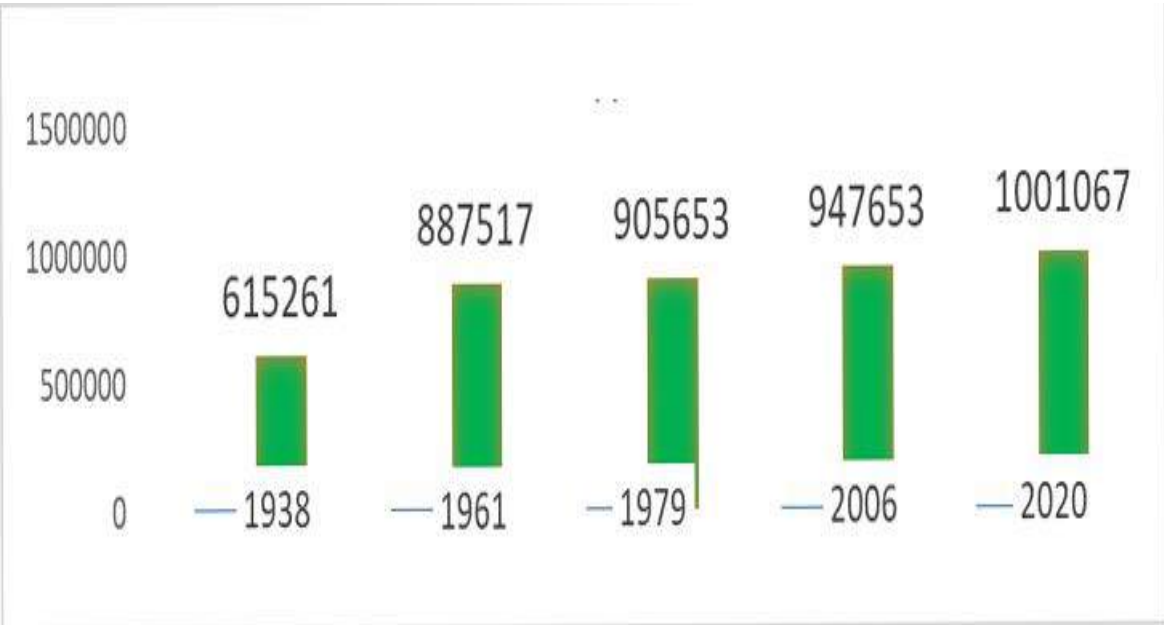
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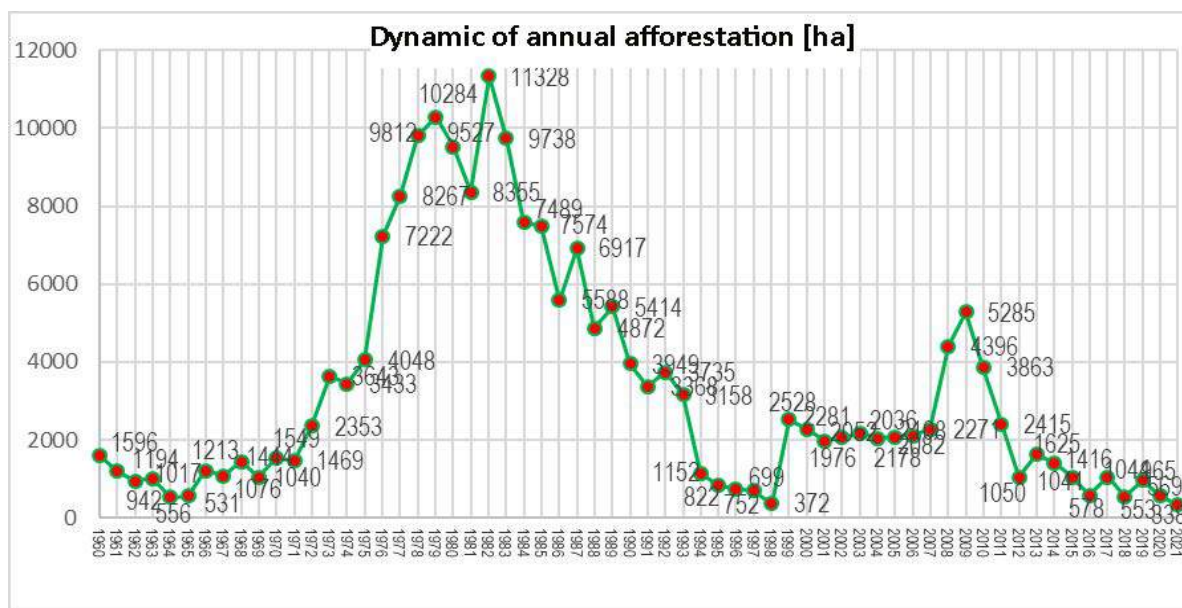
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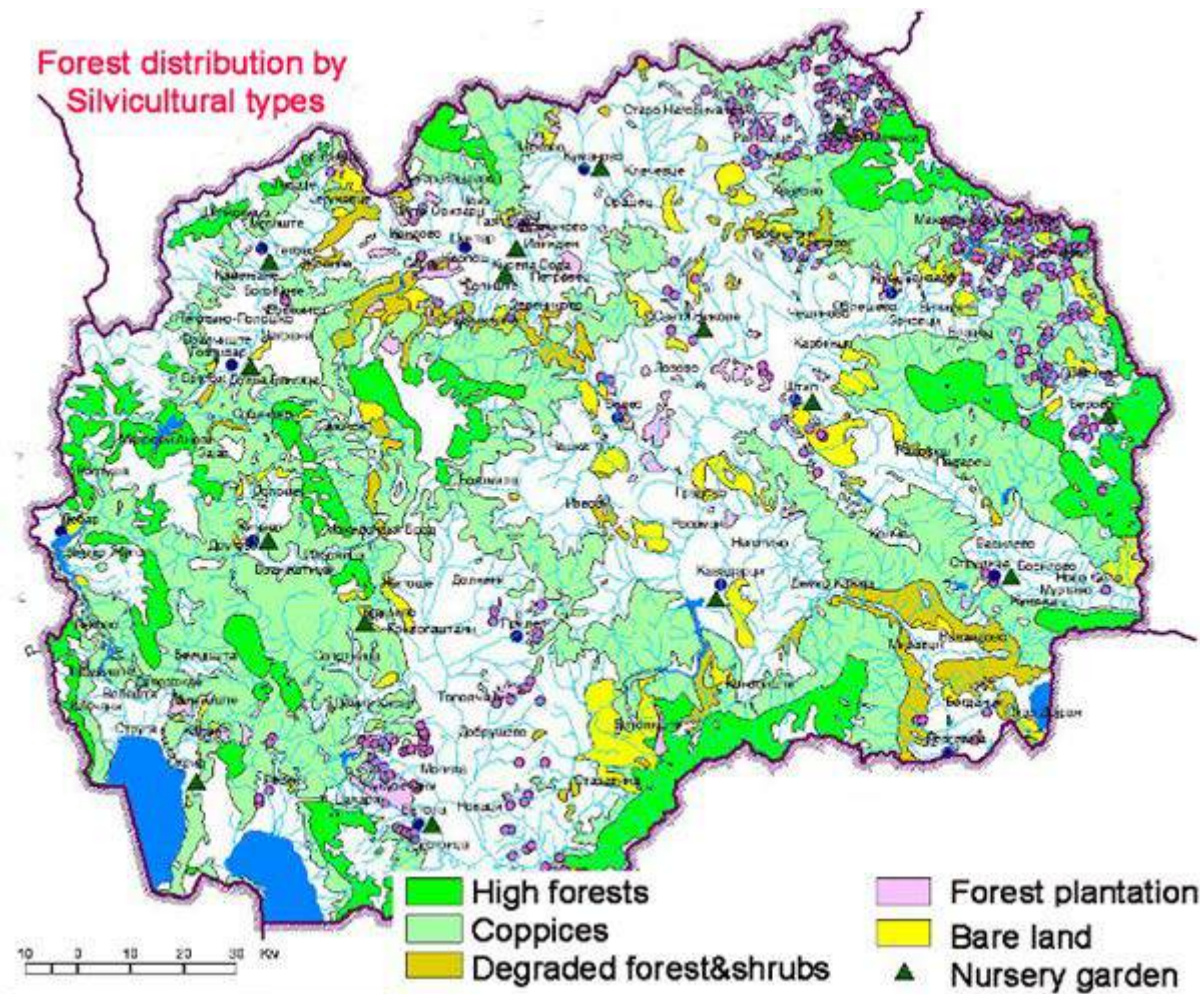
7. Annexes



A1 - Increase of Forest Fund in ha



A2 – Dynamic of annual afforestation



A3 – Forest distribution by silvicultural type

2.7. Policy Analysis Document: Country Report Republic of Srpska, Bosnia and Herzegovina

Prof. Dragan Comic

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Abbreviations

B&H	Bosnia and Herzegovina
CCA	Climate Change Adaptation
CBD	Convention on Biological Diversity
CLRTAP	Convention on Long-range Transboundary Air Pollution
EU	European Union
FAO	Food and Agriculture Organisation
FB&H	Federation of Bosnia and Herzegovina
FLEGT	Forest Law Enforcement, Governance & Trade
FMAWMF	Federal Ministry of Agriculture, Water Management and Forestry
FMP	Forest Management Plan
GIS	Geographic Information System
MOFTER	Ministry of Foreign Trade and Economic Relations
MAFW	Ministry of Agriculture, Forestry and Water Management
MCPFE	Ministerial Conference on the Protection of Forests in Europe
NFI	National Forest Inventory
NGOs	Non-governmental organisation
PFE	Public Forest Enterprise
PEFC	Programme for the Endorsement of Forest Certification
RS	Republic of Srpska
SFM	Sustainable forest management
SDG	Sustainable Development Goals
UNFCCC	United Nations Framework Convention on Climate Change

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1. Introduction

Forest is a multi-purpose object of the human environment and the basis of the forestry economy, which fulfils a number of economic, ecological, social and cultural functions. The imperative of the majority of European signatory countries from the Ministerial Conferences on the Protection of Forests in Europe (Ministerial Conference on the Protection of Forests in Europe, MCPFE) is the sustainable development of forest ecosystems, the increase of forest cover and productivity, the restoration of forests, the preservation of biodiversity, the development of generally useful functions of forests, favourable health state of forests, etc. The need for sustainable and integral development of all forest functions is closely related to the impact of forests on the ecological, social, raw material and energy development of the Republic of Srpska (RS). In recent times, the management of forests has become increasingly important due to numerous challenges they are exposed to (climate change, environmental threats, natural disasters, increase in poverty in certain regions, etc.). Forests and forest lands represent very important natural resources of the Republic of Srpska. Forestry in RS is faced with complex changes in natural and social conditions, which must be taken into account in order to ensure the development of the sector. The basic and generally accepted principles of forest management and management are sustainable development and multifunctionality of forests. Due to their application, it is necessary to ensure the balance of the relationship between the diverse needs of society and the functions of forests, as well as the integration of all interested parties, government institutions, the private sector and local communities in the process of implementing activities that contribute to the development of forestry in RS (Faculty of Forestry UNIBL, 2022).

The total area of the forest fund (area of forests and forest land) in RS is 1,352,961 ha or 54.4% of the total area of RS. The area of overgrown forest land in RS is 1,103,934 ha or 44.4% of the total area (Statistical Bulletin for Forestry of the Republic of Srpska, 2021). The actual forest cover is higher because when surveying forests in private property, forests are not surveyed on parcels that are not classified as "forest" in the cadastral classification of land. On the territory of RS, 9 basic groups of forest vegetation, 27 subgroups and 169 basic forest types were recorded. The predominant forest type in RS comprises high forests (with natural regeneration, degraded high forests and forest cultures), accounting for about 50% of the total, followed by low or coppice forests at 31%. In RS, the total volume of forests is 257,823,104 m³ (conifers 34% and broadleaves 66%). Observed by tree species, the largest share in the total volume is held by beech with 40%, fir with 15%, spruce with 14% and oak with 10% (Faculty of Forestry UNIBL, 2022). Approximately 78% of these forests are publicly owned, with the remaining 20% under private ownership (Government of the Republic of Srpska, 2012).

Given that forests and forest lands represent one of the most important natural resources of RS, it is important to mention international processes that have a significant impact on forest management policies, such as:

- Global Sustainable Development Goals (SDG)
- Ministerial resolutions on forest protection in Europe – MCPFE process (Strasbourg, 1990; Helsinki, 1993; Lisbon, 1998; Vienna, 2003; Warsaw, 2007; Oslo, 2011; Madrid, 2015, Bratislava 2021)
- UN Framework Convention on Climate Change – UNFCCC (1992)
- Directive on the preservation of natural habitats and wild fauna and flora (1992)
- Convention on Biological Diversity (1993)
- FLEGT regulation (2003)
- UN Convention on Combating Desertification (1994)

- EU Forestry Action Plan (2006)
- Directive on the Conservation of Wild Birds (2009)
- Bonn Challenge (2011)
- EU Bioeconomy Strategy (2012)
- EU Timber Regulation (2013)
- New York Declaration on Forests (2014)
- Sustainable Development Agenda 2030 (2015)
- Paris Agreement (2015)
- UN Strategic Plan for Forests 2017-2030 (2017)
- European Green Deal (2019)
- Ecological network of endangered species and habitats in the EU (Natura 2000)
- Policy and regulation of the EU in the field of forestry, environment and rural development
- SDG roadmap for the forestry sector (2019) and others

The purpose of this document is to assess the state of forest policy in the Republic of Srpska and its alignment with international and EU processes. It aims to identify gaps in achieving sustainable forest management, particularly in the context of climate change and biodiversity, and provide recommendations for addressing these gaps.

2. SWOT analysis of the forest sector of the Republic of Srpska

Based on the Guidelines for the development of the new Forestry Development Strategy of the Republic of Srpska (2022-2032) (Faculty of Forestry UNIBL, 2022), Table 1 lists the basic strengths, weaknesses, opportunities and threats for the forestry sector, primarily in relation to climate change and biodiversity, as well as closer-to-nature forest management.

Table 1. SWOT analysis of the forest sector of RS (focus on climate change and biodiversity, as well as closer-to-nature forest management)

Strengths	Weaknesses
High level of biodiversity Significant participation of stable forest ecosystems Preserved natural forests and rain-forests Significant area suitable for afforestation FSC (Forest Stewardship Council) certificate, forests and forest land are managed according to strict ecological, social and economic standards Great potential for ensuring the polyfunctionality of forest ecosystems Elaborate management systems based on tree species, habitat and stand conditions with natural forest renewal Continuously conducting forest inventories in forestry areas over a longer period of time Mixed, vital, multi-age forests with natural renewal prevail	There is not enough data on the state of forest ecosystems and the changes that are taking place Current management systems often do not recognise the existence of climate change Significant participation of degraded ecosystems and coppice forests Insufficient area of protected areas Insufficient public awareness of the importance of biodiversity and dangers as a consequence of climate change and the importance of forestry in current trends Forestry employees find it difficult to change established habits in terms of the management system A significant part of mined areas Insufficient openness to forests (insufficient network of forest communications) Realisation of the planned volume of felling (annual allowable cut) only in parts of the forest areas that are open to forest communications Gradual conversion of multi-age forests into single-age forests In certain situations, an inadequate management system Failure to comply with all the provisions of forest management plans Lack of qualified workforce Insufficient knowledge and research on the possible consequences of climate change Increasing the degree of risk for rare, relict species Illegal actions, illegal logging Spread of invasive species An incomplete system for monitoring the relationship between climate change and forests Certification of private forest management according to ecologically responsible and socially beneficial standards has not been carried out A large number of forest management units – basic planning units Outdated methodology for creating forest management plans

Opportunities	Threats
- Possible faster growth rates in certain species - Potentially new species of economic importance - Updated norms in the performance of works in forestry - Dedicated use of financial funds for special purposes for forests - Introduction of modern technologies of collection (remote detection), processing, analysis, evaluation and presentation of data in the forest inventory - Development of a modern and unique forestry information system - The possibility of using domestic and foreign financial and material resources for the improvement of the forestry sector	- A significant part of forest ecosystems in the zone of expected intense climate changes - Disappearance of rare and endangered species - Increased frequency and intensity of forest fires - Increased risk for rare and endangered forest communities - Greater damage as a result of the calamity of diseases and pests - Physiologically weakened ecosystems as a result of drought - Risk of transformation of forest ecosystems, which would result in large-scale tree mortality - More difficult preservation of biological and genetic diversity - Habitat fragmentation as a threat of biodiversity degradation - Vegetation movement (horizontal and vertical) - Lack of qualified workforce - Illegal logging and the growing need for wood as raw material - Species migration slower than the dynamics of climate change - Insufficiently developed awareness of the importance of climate change - Population migration - Unresolved property legal relations - Insufficient financial resources - Existing and predicted climate changes as well as increasingly frequent extreme climate events (frost, drought, flood, etc.) - Increased frequency and intensity of forest fires - Declining interest in the establishment of new forests and plantations - Inadequate application of prescribed management systems in high forests with natural regeneration - Limited channelling of dedicated funds for the forestry sector

Based on the same document (Faculty of Forestry UNIBL, 2022), the forestry sector of the Republic of Srpska is faced with complex changes in natural and social conditions, which must be taken into account to ensure the development of the sector. The basic and generally accepted principles of forest management are the sustainable development and multifunctionality of forests, and the basic principles of SFM are incorporated into legal and strategic documents on forestry in RS. For their successful implementation, it is necessary to ensure the balance of the relationship between the diverse needs of the society and the functions of forests, as well as the integration of all interested parties, government institutions, the private sector and local communities in the process of implementing activities that contribute to the development of forestry in RS. Forestry, together with the wood industry, is a very important economic branch for the economic development and stability of RS. There are various limitations in the forestry sector due to the complexity of the forest nature (numerous characteristics of forest ecosystems, with an emphasised complementarity, but also an occasional conflict of functions/goals) and nature laws (limited productivity, etc). That is the reason why the future development of the sector (greater added value, higher number of employees) primarily depends on the level of knowledge of the complex nature of the forest (especially risk factors), and the development of the wood industry and energy (a wider spectrum of use of wood products and biomass). For this reason, the focus of further activities is on improving the condition of forests, protecting forests from negative abiotic and biotic influences, providing timber and non-timber products, together with providing social and ecological roles of forest ecosystems. It certainly presupposes the adjustment of the organisational and institutional framework, together with the harmonisation of the regulatory framework, stable sources of financing and insisting on the strict application of strategic and operational measures.

3. Gaps in sustainable forest management under climate change challenges

The sustainable management of forests plays an important role in the global fight against climate change, while forests serve as a natural and renewable resource that sequesters carbon, maintains biodiversity, and safeguards vital ecosystems. Republic of Srpska faces a multitude of challenges in achieving sustainable forest management (SFM), especially in the context of climate change. Despite evident progress, the forestry sector is still burdened with various challenges, and some of the main SFM gaps are outlined below.

1. In practice, the ecosystem approach to forest management is not sufficiently developed because the general useful functions of forests are neglected and insufficiently valued in planning documents and practice. The priority function of production generally covers a significant number of other functions as well. During the preparation of planning documents, and in accordance with the FSC standards, forests of high protective value are singled out, along with defining other priority functions. Although little progress has been made since 2011 in terms of creating official inventories of species present and their status in RS/B&H or a suitable system for monitoring biological diversity, a step forward has been made in assessing trends in species within the Red List.
2. Polyfunctional forest management planning is not practically represented in the preparation of operational management plans and requires a new approach, especially in the segment of improvement of ecological and social functions of forests. The key lack of development and biological production in forestry is the inadequate application of defined forest management systems, with the occasional ignoring of the ecosystem approach. Also, the issue of climate change is not directly addressed in the forest management planning system, and there are no management instructions for practical support regarding this issue.
3. Usage of mechanisation within the framework of forest utilisation is limited by a large number of factors such as terrain, climate and stands, and the previous approach to forest utilisation was not at a satisfactory level. Forests were opened without previously prepared opening programmes, forest truck roads were most often designed and built based on technical and economic aspects, without evaluating other aspects important for sustainable utilisation of forests. Also, the choice of work system for forest utilisation was done according to an established template, and often without adapting to certain conditions.
4. Forest biomass, as a renewable source of energy, in the previous period was mainly provided from the available mass of firewood, but there are still significant amounts of forest residue, up to 30% of the total wood volume, which is still not used.
5. Measures that have not been implemented in the field of breeding, game protection and development of hunting and hunting tourism include the development of the Strategy for the Sustainable Development of Hunting in the Republic of Srpska, demining hunting areas and associated infrastructure, and the preparation of a cadastre of the value of hunting areas according to infrastructure quality criteria for hunting tourism.
6. Relationship with the wood industry – Lack of a law on wood processing, higher demand for wood than domestic supply, still low degree of finalisation of the production in a large number of companies (around 75% primary, 14% semi-final and 10% final wood processors), insufficient funds for investing in new technologies and innovations, as well as the lack of highly educated workforce in the wood processing sector, are problems that are present in the relations between

wood processing and forestry. Progress in improving the relationship between forestry and the wood processing industry was achieved by the adoption and implementation of the Decision on Determining the Criteria, Conditions and Methods of Distribution of Wood Assortments (adopted in 2016, with amendments in 2019).

7. The development and improvement of technology for forest utilisation are not sufficiently represented by contractors. Large damages to trees, which occur in the first phase of the hauling of wood assortments, are often ignored.
8. In private forests, some of the basic problems related to unresolved property-legal relations, usurpation, a large number of private forest owners and fragmented ownership. Owners of private forests should pay 10% of the value of the assortments for professional and technical services of the Public Forest Enterprise (tree marking and dispatching). On the other hand, owners of private forests, as well as associations of private forest owners, have the possibility (and are regular users) to apply for financing from special purpose funds for forests, which are allocated by the Ministry of Agriculture, Forestry and Water Management on an annual basis. The Ministry has created a guide for private forest owners explaining the assumptions of using and disposing of this resource. Also, certification for private forest management has not been carried out. In addition to the existing FSC standards, a solution is explored by introducing PEFC standards, which in some neighbouring countries (Slovenia) have proven to be a sufficiently high-quality solution for private forests. More active action on education, technical assistance, promotion of professional knowledge and cooperation of forest owners with different stakeholders is needed.
9. Protected areas are not fully financially self-sustainable. Further activities need to be directed towards the preservation and financial self-sustainability of these areas, which implies the need to develop personnel, material and infrastructural capacities that will ensure sustainable management of protected areas, with simultaneous control of use and avoidance of potential conflicts between nature protection and tourism development.
10. Ensuring a stable source of financial resources for the forestry sector is a prerequisite for the realisation of most of the set goals. In addition to the need to attract funds from various domestic and international funds, it is necessary to ensure the continuity and timeliness of the distribution of funds for special purposes for forests (extended reproduction) to different users, as well as for the needs of scientific and research work and improvement of the condition of private forests. Although the Law on Forests rather well defines the method of financing the simple and extended reproduction of forests, it is not fully realised in practice in the way of investing those funds in the sustainable development of forestry. The above primarily refers to the insufficient return of extended reproduction funds since in the period 2011-2021, less than 20% of the total collected special purpose funds for forests (expanded reproduction funds) directed/returned to the forestry sector (Ministry of Agriculture, Forestry and Water Management, 2022). For efficient and effective standards of sustainable development of forestry, it is necessary to develop mechanisms for managing financial resources intended for the development of the sector. In addition, it is necessary to direct efforts and carry out additional training of staff for the preparation and implementation of project activities (co)financed by grants from international financiers.
11. Access to finance is one of the most important problems faced by entrepreneurs, micro, small and medium enterprises, which is especially pronounced in countries in transition. To direct the development of the forestry sector towards the leading global trends based on the green economy, it is necessary to enable easier access to financial resources for business entities with strong entrepreneurial initiatives.

12. Given that the forestry sector is considered an important pillar of the European and global **circular bio-economy**, there are not enough initiatives for the development and promotion of the need to create new value chains and green jobs in the field of forestry, with a special focus on plantation production of fast-growing species, CO₂ sequestration and the generation of carbon credits, the use of biomass as a renewable energy source, the use of non-wood forest products, ecotourism, etc.
13. **Organisation of the forestry sector** – In addition to the fact that significant structural changes have taken place in the forestry sector of the Republic of Srpska in the last thirty years, there is still a great need to modernise the sector to achieve real sustainability, competitiveness and inclusion in global markets and trends. To achieve sustainable development, it is necessary to adopt sustainable models of production and consumption with a focus on a low-carbon economy, create new value chains with the creation of new jobs in the sector, ensure the long-term use of ecosystem services of the forest, modernise sales systems, all together with developing a regulatory framework and monitoring the activities of the forestry sector on the way to a green economy.
14. **Lifelong learning system** – A consistent lifelong learning programme for forestry professionals is missing. Enhancing education and training programmes is crucial for developing the skills and knowledge needed to address contemporary challenges in the forest sector. Investment in capacity building through training programmes is essential for modernising forest operation, meeting EU standards, and fostering an understanding of socio-political and economic aspects of natural resource management.
15. **Insufficient inter-institutional cooperation** – There is a need for better cooperation between various institutions in the forest sector and related fields such as water management, agriculture, environment, tourism, and energy. Harmonising regulatory instruments, policies, and strategies among these sectors is crucial for integrated and sustainable forest management.
16. Insufficient **emphasis on adapting forest management practices** to the changing climate, which includes addressing the increased risk of forest fires, pest infestations, and drought.
17. **Limited involvement of different stakeholders**, such as local communities and other relevant stakeholders, in forest management decisions.
18. **Communication capacities** within the forestry sector **are underdeveloped**. Strengthening communication, securing budget resources, and implementing a communication strategy can bridge this gap and facilitate information sharing among sector stakeholders.

Following the ranking of priorities within this research, and as agreed with the representatives of the Ministry of Agriculture, Forestry and Water Management (2022), the target areas for the forestry sector in the Republic of Srpska in the next 10 years according to importance, are as follows:

1. Further insist **on the application of Closer-to-nature Forest Management principles**
2. Developing/updating the **strategic and legal frameworks**
3. Improve the existing **organisational framework of PFE Forests of Republic of Srpska**
4. Perform **National Forest Inventory** (priority phase – delineation of vegetation types)
5. Promote and adopt a **lifelong learning system** in the forestry sector
6. Ensure **stable and continuous financing** of the sector from **domestic and foreign funds**

4. Thematic areas

The following thematic areas have been identified as strategic goals in the preparation of the Forest Development Strategy of the Republic of Srpska (Faculty of Forestry UNIBL, 2022):

- **Objective 1: Increasing forest coverage, productivity and quality of forests and increasing contribution to global efforts to mitigate climate change**
- **Objective 2:** Improving the multifunctional (economic, ecological and social) benefits of forestry, including improving the living conditions of the population in rural areas
- **Objective 3: Preservation of biodiversity, increasing the area of protected forests and other special purpose forest areas**
- **Objective 4: Increasing new and additional financial resources for sustainable forest management and strengthening education, scientific and technical cooperation and partnerships**
- **Objective 5:** Sustainable forest management including public promotion, international agreements, cooperation, coordination, coherence and synergy with sectors, partner organisations and relevant actors related to forestry at all levels

In the following text, for the purposes of this study, chosen thematic areas were defined in accordance with the way they are defined in the Guidelines for the Forestry Development Strategy of the Republic of Srpska (Faculty of Forestry UNIBL, 2022)

4.1. Increasing forest coverage, productivity and quality of forests and increasing contribution to global efforts to mitigate climate change

The forest structure according to categories is not satisfactory due to the high participation of degraded and coppice forests. In high forests with natural regeneration, the prescribed forest management systems are not consistently implemented, insufficient melioration is carried out for high degraded and coppice forests and timely thinning is not performed in forest cultures. This has a negative impact on productivity, i.e. on the amount and quality of growth and yield. High forests with natural regeneration are far from the normal state in terms of the distribution of volume increment and volume, as there is usually a lack of trees in the strongest diameter classes. The productivity and quality of forests have a direct impact on the economic benefits of forest management, making the need for improving growth and yield in terms of quantity and quality imperative. The high prevalence of coppice forests has a negative impact on the economic effects of management. These forests do not utilise the productive potential of their habitat and have reduced growth and yield quality. In the forest cultures, the management so far has not sufficiently implemented appropriate cultivation measures (care measures), which is why they have been neglected in cultivation with a large share of low-quality trees that are susceptible to the negative effects of abiotic nature. In a climate of risk and uncertainty, forestry is faced with the basic task (priority) of adapting the framework management system to closer-to-nature forest management. This implies the promotion of management systems that encourage the multi-age structure of forests, indigenous tree species, adaptability to climate change and preservation of biodiversity, ecosystem, species and genetic diversity and natural regeneration of forests. Forest management classes, due to their specific ecological, vegetation and production characteristics, management objectives and general stand condition, require the application of different forest management systems. In recent times, the impacts of climate change on forest ecosystems have become increasingly pronounced. This impact is locally and regionally significant, requiring the need to find strategic adaptation solutions to mitigate negative changes in terms of wood produc-

tion, carbon sequestration, biodiversity protection, quantity and quality of water and other functions, with a risk assessment of socio-economic consequences. Increasing forest coverage as an important element in mitigating climate change is closely related to the quality of forest reproductive material. Damage, as a consequence of poor-quality seeds and planting material is long-term and can be seen in the small growth of planted forests, their stability and tolerance to abiotic and biotic factors, and is today particularly relevant to the topic of adapting to climate change. The forest fund of the Republic of Srpska owns around 170,000 hectares of bare land suitable for afforestation, and there are significant areas for establishing plantations on sites suitable for fast-growing species. Quality control of forest reproductive material is carried out according to Yugoslav standards, which were written in the mid-20th century. The parameters for quality defined in this way do not follow new technologies and methods for the production of seeds and planting materials, nor international standards. Illegal activities in forestry are present and defined as all illegal actions related to forest ecosystems, industries related to forests, and timber and non-timber products (illegal logging, rigged public procurements, misrepresented unimplemented forest cultivation works). The appearance of diseases and pests, as well as increasingly frequent forest fires, diminish the quality of forests and their economic value.

In relation to the agreed criteria of sustainable forestry development, the problem is the lack of information needed for the realistic development of plans. More efficient forest resource management, simplified reporting, data exchange, knowledge transfer among target groups, raising awareness about the importance of forests and forest ecosystems for global societal well-being, are unimaginable without integrated information systems for collecting, storing, analysing, and displaying all types of data within the forestry sector. Information systems should be designed in accordance with international standards, with special emphasis on easy access to data and services. Methods of accessing and using data should be formally prescribed and legally regulated.

The effects of the realisation of this objective: The resilience and ability to adapt all types of forests to natural disasters and climate change impacts will be more certain. By applying forest management systems in accordance with habitat conditions, ecological characteristics of species and forest conditions (natural conditions), a sustainable and optimal stand structure is achieved that is in line with natural forest development processes. The development of the system on theoretical and practical bases, based on nature (closer-to-nature silviculture, CNS), increases the stability of forests and their contribution to mitigating climate change. The measure improves the implementation of projects for the performance of works in forestry, especially in commercial, high forests with natural regeneration. The basic indicators of forest productivity, volume and growth in volume will increase, as well as their quality structure. A significant contribution to the development of forestry is expected from the establishment of new forests, which will affect the increase in carbon dioxide sequestration. Larger stocks and increments will enable greater economic efficiency of business operations. Large areas of abandoned private property will be utilised and put into production and use of the production potential. The forest management planning system, in addition to the traditionally significant production function of forests, will be improved towards the development of forests that meet the basic concepts of sustainable development, preservation and protection of biodiversity, and the fight against climate change. Forestry planning will be based on new methodological approaches and modern information technologies. The planning system will rely on accurate assessments of areas and valuation elements, supervision and control of valuation, forest classification, planning for the consideration of multiple forest functions, improvement of operational plans, development of management systems, clear definition of property boundaries and availability of information needed at the international level, as a result of involvement in international associations (UN-FAO, UNECE, TBFRA, MCPFE, FISE, etc.). Information on forestry will be linked together in a unique information system and made available to interested parties.

Table 2. lists the measures, responsible institutions/organisations and the implementation period for increasing forest coverage, productivity and quality of forests and increasing contribution to global efforts to mitigate climate change.

Table 2. Measures, responsible institutions/organisations and the implementation period for increasing forest coverage, productivity and quality of forests and increasing contribution to global efforts to mitigate climate change

Measure	Responsible institution/ organisation	Period of implementation
Improvement, development and adequate application of management systems in high forests with natural regeneration based on closer-to-nature forest management	PFE Forests of the Republic of Srpska, Inspectorate, Faculty of Forestry UNIBL	Continuously 2022-2032
Reclamation of high degraded forests and conversion of coppice forests	PFE Forests of the Republic of Srpska, Inspectorate, Faculty of Forestry UNIBL	Continuously 2022-2032
Improving the state and management of forest cultures	PFE Forests of the Republic of Srpska, Inspectorate, Faculty of Forestry UNIBL	Continuously 2022-2032
Defining the region of provenance and revision of seed objects	Faculty of forestry, University of Banja Luka; PFE Forests of the Republic of Srpska	2022-2025
Establishment of seed plantations, provenance and clonal tests for the most important woody species, respecting the aspect of climate change	PFE Forests of the Republic of Srpska	Continuously 2022-2032
Control of the quality and circulation of forest reproductive material in accordance with international practices	Inspectorate RS; Faculty of Forestry UNIBL; PFE Forests of the Republic of Srpska	2022-2025
Production of planting material in accordance with the guidelines	PFE Forests of the Republic of Srpska	Continuously 2022-2032
Afforestation of bare trees in accordance with the recommendations of the Master Plan for Afforestation of Bare Trees of the Republic of Srpska, respecting recommendations on planting density based on habitat conditions and characteristics of species	PFE Forests of the Republic of Srpska	Continuously 2022-2032
Plantations of fast-growing species with the promotion of autochthonous and controlled use of allochthonous	PFE Forests of the Republic of Srpska, private owners	Continuously 2022-2032
Ecological and social (functional) aspects that are important in the selection of species while establishing new forests, innovative procedures	PFE Forests of the Republic of Srpska, private owners	Continuously 2022-2032
Production and transfer of planting material in accordance with expected changes in habitat conditions and climate	Faculty of Forestry, University of Banja Luka; PFE Forests of the Republic of Srpska	2022-2025
Harmonisation of regulations on the obligation to apply the nature of close management and its implementation in operational plans	MAFW, PFE Forests of the Republic of Srpska, Research Development and Project Centre	Continuously 2022-2032

Measure	Responsible institution/ organisation	Period of implementation
Revision of goals, measures and plans for active adaptive forest management and application of nature-based solutions (NbS)	PFE Forests of the Republic of Srpska, Faculty of Forestry, University of Banja Luka	Continuously 2022-2032
Forest health monitoring, according to the international methodology – ICPF, for Level I and establishment of Level II	Ministry of Agriculture, Forestry and Water Management (MAFW), PFE Forests of the Republic of Srpska	Continuously 2022-2032
Strengthening of capacities for preventive fire protection	PFE Forests of the Republic of Srpska	Continuously 2022-2032
Strengthening capacity for extinguishing and managing fires	PFE Forests of the Republic of Srpska; private forest owners; users of forests and forest land, media, population	Continuously 2022-2032
Monitoring the status and trends of changes in forest conditions using remote detection	PFE Forests of the Republic of Srpska, research and development and project centre	Continuously 2022-2032
Integral protection of forests and biological methods of combat using modern material and technical means for forest protection	PFE Forests of the Republic of Srpska	Continuously 2022-2032
Isolation of potentially endangered locations from mines, erosion, floods, construction and maintenance of coastal protection (line) forests using nature-based solutions (NbS)	PFE Forests of the Republic of Srpska, Faculty of Forestry, University of Banja Luka	Continuously 2022-2032
Forest management control and development of a preventive protection system against unauthorised and illegal activities and prevention of usurpation	PFE Forests of the Republic of Srpska	Continuously 2022-2032
Adhering to sustainable forest management principles according to FSC and other standards and certification of private forests	MAFW; PFE Forests of the Republic of Srpska; RDPC	Continuously 2022-2032
Development of methodologies for the preparation of forest management plans for state-owned forests and for privately owned forests	Scientific educational institutions, PFE Forests of the Republic of Srpska	Continuously 2022-2032
Defining the basic planning units (planning levels) in forestry for forests owned by the Republic of Srpska	Scientific and educational institutions, PFE Forests of the Republic of Srpska	Continuously 2022-2032
Application of remote sensing (and modern instruments) in forest inventory	Scientific educational institutions, PFE Forests of the Republic of Srpska	Continuously 2022-2032
Development of methodology and implementation of a permanent forest inventory on large areas (NFI)	Scientific educational institutions, research and development and project centre, design companies	Continuously 2022-2032
Improving the development of projects for forest work implementation (executive projects)	Scientific educational institutions, PFE Forests of the Republic of Srpska	Continuously 2022-2032
Development of a modern integrated and integral spatial information system in forestry	Ministry of Agriculture, Forestry and Water Management / PFE Forests of the Republic of Srpska	2022-2023

Measure	Responsible institution/ organisation	Period of implementation
Development of modern integrated spatial information systems in hunting	PFE Forests of the Republic of Srpska, hunting associations, academy, nature protection sector	2022-2023
Definition of protocols for data exchange between information systems in the field of forestry and hunting with other sectoral information systems	Ministry of Agriculture, Forestry and Water Management / PFE Forests of the Republic of Srpska	2023-2024
Defining a protocol (procedure) for reporting on the state of forests in the Republic of Srpska to international organisations	Ministry of Agriculture, Forestry and Water Management / PFE Forests of the Republic of Srpska	2023-2024

4.2. Preservation of biodiversity, increase of protected forests and other special purpose forest areas

In order to ensure continuous and long-term sustainable use of forest resources, especially in the context of climate change adaptation and mitigation, it is necessary to maintain forest ecosystems in a stable condition, which is achieved by preserving natural biodiversity (genes, species, and habitats) through their active or passive protection (conservation, e.g. complete protection of virgin forest ecosystems). It is necessary to emphasise that the principles and methods of active protection are much more important and widespread, and forestry as an economic activity can also be viewed as a pillar of nature protection, because sustainable forest management is nothing but active protection in time and space. To properly approach these activities, it is necessary to have insight into the initial, current, potential (trend), and optimal state of forest ecosystems. The answer to the initial and current state is provided by an inventory (identification) of species and habitats in space and time, while a forest habitat and species monitoring system is a key activity in assessing the trend of forest ecosystems, i.e. their potential state. One of the ecosystem services provided by high conservation value forests is the protection of biodiversity, so high conservation value forest (HCVF) that have this purpose and are declared according to the provisions of the Law on Forests can overlap with protected forests (or protected areas that are declared according to the provisions of the Law on Nature Protection).

Protected forest ecosystems and plant and animal species, as well as a good portion of HCVF, meet the criteria to become part of the Ecological Network (legal provision provided in the Law on Nature Protection), the Emerald Network (European network of protected areas in the EU the establishment of which is regulated by the Bern Convention), as well as the NATURA 2000 network (network of protected areas within the EU the establishment of which is regulated by the Directive 92/43/EEC (1992) on the conservation of natural habitats and wild fauna and flora (1992)) and the Council Directive on the conservation of wild birds 79/409/EEC (1979). In order to protect forest ecosystems in accordance with the Law on Nature Protection, it is necessary to collaborate with the nature protection sector. In addition to inventory and monitoring of domestic species and habitats, in order to prevent the negative impact on growth and regeneration of native species, as well as on biodiversity as a whole, it is necessary to monitor and control the state of invasive species in forest ecosystems. In the Republic of Srpska, there is a need for up-to-date classification of habitats and the creation of maps of habitat types. There is no inventory of plant and animal species (except for a list of vascular flora species, which provides information on current knowledge of higher plants throughout the Republic of Srpska, but not specifically in forest ecosystems), nor an inventory of the genetic variability of any woody species. There is no monitoring of any species or habitats, and it is not known which invasive species

are present in our forest ecosystems or to what extent, so there are no plans for managing invasive species. There are no programmes or projects that address the relationship between biodiversity status and climate change for the purpose of adaptation and mitigation of their negative impacts. An ecological network has not been established, nor have forest areas suitable for inclusion been identified. We do not have enough knowledge about rare, endemic, internationally significant, protected, and endangered plant and animal species and habitats within forest ecosystems. Although a certain number of High Conservation Value Forests (HCVFs) have been proposed by forest management companies and certified according to FSC standards, they have never been formally legally declared and the distribution according to types is very uneven (over 90% are protective forests). Collaboration with the nature protection sector has improved in the last decade, but it is still insufficient. Three priorities have been identified and included in this strategic objective:

- Inventory and monitoring of habitats, plant and animal species
- Identification of endangered habitats and species in forest ecosystems
- Increasing the surface area and management of protected areas in accordance with IUCN criteria and the Nature Protection Law (Official Gazette of the Republic of Srpska, No. 20/14) and special purpose forests

The effects of realisation of this objective: The main effects of mapping to level 2 of the EUNIS classification would enable a clear definition of areas suitable for afforestation, updating existing thematic maps in the Forest Management Plan, and laying the foundation for later detailed mapping. Mapping would have the effect of clearly defining areas suitable for afforestation. Monitoring selected species and habitats (as well as invasive species) is important for assessing their status, early detection of negative trends, and adapting management methods to maintain favourable conditions for nature and reduce negative impacts on business operations. Designating protected areas, strict nature reserves, and areas suitable for inclusion in the Ecological Network would contribute to the conservation and improvement of ecosystem services provided by forest ecosystems, with positive effects on business operations. Through consistent implementation of certification principles and protection of strict nature reserves, as well as cooperation with the nature protection sector, the forestry sector would achieve increased profits from non-timber but also timber-related functions of forest ecosystems.

Table 3. lists the measures, responsible institutions/organisations and the implementation period for biodiversity preservation, increase in the area of protected forests and other special purpose forest areas.

Table 3. Measures, responsible institutions/organisations and the implementation period for biodiversity preservation, increase in the area of protected forests and other special purpose forest areas

Measure	Responsible institution/ organisation	Period of implementation
Identification of habitat types within forest ecosystems based on the EUNIS classification (harmonisation with national classifications – phytocoenological, forest types)	Faculty of forestry, University of BL, IF, MSPCE	2022-2025
Mapping habitat types up to EUNIS level 2	Faculty of forestry, University of BL	2023-2032
Monitoring of selected key species and habitats	PFE Forests of the Republic of Srpska, Faculty of forestry University of BL, MSPCE, IPCHNH	Continuously 2022-2032

Measure	Responsible institution/ organisation	Period of implementation
Inventory and monitoring of the state of invasive species	PFE; Faculty of Forestry UNIBL; MSPCE, IPCHNH	Continuously 2022- 2032
Monitoring the condition of biodiversity in the function of adaptation and mitigating the negative effects of climate change	PFE; Faculty of Forestry UNIBL; MSPCE, IPCHNH	Continuously 2022- 2032
Inventory and preservation of genetic resources in accordance with the Programme for the Preservation of Genetic Resources of the Republic of Srpska	PFE "Forests of the Republic of Srpska", Faculty of forestry University of BL	Continuously 2022- 2032
Identification of potential forest areas suitable for inclusion in the Ecological Network	PFE; nature protection sector; Faculty of Forestry UNIBL; MSPCE	Continuously 2022- 2032
Identification of rare, endemic, internationally significant, protected and endangered plant and animal species and habitats	PFE; Faculty of Forestry UNIBL	2023-2025
Identification of potential forests of special purpose (HCVF)	PFE; IPCHNH	Continuously 2022- 2032
Designation and declaration of special purpose forests (HCVF)	PFE Forests of the Republic of Srpska, Faculty of Forestry University of BL	Continuously 2022- 2032
Establishment of forest management and governance systems for special purpose forests through the development of management plans and forest management plans	PFE; Faculty of Forestry UNIBL	Continuously 2022- 2032
Cooperation with the nature protection and spatial planning sector in the allocation and registration of protected areas	PFE; Faculty of Forestry UNIBL	Continuously 2022- 2032
Management of invasive species	PFE; Faculty of Forestry UNIBL	2022-2025

4.3. Increasing new and additional financial resources for sustainable forest management and strengthening education, scientific and technical cooperation and partnerships

The optimal use of forest resources is based on the principle of sustainable management continuity, which involves ecologically responsible, socially beneficial and economically sustainable management of forests and forest land, synthesising matter, energy, and natural processes. The concept of forest engineering development is based on technological advancements and finding solutions to problems that arise during fieldwork. To choose an appropriate work system, knowledge and skills are necessary that require a comprehensive approach to finding optimal solutions in order to determine an economic and rational way of performing different forestry work, wood processing and hunting. This is comprehensively referred to as bioeconomy in modern conditions. The need to adopt new economic trends in forestry and other industries is becoming increasingly pronounced due to the growing awareness of the benefits of forests, the global awareness of the multiplication of global environmental problems, climate change, increasing demand for raw materials and energy, as well as the global economic crisis caused by the 2008 financial crisis and the crisis caused by the COVID-19 pandemic in 2020. The conceptual framework for the recovery and economic revitalisation of forestry is offered by green economy and circular bio economy, through holistic transformation and management of natural and social systems with the goal of achieving sustainable development. Envi-

ronmental services as benefits and gains are recognised within sectoral cooperation, but the problem is the unequal distribution of responsibilities and costs that follow them (e.g. protection of soil and water, urban forests, recreation, tourism, etc.) and are left to the forestry sector. The forestry sector is already undergoing significant structural changes and diversification in the production of materials that can help transform major economic sectors such as energy, construction, and various industrial sectors. This portfolio of current and future products and activities will require intensification of the educational process and scientific research towards specialised services that further multiply the economic impact of forestry and the potential for opening new green jobs. For the successful implementation of the aforementioned, it is necessary to mobilise existing and additional financial resources from various sources in order to apply the principles of sustainable forest management and develop the forestry sector and related sectors. Along with projections from relevant international organisations that indicate future significant increase in global wood consumption, monitoring and alignment with new market demands pose a challenge but also an imperative for future forestry development. Various technical and financial support programmes are available for developing countries, but they are currently not sufficiently utilised in our country/entity. Intensive training of personnel, together with the provision of material and financial support, should enable a transition towards an active approach of finding new potentials and attracting financial and technical assistance from domestic and international funds. There is a pronounced need for modernising the sector with the aim of achieving real sustainability, competitiveness, and inclusion in global markets and trends. To achieve real sustainable development, it is necessary to adopt sustainable models of production and consumption with a focus on a low-carbon economy, provide decent jobs in the sector, ensure the long-term use of forest ecosystem services while developing a regulatory framework and monitoring of the forestry sector towards green and circular bioeconomy. Negative demographic trends, an increasing proportion of the population living in urban areas without direct contact with forests, and a relatively low employment standard in the forestry sector result in reduced interest in working in forests, and therefore reduced interest in forestry education. There are still limited opportunities for rural life and work stimulation programmes, which would have a positive impact on the number of interested students in secondary schools and universities in the field of forestry. In the EU Forest Strategy 2030, the European Commission proposes eight measures for the restoration of European forests and the protection of the forestry sector, including a measure that entails providing education and training to individuals employed in the forestry sector and increasing the attractiveness of forestry for young people. Training and professional development of workers are very important because forestry jobs are among the most dangerous occupations. Society's investment in science and scientific research aims to achieve and improve social interests and limit negative impacts on the environment. However, despite the evident global progress in all areas of forestry science, there is still a weak and inadequate investment in scientific research in forestry at the local level. The existing research capacity is insufficient for the research and development needed given the state of forest ecosystems and future challenges, especially in the context of the impacts of climate change and the ecological services of forest ecosystems. It is necessary to ensure that society as a whole recognises the role and importance of investing in research and development in the field of forestry, thus creating the necessary conditions for sustainable forest management that is a natural solution for achieving multiple goals.

The effects of realisation of this objective: Improving the cutting and production of forest wood assortments would lead to greater financial benefits for forestry, while greater accessibility of forests through primary forest roads would reduce transportation costs, one of the largest costs associated with forest utilisation. Increasing the volume of production in managed forests and plantations can also contribute to the production of forest biomass for energy. Establishing a specialised secondary

forestry school would create significantly better learning conditions and thus greatly improve the quality of education. Strengthening higher education institutions enables the improvement of the quality of educational and scientific research work, which is a precondition for the improvement of the forestry sector. Educational and scientific bases and permanent experimental plots create the conditions for improving scientific research, educational work and continuous training in forestry in the context of lifelong learning. By strengthening research capacity, the conditions are created for the improvement of research work as one of the key pillars for sustainable forest management. The realisation of the strategic goal would create the necessary economic conditions for the development of the forestry sector, improve interest in education and scientific research and increase the number of professional workers in forestry. Table 4. lists the measures, responsible institutions/organisations and the implementation period for increasing new and additional financial resources from all sources for sustainable forest management and strengthening education, scientific and technical cooperation and partnerships.

Table 4. Measures, responsible institutions/organisations and the implementation period for increasing new and additional financial resources from all sources for sustainable forest management and strengthening education, scientific and technical cooperation and partnerships

Measure	Responsible institution/ organisation	Period of implementation
Support for increasing the volume of production (cutting volume) and monitoring the quality of the production process	PFE Forests of the Republic of Srpska, Inspectorate	Continuously 2022-2032
Support for the improvement of the existing network of forest roads (design, construction and reconstruction of forest truck roads)	PFE Forests of the Republic of Srpska; NP	Continuously 2022-2032
Developing forest opening programmes at the level of forest management units and for privately-owned forests	PFE Forests of the Republic of Srpska; Licensed companies	Continuously 2022-2032
Support for the development of biomass utilisation programmes from forests at the level of forest management plans, as well as for private forests	PFE Forests of the Republic of Srpska; WI	Continuously 2022-2032
Increasing investments and subsidies in the modernisation of forestry work equipment	MAFW; PFE Forests of the Republic of Srpska	Continuously 2022-2032
Increasing investments in new equipment to replace depreciated ones (forest, agricultural tractors and chainsaws)	PFE Forests of the Republic of Srpska	Continuously 2022-2032
Mobilisation of existing and additional financial resources, with increased access to financial resources for economic and other entities in the forestry sector	Government of the Republic of Srpska; PFE Forests of the Republic of Srpska; LC; APF; Faculty of Forestry; MSPCE; NP	Continuously 2022-2032
Constant monitoring of regional and global supply and demand trends	Government of Republic of Srpska; PFE Forests of the Republic of Srpska; PF; Faculty of Forestry	2022-2025
Strengthening capacity to identify and attract financial resources from domestic and international sources	Ministry of Agriculture, Forestry and Water Management; Faculty of Forestry; PFE Forests of the Republic of Srpska	Continuously 2022-2032
Improve the efficiency and effectiveness of business entities in the forestry sector	PFE Forests of the Republic of Srpska, Faculty of Forestry, Forestry inspection	Continuously 2022-2032

Measure	Responsible institution/ organisation	Period of implementation
Valorisation of the total values of forest ecosystems (economic, ecological and social)	PFE Forests of the Republic of Srpska, Faculty of Forestry	2023-2028
Harmonisation of the organisational structure of business systems in forestry, with intensive diversification of activities and increased investments	PFE Forests of the Republic of Srpska; COC, FF; MAFW	Continuously 2022-2032
Diversification of activities and increase of investments in the forestry sector	PFE Forests of the Republic of Srpska; COC; FF; HA	Continuously 2022-2032
Application of the marketing concept of business, with the development of entrepreneurship	MAFW; PFE Forests of the Republic of Srpska; COC; FF	Continuously 2022-2032
Training of personnel and professional staff in forestry and hunting through the development of a lifelong learning system	Scientific and educational institutions, PFE Forests of the Republic of Srpska	Continuously 2022-2032
Establishment of a specialised secondary forestry school and strengthening of higher education institutions	Scientific and educational institutions	Continuously 2022-2032
Establishment of a professional centre for professional training of workers in forestry	Scientific and educational institutions, PFE Forests of the Republic of Srpska	Continuously 2022-2032
Establishment of teaching and scientific bases and a network of permanent test areas	Students and high school students	Continuously 2022-2032
Staff training for the preparation and management of especially international projects	PFE Forests of the Republic of Srpska, Ministry of Agriculture, Forestry and Water Management, Faculty of Forestry	Continuously 2022-2032
Support for fundamental and applied research regarding the adaptation of forests to climate change and other ecological disturbances and risks	MAFW; FF; MSPCE; IF; IO	Continuously 2022-2032
Creation of a framework plan for financing research and development with an emphasis on the need to solve acute problems in practice	Scientific and educational institutions; PFE Forests of the Republic of Srpska; Faculty of Forestry	Continuously 2022-2032
Strengthening research capacities and achieving better results of applied development programmes and scientific research projects	Scientific and educational institutions, research and development and project centre	Continuously 2022-2032

5. Literature

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2.8. Policy Analysis Document: Country Report SERBIA

Prof. Nenad Petrovic

The forestry sector in the Republic of Serbia has been under constant improvement in the previous period. Improvement started after the year 2000, and establishing of the Directorate of Forests as a separate administrative unit within the Ministry of Agriculture, Forestry and Water Management. Different international projects started the process of preparation of strategic and legal documents that are in force at this moment. Creating updated sectoral long-term vision throughout the new Forest Strategy and updated policy instruments supporting their smooth implementation. Public participation should be secured by creating and implementing this process. The Forest Strategy should have a clear monitoring mechanism in order to fine-tune some deviation from defined objectives or selected measures.

Particular emphasis is placed on management issues in private forests, which occupy about one-half of the total forest area and are characterised by a poor forest state, fragmented holdings and unsolved property ownership issues. These problems make forest management even more complicated, together with new owners of larger estates (churches, cooperatives, large landowners) and the state's interest to participate in encouraging the development of the private sector to achieve sustainable development goals. Creating targeted forest policy instruments and stimulating the organisation of private forest owners' association could be one of the biggest challenges but at same time, the greatest opportunity for securing sustainable forest management.

For the past 20 years, the main characteristics of planning in the forestry sector has been a lack of participation of stakeholders in the decision-making process. At this moment, preparation of different by-laws that follows the Law on Forests is underway, first the by-law that regulates forest management planning as the most important process in forestry. New forest legislation should take into consideration climate change challenges and be flexible at the technical level in order to have a prompt and adaptable approach.

The new strategic document for the forestry sector is in the process of preparation. In addition to this, draft law regulating the trade of timber in line with EUTR was developed in March 2023.

The lack of appropriate inter-sectoral and cross-sectoral cooperation leads to slower fulfilment of tasks set up in strategic documents of different sectors and intensifying conflicts between different stakeholders. Regional cooperation should be established in order to create a forest exchange platform. Best practice exchange from the region on different topics will be of value so that other countries could benefit from experiences and implementation problems.

Integration of new elements into forest management planning in forestry practices tested on pilot areas should be one of the challenges in the future. Target-oriented forest management guidelines, site mapping, forest function, landslide cadastre should be further elaborated and capacity building should be prepared and executed with forestry practitioners.

Continuous education as an instrument for the implementation of new elements in forest management planning is in development stages. Long-term education strategy is one of the main instruments for securing sustainable forest management in the future and could be considered as one of the important climate change adaptation instruments in forest management.

A SWOT analysis of the Serbian forestry sector was performed within the document Roadmap towards a National Forest Development Programme, and the results of this analysis are presented in the following table.

Table 1. Strengths, weaknesses, opportunities and threats in the forestry sector in Serbia

Strengths	Weaknesses
Strong state forest enterprises	Very high number of private forest owners and fragmentation of forest parcels/plots
Protective forests especially in Vojvodina	Illegal logging
Hunting and wild animal management	Waste and littering in forests
Opportunities	Threats
Awareness-raising campaigns	Weak law enforcement
Increasing income of private forest owners	Too many management plans on different levels
Preparation for the Natura 2000 network	Non-beneficial competition between the forest industry and pellet, firewood etc. production
Education and implementing new organisational forms	State control in private forests
Compulsory or private membership to represent interests in forest management organisations	Illegal Waste Dumps
Investments in wood processing industry	
Biomass production	

In addition to the SWOT analysis, for the purpose of preparation deficits/gaps for achieving SFM in Serbia are identified. Those gaps are formulated for different aspects of SFM and are presented in the following text:

Forest management

- Afforestation as a possibility for increasing contribution of the forestry sector to climate change mitigation is not used at the appropriate level, especially near urban areas
- Lack of coordination among legislation and financial instruments from different forest-related sectors hindering unlocking afforestation and other nature-based solution potential towards land degradation neutrality (nature protection, agriculture etc.)
- Forest biodiversity is not integrated in forest management planning and monitoring systems (draft methodology prepared but it is not part of FMP practice yet)
- Concept of CNFM is mentioned in the draft by-law, but it is not operationalised

Forest management

- Forest management guidelines related to forest management (practice-oriented), which describe intervention in forests from the beginning to the end of the production period is missing (at the moment 20 out of 27 guidelines finished)
- Forest inventory is not adopted for future permanent monitoring approaches in achieving SFM and biodiversity objectives
- Sustainable forest management of private forests is a great challenge especially in the changed socio-economic environment and depopulation of rural areas (the new generation of small-scale private forest owners have different objectives than their predecessors)

Education, research and knowledge transfer

Lack of national research agenda

Lack of updating curriculum at university regarding teaching approaches (service learning) and new challenges in the forestry sector (climate change, active management in protected areas, bioeconomy)

Institutional setup for long-term education regarding prompt knowledge transfer from science to practice in the forestry sector is missing (Chamber of forest Engineers is established but not fully operationalised)

Long-term demonstration and research setup is missing as instrument of research, continuous education and monitoring

Financial instruments

- Payment for ecosystem services does not exist (although there was such an example in Serbia, it ended after a few years)
- Financial instruments for wood mobilisation from sustainable private forest management practice does not exist

Monitoring and communication

- Comprehensive forest information system as instrument for regular monitoring of intervention into forest ecosystems and their effects on SFM is missing (by-law on forest information system was adopted but the process of implementation has only recently started)
- Integrated forest fire information system is missing
- Communication strategy towards other sectors and the society is not adequate (no climate change council has been established as the coordination body of different sectors)

Legislative and institutional frameworks

- Forest strategies as future common vision of the forests is outdated (climate change, bioeconomy, forest biodiversity, different forest risks should be taken in consideration)
- More flexible and adaptive forest regulatory framework is missing
- No monitoring of the achievement of strategic objectives proposed by the previous strategy has been done so far
- Forestry is not well-recognised in rural development programmes and financing mechanisms (IP-ARD system is not fully integrated for private forest owners)
- EUTR FLEGT initiatives have not been accomplished although the process has been initiated

Following the analysis of deficits/gaps in the forestry sector, as well as the performed SWOT analysis, general recommendations are provided here for the improvement of the Serbian forestry sector:

- Implementation of the Closer-to-Nature Forest Management with clear practice-oriented management guidelines taking into consideration climate change should be finished and people trained
- Biodiversity aspects in forest management planning and monitoring should be established and people trained (could be basis for Nature 2000 in the future)

- Sustainable forest management with wood mobilisation in private forests taking into consideration the changing socio-economic characteristics of private forest owners (urbanisation of forest owners)
- Unlocking potential for afforestation/nature-based solutions in forest land and other land-use categories, taking into consideration climate change
- Initiate new financial support mechanism for achieving SFM (payment for ecosystems services system was already established and could be easily applied again)
- Create institutional setup for knowledge transfer and continuous education in the forestry sector (including demonstration and research plots in the field)
- Establishment of the forest information system as a monitoring instrument including different modules and capacity building for use of remote sensing in the monitoring process
- Updating or creating adaptable new strategic and regulatory frameworks based on common vision and new challenges in the forestry sector (climate change, bioeconomy, forest biodiversity, EUTR, rural development, etc.)

In addition to the recommendations made by the national consultant for Serbia, within the project titled Improvement of Forest Management in Serbia as a Contribution to Climate Change Adaptation and Mitigation, a Roadmap towards a National Forest Development Programme was prepared, defining thematic areas as priorities in the forestry sector policy of Serbia, as follows:

1. Institutional and regulatory context of the forestry sector
2. System of forest management, planning and implementation
3. Socio-economic and cultural context of the forestry sector
4. Import and export of timber products
5. Forest support system
6. Forest Information System
7. Research, education and training in the forest sector

Those thematic areas are defined in consultation with stakeholders from the forestry and forestry-related sectors, based on GAP analysis. Each thematic area consists of a short description, relevant EU framework, situation analysis in Serbia and possible fields of action.

Fields of action, in the framework of thematic areas, have been defined as follows:

1. Institutional and regulatory context of the forestry sector

- Strengthen the capacities of the labour force in the forestry sector, including forest workers and machine operators
- Enhance the capacities of forestry inspection/local forestry inspection offices to cope with the updated and additional tasks related to the EU acquis (plant protection, placing on the market, EUTR/FLEGT/EUDR, RED II/RED III, forest reproductive material, etc.)
- Develop permanent cooperation and adapt the legal framework as a precondition for delegating defined tasks from the Directorate of Forests to other institutions (e.g. for forest monitoring, database management and further analysis and research of NFI data, training and extensions services)
- Create department/capacities for establishing and implementing future Rural Development Programmes
- Introduce a new legal act on import and control of timber and timber products; establish timber inspection in accordance with EUTR/FLEGT/EUDR
- Review alignment of national laws on plant health and forest reproductive material to EU legislation
- Review alignment of rules concerning the state of forest enterprises with EU provisions (competition law, public procurement, state aid in forestry)
- Clarify and establish institutional cooperation with other authorities in the fields of EUTR/, FLEGT/EUDR, CITES, nature protection, etc., e.g. Customs, Ministry of Trade (competent authority, modes/procedures)

2. System of forest management, planning and implementation

- Finalise the National Forest Inventory supported by the FAO/GEF project and mandate a permanent custodian (institution) for further analysis of data, research, reporting and providing facts-based information for further policymaking by the Directorate of Forests
- Develop and complete seven Regional Forest Development Plans (two will be piloted by the FAO/GEF project)
- Develop additional (missing) national guidelines for forest management planning
- Build capacities for forest management planning at all levels in order to develop and maintain forest management plans
- Adapt legal framework, as necessary

3. Socio-economic and cultural context of the forestry sector

- Encourage the participation of stakeholders at all levels in forest policymaking processes (especially in rural areas) by the facilitation of public dialogue and inclusive and coherent forest governance framework (new EU Forest Strategy, LEADER initiative in the context of RDP)
- Develop a dialogue platform between the forest sector and timber industries (timber, paper and cardboard and bioenergy industries) to seek synergies and align interests along the whole value chain and maximise national value addition and employment creation
- Enhance education of professionals at all levels, forest owners and the general public using outputs from the forest information system
- Public awareness efforts need to be strengthened through transparent and proactive public relations activities
- Promote sustainable forest management and the role of forests in the bioeconomy, aiming at the young generation and the general public (e.g. forest pedagogy activities)
- Build capacities in public awareness and communication skills in all relevant institutions with particular emphasis on the Directorate of Forests, Chamber of Forestry Engineers for a national communication campaign promoting sustainable forest management (see chapter on education and research)
- In addition to institutional changes, develop and implement a forest communication strategy to achieve positive perception of the forest sector and its policy, emphasising openness and transparency
- Strengthen cross-sectoral coordination and cooperation with the purpose of avoiding conflicts between different attitudes of stakeholders
- Explore synergies with related sectoral policies (energy, environment, tourism) to move closer to the Sustainable Development Goals and strengthen all social and environmental functions of forests (sustainable tourism, reducing energy poverty, biodiversity targets, etc.)

4. Import and export of timber products

- Perform a gap analysis of current legal frameworks to determine competencies of national and international trade of timber and timber products
- Determine the Competent Authority(ies) to enforce checks on domestic timber and timber products and the operators relating thereto as well as enforce checks on imported timber and timber products (including FLEGT-licensed timber)
- Set up a legal basis for cooperation with other authorities (e.g. customs) and exchange of data as well as corresponding procedures
- Analyse the requirements for inspection capacities for domestic timber trade as well as import control to determine human resource requirements

5. Forest support system

- Develop and define forest support measures in the future NFDP to be financed from the Forest Budget Fund
- Provide necessary resources on all levels (personnel, financial, data, know-how, information, etc.) for the preparation, implementation, evaluation, etc. of the national support system (and in the future RDP)
- Simplify the forest support system and develop ways to increase the ability for private forest owners to apply and receive forest subsidies more effectively
- Design and implement an effective and transparent control and evaluation system, including all the necessary data (processing, monitoring, and evaluation of forestry measures) with the involvement of professional organisations and private forest owners
- Build capacities within the Directorate of Forests (e.g. two forestry engineers) to administrate forest subsidies (this unit could then be shifted to a future payment agency)
- In view of EU accession, setting up of one separate paying agency (combining agriculture and forestry support systems) and ensuring sufficient forestry experts in the same institution
- Implement co-financing arrangements for projects, as stipulated by rulebooks

6. Forest Information System

- Finalise the second National Forest Inventory (currently undertaken by FAO/GEF)
- Complete and implement an Integrated Forest Information System (already started by FAO/GEF) that can be harmonised with other multinational systems (e.g. FISE)
- Identify, mandate and finance one institution as the custodian of the FIS to maintain and care for databases, conduct research and provide for continuous and coordinated analysis and provision of data
- Develop guidelines or rules to facilitate the exchange of information between different databases of various institutions, harmonisation of data sets and enabling the exchange of information based on a legal/contractual basis, taking into consideration the EU INSPIRE Directive
- Bring the issue of an incomplete and outdated national cadastre to the highest political agenda (as it concerns the entire land-use sector)
- Enable relevant parts of the data and information stored in the Integrated Forest Information System to be broadly available to the public

7. Research, education and training in the forestry sector

- Develop a Roadmap on Research and Innovation in forestry to support the transfer of innovation in the forest sector through functional connections between institutions and organisations
- Establish a research advisory coordination body consisting of all recent actors in the field of forestry
- Develop a better connection between scientific and research organisations and enterprises, ensuring the timely and effective application of research results in practice
- Stimulate multidisciplinary research on the role of forests in climate change adaptation and mitigation and biodiversity conservation (e.g. closer-to-nature forestry, biomass utilisation); enhance valorisation of forest functions (e.g. ecosystem services)
- Improve cooperation with the European research community and support involvement of Serbia's forestry research into Horizon Europe and related instruments (ERA-NET, ERA-NET Cofund and follow-up programmes, EIP-Agri) by mirroring research topics at the national level
- Develop Roadmap on Forestry Education which defines needs for professional staff, appropriate institutional adjustments and curricula contents, in cooperation with forest practitioners
- Develop and implement lifelong learning and advisory systems to reflect current and expected development of capacity needs in the forest sector in Serbia
- Establish an advisory body for forestry education and training at all levels to define and secure the needs for professional staff, appropriate innovation of education programmes and curricula
- Implement the National Strategy for Forest Genetic Resources with proper measures identified and undertaken

Meanwhile, since the Roadmap was published during March 2023, some of the possible actions have been completed, for example, the finalisation of NFI.





