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FACULTY of FORESTRY in SKOPJE

FOREST ECOLOGY AND MANAGEMENT IN THE UPPER BREGALNICA REGION OF MACEDONIA (MALESH)

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This paper was based on the information contained in nine specific forest management plans for the two subsidiaries (Berovo and Pehchevo) of PE Macedonian Forests and other relevant data. As such it represents the first document of its kind for the upper Bregalnica region.

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INTRODUCTION

The region of Malesh occupies the eastern part of Macedonia and comprises the upper watershed of the Bregalnica River. It is a natural unit characterized by its specific natural geographic, cultural and historical features. In administrative terms, two local self-governments exist within the region today: Berovo and Pehchevo. The forests in this area are managed by two forest holdings: "Maleshevo" from Berovo and "Ravna Reka" from Pehchevo. Since 1998, both forest holdings are integrated into thepublic enterprise “Macedonian Forests” from Skopje.

Forest management, i.e. the use of forests, in the region of Malesh has a long tradition. However, only a few written documents are preserved for the period before 1947.

During five centuries of the Ottoman Empire rule, the forest in the area was regarded as their property and they gave the local population leasing rights for periods of 10 years and locals had to pay a special tax on forest use under the so-called "Kanun Erori" bill. The Ottoman Empire authorities issued special deeds for the use of forests in this area. The conscientious forest users had been granted permanent forest use by payment of certain compensation. In that time, the population had the right to freely use non-wood forest products from the forest and forest land.

In 1926, a delimitation was made for the first time between areas covered by forest management, comprising namely the territory of today’s forest management unit "Maleshevski Mountains II – Ratevska Reka".

In 1928, the region of Malesh started a delimitation process between state and private forests. This process continued until 1932, resulting in the delimitation between municipal, village and private forests.

The preconditions for planned forest management were established with the adoption of the following state regulations: "Manual on state forests" (1931), "Guide to marking the trees for felling and determination of income in uneven aged forests" (1937), "Guidelines on Forest Inventory" (1946) and the "General Guidelines on Forest Management" (1948).

Particular progress in creating the planned forest management was made with the establishment of the Forest Service in 1947, as part of the Secretariat for Agriculture, Forestry and Water Management. The main activity of the Forest Service consisted in preparingten-year plans on forest management.

After the Second World War all forests in the region of Malesh (as well as in Macedonia) were declared as national property, but still the privateownership over a certain part of the fund was retained.

In 1947, the forests in the region of Malesh were under the administration of the People's District Committee in Berovo. Also, the state forest economy was established in Berovo which performed the silvicultural forest operations in the forests in the region of Malesh.

In the period from 1947 to 1949, the first wood processing plant was developed, initially with one machine, which had a processing capacity of 1500 m³ of wood. This started the development of the forest industry in the region.

Greater opportunities for the development of forest management in the area begun in 1952, when the forest management holdings were established in Macedonia and the first forest management plans (today called Special plans for forest management) for a period of 10 years were introduced. The elaboration of forest management plans for each forest management unit (as obliged by Law) was introduced later, based on the Law on Forests of 1974.

The planned and sustainable forest management in this area started with the establishment of the forest holdings in Berovo and Pehchevo, and the preparation of the first forest management plans is based on the management sustainability principle. This initiated the improvement of the forest fund's structure, which was greatly impaired, particularly. In the part closer to the populated areas and, in the oak forest belt, where the clear cuts were performed, as well as the use of trees and forests to feed cattle, excessive fuelwood collection and other negative practices.

In the period until 1960, the forest fund was primarily used to feedthe wood industry mills, so the silviculture and protection of forests were performed by the state forest holdings.

The two forestry organizations worked together until 1974 when the forestry was separated and began to independently perform all forest activities, such as silviculture and use of forests, forest protection, building of forest access roads, forest management, etc.

Up to 1998, the two forestry holdings in the region of Malesh operated as two independent legal entities, "Maleshevo" in Berovo and "Ravna Reka" in Pehchevo. Since 1998, they are integrated into the public enterprise "Macedonian Forests" from Skopje.

As before, their work today is based on the specific plans on forest management. Up to the year 2000, these plans were elaborated by the Forest Service; since 2000, forest management planning has been integrated as a separate sector for Forest and Hunting Management and Design within the public enterprise "Macedonian Forests" - Skopje.

Specific plans on forest management are made for all forests covered by the forest management units and they are valid for ten years. Such plans are reviewed and approved by the Commission at the Ministry of Agriculture, Forestry and Water Economy of the Republic of Macedonia.

In the specific forest management plans, according to the Rules for the content of the specific forest management plans, the Special Plans for silviculture and protection of forests and Annual Performance Plans (Official Gazette of RM No. 48/98) determine: the name of forest management units, location, boundaries, the area of forests and the area of non-forestedland within the borders of forest management units, soil and environmental conditions, forest associations, state of the forests, the value of forests, forest management in the past, the future management objectives, tasks and measures to be taken for forest use, silviculture and protection, and economic-financial results.

The Specific forest management plan consists of: a textual part, forms and maps. The textual part and the forms are unified into a A4 format booklet, with maps attached.

The Specific forest management plan is developed based on data collected from the field in the year preceding the period for which the plan refers to.

Most of the forests in the upper Bregalnica region are managed by both subsidiaries of PE Macedonian Forests in Berovo and Pehchevo i.e. the region of Malesh.

In this paper, the review i.e. summary of data and information together with cartographic, spreadsheet and graphical displays is given of Specific Management Plans for all forest management units pertaining to the region of Malesh: "Bukovik Bajaz-Tepe"; "Maleshevski Mountains I"; "Maleshevski Mountains II - Ratevska River"; "Bregalnica"; "Ograzhden"; "Obeshenik"; "Djami Tepe"; "Gubenek-Paruca"; and "Goten-Shirok Dol".

Each of the nine forest management units listed above covers a forest area of approximately 3,000 – 5,000 ha, and as for now, they have not been summarized in a separate document as a whole (e.g. a regional forest development plan).

From the collected data, four types of maps were digitalized and prepared for the region of Malesh: (i) vegetation map, (ii) soil map, (iii) map of forest stands , and (iv) forest road infrastructure map.

Additionally, information is given on the topics not covered by the Specific forest management plans, in particular: forest land tenure and ownership patterns, socio-economic conditions, seed stands and seed orchards, forest conservation, old (virgin) forests without significant disruption, and guidelines for ecosystem-oriented forest management.

LAW ON FORESTS AND OTHER LEGAL REFERENCES

The Law on Forests (Official Gazette no. 64/09, 24/11, 53/11, 25/13, 79/13, 147/13 and 43/14), is a general law regulating the planning, management, silviculture, protection, use and maintenance of forests as natural resources, as well as the forest land, the exercise of public functions of forests, rights and obligations of forest use, financing, and other issues of importance to forests and forest lands as a principle of biological, economic, social and environmental acceptability.

The provisions of this law apply to all forests and forest lands regardless of ownership and use and, according to the Law on Forests, forests could be state and private property.

The main goals of the Law on Forests are:

- to permanently preserve the forest area, to increase its value and provide the greatest growth and increment under the current natural and site conditions;

- to ensure sustainable management, and protection of forests and forest lands in a way and at a rate that is sustainably maintained and to improve their production capacity, biodiversity, capacity for regeneration and vitality in the interest of current and future development of economic, environmental and social functions of the forest, in order not to disturb the ecosystem.

The planning and management of forest and forest land is accomplished through:

- Special plans on forest management,
- Program on forest management, and
- Annual plans on forest management.

In accordance to the Law on Forests, the types of forests according to their use are as follows:

- *Economic forests*, which are primarily used for continuous production of wood assortments and other forest products and services;
- *Protective forests*, which are primarily used to protect land, water, settlements, infrastructural systems and other facilities and properties;
- *Forest and hunting reserves*, which are determined to protect the rare species of forest trees, wildlife and biodiversity conservation;
- *Forest parks and picnic areas*, which are used for resting, sports and recreation;
- *Memorial forests*, which are used for marking important historical events;
- *Forests for forest seed production*, which are used for production of recognized and quality reproductive material;
- *Forests for science and teaching purposes*, which are used for education and research in the field of forestry;
- *Forests in protected areas*, which are declared in accordance with the Law on Nature Protection.

In addition to the provisions of the Law on Forests, the forests are covered by other laws and regulations, such as:

- Law on Nature Protection (Official Gazette of RM No. 67/04, 14/06, 84/07, 35/10, 47/11, 148/11, 59/12 and 13/2013);
- Law on Hunting (Official Gazette of RM No. 26/09, 136/11, 01/12, 69/13, 164/13 and 187/13);
- Law on Pasture Management (Official Gazette of RM No. 3/98, 101/2000, 89/2008, 105/2009, 42/10 and 2013);

- Water Law (Official Gazette of RM No. 87/08, 06/09, 161/09, 83/10 and 51/11);
- Law on Fisheries and Aquaculture (Official Gazette of RM No. (7/08, 67/10, 47/11, 53/11 and 95/12);
- Law on Agriculture and Rural Development (Official Gazette of RM No. 49/10);
- Rulebook on the content of special plans on forest management, special plans on silviculture and protection of forests and Annual Performance Plans (Official Gazette of RM No. 48/98);
- Rulebook on the form, content and manner of keeping the cadaster of forests and forest lands (Official Gazette of RM No. 75/10);
- Rules on the establishment and maintenance of forest order (Official Gazette of RM No. 75/10);
- Rules on the determination of price of forest damage (Official Gazette of RM No. 75/10);
- Rulebook on the manner of providing firewood to individuals for their own needs from the state forest and the format and content of the form to keep track of the cut timber (Official Gazette of RM No. 75/10);
- Rules on the type and method of marking, the manner of issuing a receipt, sale of timber cut, form and content of the register of issued and verified receipt, the form and content of the dispatch, the form and content of the request for issuance of receipt and amount of the fee for the issued receipt (Official Gazette of RM No. 75/10);
- Rulebook on issuing a license to perform professional activities in the field of forestry, the form and content of the application for a license, the form and content of the license, the form, content and manner of keeping the register of issued licenses and the fee for its issuance (Official Gazette of RM No. 75/10);
- Rulebook on the form, content and manner of filling the monthly report on harvesting, delivery and transport (Official Gazette of RM No. 75/10);
- Regulations on the procedure for the use of data and the amount of compensation for their use (Official Gazette of RM No. 75/10);
- Regulation amending the Regulation on the type and method of marking, the manner of issuing the receipt, sale of timber cut, form and content of the register of issued and verified receipt, the form and content of delivery receipt, and amount of fees for the issued delivery receipt (Official Gazette of RM No. 82/10);
- Law on reproductive material of forest trees (Official Gazette of RM No.55/07 148/11);
- List of important commercial forest tree species (Official Gazette of RM No.131/08);

- Rules on determining the quantity of reproductive material for special purposes (Official Gazette of RM No.131/08);
- Rulebook on the conditions for the recognition of types of basic reproductive material (Official Gazette of RM No.131/08);
- Rulebook on the form, content and manner of keeping the register of provenance areas (Official Gazette of RM No.131/08);
- Rulebook on the form and content of the request for recognition of basic material types and the form and content of expert opinions on the recognition of the basic material (Official Gazette of RM No.131/08);
- Rulebook on the form and content of the certificate for recognized basic material and the form, content and manner of keeping the register of recognized basic material (Official Gazette of RM No.131/08);
- Rulebook on the form, content and manner of keeping the register of producers and traders of reproductive material of forest trees (Official Gazette of RM No.131/08);
- Rulebook on the form and content of the certificate of origin of reproductive material (Official Gazette of RM No.131/08);
- Rulebook on the content and manner of keeping trade books (Official Gazette of RM No.131/08);
- Rulebook on the form and content of the expert control of production of planting material and the form and content of the certificate of quality planting material (Official Gazette of RM No.131/08);
- Rulebook on the form and content of the examination and determination of the quality of reproductive material (Official Gazette of RM No.131/08);
- Rulebook on the form and content of certificates of seed quality and / or plant parts (Official Gazette of RM No.131/08).

Besides the Law on Forests, the **Law on Nature Protection** (Official Gazette of RM No. 67/04) is the general law regulating the protection of nature through the protection of biological and landscape diversity and protection of natural heritage within the protected areas and outside of protected areas.

The objectives of the Law on Nature Protection can be summarized as follows:

- Identification and monitoring the nature's state;
- Conservation and restoration of existing biological and landscape diversity in a state of natural balance;

- Establishing a network of protected areas for permanent protection of properties that have acquired the status of natural heritage;
- Ensuring the sustainable use of natural resources for the benefit of current and future development, without significant damage to parts of nature with the least possible disturbance of the natural balance;
- Prevent harmful activities by physical and legal persons and disturbances in nature because of technological development and execution of various activities, i.e. providing the best possible conditions for protection and development of nature;
- Enabling citizens to exercise their right to a healthy living environment.

In order to improve the situation in forestry, on 11.06.2004 the Parliament passed **the Spatial Plan of the Republic of Macedonia**, which contains projection for the development of forestry till 2020. The main objectives were geared towards increasing forest area according to global regionalization and categorization of space, improving the quality of forests by improving the species composition, converting coppice into high forests, reconstruction of degraded forests and shrubs, taking silvicultural measures in all stages of forest development, introduction of modern equipment and technology in the utilization of forest products, increased openness of forests, and taking timely precautions in protection of forests.

In terms of forest management, the wider concept of forest contributing sustainable development is envisaged as a way of promoting the forests and enhancement of the forest fund.

On 19.06.2006, the Ministry of Agriculture, Forestry and Water Economy adopted the Strategy for sustainable development of forestry in Macedonia. With this Strategy, the priorities of forestry in the future will be directed towards socially beneficial functions of forests and to the protection of biodiversity and care for nature and the environment in general.

1. OBJECTIVES OF FUTURE FOREST MANAGEMENT IN MALESH

The objectives of future forest management are prescribed by the Law on Forests (Official Gazette of RM No. 47/97, 7/00 and 89/04) and apply to all forest management units. They refer to the sustainability of forest management, increasing the area covered byforests, increasing forestgrowth and increment, as well as improvement of the forest stands' structure per tree species and quality.

Moreover, the objectives also refer to the impact of forests on the protection of the environment, particularly: protection of land, settlements, roads and other infrastructure facilities, riverbeds from the influences of erosive processes; improving the condition of the water regime and the sediment erosion regime; climate regime; soil fertility; regulating the regime of air purification and improvement of water quality; creating conditions for health treatment, recovery, sport and recreation, tourism, hunting, etc.

The objective of the forest management can be biological, technical, productive, and socially beneficial functions.

1.1. Biological objectives

The role of the biological objectives is to provide a permanent increase of timber volume and yield in quantity and quality. Then, improvement of stand composition. Increasing the wood stock per unit area in all stands and achieve maximum growth and yield in the shortest period. Also, the biological objectives, with the help of some tending measures, have the task to establish the correct layout of plantations per classes of age, i.e. plantations grouped into classes by age, to occupy approximately the same area.

The achievement of the biological objectives requires the implementation of the following economic measures:

- The annual allowed timber cut should not exceed the specified annual timber growth within the entire forestry unit or economic class.
- The stands to be managed in a manner that would not disrupt sustainable and economically viable forest management.
- To ensure natural regeneration and smooth development of stands through quality and biological impacts.
- The afforestation of bare forest land to be done with productive tree species, as well as implementation of tending measures in afforested areas.
- Quick and complet removal of all trees that, from the burned areas, that are destroyed and those that are considered as having no perspective in their further development.

1.2. Technical objectives

The technical objectives should enable that all requirements are met for the application of plans and measures for forest management. They should create conditions for efficiency, effectivenessand profitability of forest operations. As such, the following economic tasks have been defined:

- Improvement of the road network in length and quality, as well as permanent maintenance of existing roads.
- Improvement of the working means at all stages in the production process, especially during harvesting, transportation and supply of timber assortments.
- Continuous provision of expert personnel and skilled workers, and their permanent education.

1.3. Productive objectives

The productive objectives have to ensure greater quality and production of forest products to meet customers' needs. In order to meet these objectives, it is necessary to plan such measures that will give the best results in a shorter period of time.

The region of Malesh has favourable natural conditions for the development of quality forest stands, which may have the potential for greater production of timber volume as per quality and quantity. This applies especially to the increased use of timber technical wood in the total wood production. The future forest management should be directed towards maintaining and improving the forest production, in quality and quantity.

1.4. Socially beneficial objectives

These objectives have the task to ensure sustainable maintenance and improvement of the protective and other socially beneficial functions of the forest. They also include permanent maintenance of the area in which the forest is located and in it’s immediate vicinity, and permanent protection of settlements, roads and other facilities, improving the climatic conditions, water regime and human health.

1.5. Grouping of stands in economic classes

Whenpreparingspecific plans for forest management, agrouping of forest stands in economic classes is undertaken as prescribed in Article 29 of the Rules for the preparation of specific forest management plans. Economic classes may have subclasses and they are displayed based on the following unique classification:

1. Economic class, “A”- Pure high stem beech stands

Subclasses:
-“A1”- selective,
-“A2”- even aged,
-“A3”- grouping even aged,
-“A4”- degraded,
-“A5”- protective.

2. Economic class “B”- Mixed high stem stands of beech and other species

Subclasses:
-“B1”- beech and Sessile oak,
-“B2”- beech and European aspen,
-“B3”- beech and Scots pine,

-“B4”- beech and Austrian pine,
-“B5”- beech and Silver fir,
-“B6”- beech and Norway spruce,
-“B7”- beech and Macedonian pine,
-“B8”- beech and other deciduous trees and conifers.

3. Economic class, “V”- Pure high stem Sessile oak stands,

4. Economic class, “G”- Mixed high stem Sessile oak stands and other species

5. Economic class, “D”- Pure high stem coniferous tree stands

Subclasses:
-“D1”- Scots pine,
-“D2”- Austrian pine,
-“D3”- Silver fir,
-“D4”- Norway spruce,
-“D5”- Macedonian pine,
-“D6”- Greek juniper.

6. Economic Class, “E”- Mixed high stem coniferous and deciduous tree stands

Subclasses:
-“E1”- conifers and beech,
-“E2”- conifers and Sessile oak,
-“E3”- Silver fir and pine,
-“E4”- Silver fir and Norway spruce,
-“E5”- Silver fir and Macedonian pine,
-“E6”- other conifers.

7. Economic class, “I”- Pure high stem other deciduous tree stands

8. Economic class, “J”- Afforested tree stands

Subclasses:
-“J1”- deciduous,
-“J2”- coniferous,
-“J3”- mixed.

9. Economic class, “K”- Plantations

Subclasses:
-“K1”- deciduous,
-“K2”- coniferous,
-“K3”- mixed.

10. Economic class, “N”- Low stem beech stands

Subclasses:

-“N1”- quality beech stands on good site conditions,
-“N2”- low quality beech stands on good site conditions,
-“N3”- low quality beech stands on bad site conditions,
-“N4”- stands with introduced deciduous and coniferous tree.

11. Economic class, “M”- Low stem Sessile oak stands

Subclasses:
-“M1”- quality Sessile oak stands on good site conditions,
-“M2”- low quality Sessile oak stands on good site conditions,
-“M3”- low quality Sessile oak stands on bad site conditions,
-“M4”- stands with introduced deciduous and coniferous tree.

12. Economic class, “L”- Other oak low stem stands and other deciduous tree species

Subclasses:
-“L1”- low quality Sessile oak stands on good site conditions,
-“L2”- low quality Sessile oak stands on bad site conditions,
-“L3”- stands with introduced deciduous and coniferous tree.

13. Economic class, “SH”- shrubs,

14. Economic class, “C”- shrublands,

15. Economic class, “P”- plantations.

16. Economic class, “O”- areas with no forest cover

Subclasses:
-“O1”- fields,
-“O2”- meadows,
-“O3”- pastures
-“O4”- rocks,
-“O5”- for other purposes (road, power line, channel, etc.).

Table 1 displays the structure of economic classes and subclasses by area occupied, timber volume and increment for all forests covered by special plans for forest management in the region of Malesh.

From the data given in Table 1, we can see that there a large number of economic classes and subclasses represented in the forests in the region of Malesh.

All the above mentioned economic classes cover an area of **33,125 ha**, with **7,290,234 m³** of timber volume, **120,567 m³** of current increment and **45,731 m³** of average increment.

Table 1. Structure of economic classes and subclasses by area occupied, timber volume and increment

Economic class	Economic subclass	Area (ha)	Timber volume (m3)	Current annual increment* (m3/ha)	Average annual increment** (m3/ha)
A	A1	2,150.01	859,485	11,609	0
	SUBTOTAL B + P	**2,150.01**	**859,485**	**11,609**	
	A2	404.58	91,701	968	913
		13.10	1,870	34	0
		1,410.30	449,500	4,488	4,397
		41.70	10,354	261	187
	SUBTOTAL B + P	**1,936.58**	**589,600**	**6,190**	**6,245**
	A3	621.90	191,708	3,027	0
		1,757.50	612,087	7,667	0
		115.24	29,199	441	0
		1,641.10	498,300	10,382	0
	SUBTOTAL B + P	**4,135.74**	**1,331,294**	**21,517**	**0**
	A4	43.20	12,224	106	106
	SUBTOTAL B + P	**43.20**	**12,224**	**106**	**106**
	SUBTOTAL	**8,265.53**	**2,792,603**	**39,422**	**6,351**
B	B1	112.84	24,527	255	232
		1,007.17	248,428	3,683	0
	SUBTOTAL B + P	**1,120.01**	**272,955**	**3,938**	**232**
	B2	111.20	33,765	378	357
		17.70	4,218	68	0
		349.20	102,854	1,429	208
		19.60	5,564	79	0
	SUBTOTAL B	**497.70**	**146,401**	**1,954**	**565**
	B3	2,206.80	692,352	16,713	116
	SUBTOTAL B + P	**3,002.20**	**973,584**	**21,066**	**196**
	B4	342.80	73,630	1,905	0
		10.30	2,452	45	28
		900.54	251,784	4,036	0
	SUBTOTAL B + P	**2,089.85**	**494,854**	**8,903**	**2,701**
	B5	33.30	9,739	272	0
	SUBTOTAL B + P	**33.30**	**9,739**	**272**	**0**

	B8	488.50	94,675	1,171	837
		488.20	103,488	1,420	1,081
	SUBTOTAL B + P	**1,189.44**	**265,994**	**3,875**	**1,918**
	SUBTOTAL	**7,932.5**	**2,163,527**	**40,008**	**5,612**
V	V	460.84	71,875	783	717
		247.00	49,603	387	508
	SUBTOTAL	**707.84**	**121,478**	**1,170**	**1,225**
G	G	566.82	84,083	1,081	926
		215.10	46,121	458	475
	SUBTOTAL	**781.92**	**130,204**	**1,539**	**1,401**
D	D1	10.90	2,590	39	24
		197.00	6,625	254	120
	SUBTOTAL B + P	**207.90**	**9,215**	**293**	**144**
	D2	1,096.80	282,074	2,718	3,291
		640.30	95,115	1,727	498
	SUBTOTAL B + P	**4,239.82**	**609,644**	**12,683**	**9,381**
	SUBTOTAL	**4,447.72**	**618,859**	**12,976**	**9,525**
E	E1	286.56	87,601	1,349	0
		26.80	4,558	141	58
	SUBTOTAL B + P	**887.69**	**287,070**	**4,697**	**2,062**
	E2	7.80	2,028	37	0
	SUBTOTAL B + P	**7.80**	**2,028**	**37**	**0**
	SUBTOTAL	**895.49**	**289,098**	**4,734**	**2,082**
I	I	2,609.64	366,856	4,225	3,804
	SUBTOTAL B + P	2,609.64	366,856	4,225	3,804
	SUBTOTAL	**2,609.64**	**366,856**	**4,225**	**3,804**
	N1	459.51	82,302	1,206	1,396
	SUBTOTAL B + P	459.51	82,302	1,206	1,396
N	N2	230.40	38,297	408	356
		794	102,501	1,002	1,467
	SUBTOTAL B + P	**1,024.40**	**140,798**	**1,410**	**1,823**
	SUBTOTAL	**1,483.91**	**223,100**	**2,616**	**3,219**
J	J2	169.00	9,633	843	414
		34.70	1,296	163	41
		11.60	758	76	27
		404.90	30,983	2,063	1,014
		1,383.20	189,354	5,291	4,783

		60.25	5,389	219	168
	SUBTOTAL B + P	**2,342.85**	**284,067**	**10,161**	**7,727**
	J3	40.17	4,323	176	124
	SUBTOTAL B + P	**40.17**	**4,323**	**176**	**124**
	SUBTOTAL	**2,383.02**	**288,390**	**10,337**	**7,851**
K	K2	8.60	109	13	7
		68.00	0	0	0
		25.00	100	88	9
		148.90	1,044	133	80
	SUBTOTAL B + P	**423.30**	**1,253**	**234**	**96**
	K3	37.00	1,269	104	93
	SUBTOTAL B + P	**37.00**	**1,269**	**104**	**93**
	SUBTOTAL	**460.30**	**2,522**	**338**	**189**
M	M1	44.56	8,021	93	154
	SUBTOTAL B + P	**79.36**	**10,839**	**93**	**154**
	M2	33.50	246	23	12
		115.28	19,742	213	198
	SUBTOTAL B + P	**373.18**	**27,931**	**496**	**444**
	M4	168.30	10,255	258	258
	SUBTOTAL B + P	168.30	10,255	**258**	**258**
	SUBTOTAL	**620.84**	**49,025**	**847**	**856**
	L1	129.60	5,108	167	140
	SUBTOTAL B + P	**129.60**	**5,108**	**167**	**140**
		8.00			
L	L2	2,063.60	219,392	1,887	3,172
	SUBTOTAL B + P	**2,071.60**	**219,392**	**1,887**	**3,172**
		69.90	11,401	148	136
	L3	161.80	8,671	153	168
	TOTAL B + P	**231.70**	**20,072**	**301**	**304**
	SUBTOTAL	**2,432.90**	**244,572**	**2,355**	**3,616**
C	**C1**	**103.4**			
	TOTAL	**33,125**	**7,290,234**	**120,567**	**45,731**

Current annual increment: the increment over a period of one year at any stage in tree's life
****Mean annual increment: mean increment of the tree until a specific age***

Economic class (A) - pure high stem beech stands. It has several subclasses, including:

- Subclass (A1) - high stem pure beech selection stands occupy an area of 2,150 ha, with a timber volume of 859,485 m³ and a total current increment of 11,609 m³ per year.
  These are the stands where the shelterwood cutting systemis applied. Adult and thick trees are removed, or the ones that remained from the previous cutting and those with poor quality, diseased and damaged trees. Upon executing the cutting cycle under the shelterwood system, vital and quality trees will remain in the forest stands will accumulate timber volume and natural forest regeneration will be encouraged under this silvicultural system.

- Subclass (A2) - high stem pure beech stands occupy an area of 1,936.58 ha, with 589,600 m³ of timber volume, with 6,190 m³ of total current increment and an average increment of 6,245 m³. Regenerativecuttings are planned to be performed in these stands.

- Subclass (A3) - high stem pure grouping even aged stands occupy an area of 4,135.74 ha, with a timber volume of 1,331,294 m³ and a total current increment of 21,517 m³. Group-selective cuttings are planned in these stands.

- Subclass (A4) - degraded beech stands, cover an area of 43,20 ha, with a timber volume of 12,224 m³, a total current increment of 106 m³ and an average increment of 106 m³. Clear cuttings and direct conversion are planned in these stands.

- Economic class (B) – consists of high stem mixed beech stands and other species.
The following economic subclasses are included in this class:

- Subclass (B1) - covers the high stem mixed stands of beech and Sessile oak. They occupy an area of 1,120 ha, with a timber volume of 272,955 m³, a total current increment of 3,938 m³ and an average increment of 232 m³. Selective cutting is planned in these stands.

- Subclass (B2) - covers high stem mixed stands of beech and European aspen. They occupy an area of 497.70 ha, with a timber volume of 14,601 m³, a total current increment of 1,954 m³ and an average increment of 565 m³. Group-selective and generative cuttings are planned in these stands.

- Subclass (B3) - covers the high stem mixed stands of beech and Scots pine. They occupy an area of 3,002.20 ha, with a timber volume of 973,584 m³, a total current increment of 21,066 m³ and an average increment of 196 m³. Group-selective and generative cuttings are planned in these stands.

- Subclass (B4) - covers the high stem mixed stands of beech and Austrian pine. They occupy an area of 2,089.85 ha, with a timber volume of 494,854 m³, a total current increment of 8,903 m³ and average increment of 2,701 m³. Group-selective and generative cuttings are planned in these stands.

- Subclass (B5) - covers high stem mixed beech and silver fir stands. They occupy an area of 33.30 ha, with a timber volume of 9,739 m³ and a total current increment of 272 m³. Because it is a small area and there is rare occurrence of silver fir in the beech stand, it’s not planned to execute any cuttings or silvicultural measures.

- Subclass (B8) - covers high stem mixed beech and stands and other deciduous and coniferous tree species. They occupy an area of 1,189.44 ha, with a timber volume of 265,994 m³, a total current increment of 3,875 m³ and an average increment of 1,918 m³. It is planned to perform thinnings in these stands.

- Economic class (V) - covers high stem pure sessile oak stands. They occupy an area of 707.84 ha, with a timber volume of 121,478 m³, a total current increment of 1,170 m³ and an average increment of 1,225 m³. No cuttings, or silvicultural measures are planned for high stem sessile oak stands.

- Economic class (G) - covers high stem mixed sessile oak stands and other species. They occupy an area of 781.92 ha, with a timber volume of 130,204 m³, a total current increment of 1,539 m³ and an average increment of 1,401 m³. Most of these stands burned in forest fires and therefore clear cuttings are planned here.

- Economic class (D) - covers high stem pure coniferous stands. This economic class includes two economic subclasses.

- Subclass (D1) - covers high stem pure even aged stands of Scots pine. They occupy an area of 207.90 ha, with a timber volume of 9,215 m³, a total current increment of 293 m³ and an average increment of 144 m³. The silvicultural measures applied here are thinnings and generative cuttings.
- Subclass (D2) - covers high stem pure even-aged stands of Austrian pine. They occupy an area of 4,239.82 ha, with a timber volume of 609,644 m³, a total current increment of 12,683 m³ and an average increment of 9,381 m³. Most of the stands from this economic class are of natural origin and raised by seeds from the older stands of Scots and Austrian pines. They mainly occupy abandoned land, bare land, and former agricultural land. Thinnings are planned in the younger stands of this class, and generative cuttings are planned in the older stands.

- Economic class (E) - covers high stem mixed stands of conifers and deciduous trees. This economic class includes two subclasses.

- Subclass (E1) - covers high stem mixed coniferous stands and beech. They occupy an area of 887.69 ha, with a timber volume of 287,070 m³, a total current increment of 4,697 m³ and an average increment of 2,062 m³. Single selective cuttings and thinnings are planned in these stands.

- Subclass (E2) - covers high stem mixed coniferous stands and Sessile oak. They occupy an area of 7.80 ha, with a timber volume of 2,028 m^3 and a total current increment of 37 m^3. Single selective cuttings and thinnings are planned in these stands.

- Economic class (I) - covers high stem pure stands of other deciduous trees. They occupy an area of 2,609.64 ha, with a timber volume of 366,856 m^3 and a total current increment of 4,225 m^3. Clear cuttings are planned in these stands. In addition, direct conversion or replacement of existing tree species with Austrian and Scots pine is performed here.

- Economic class (J) - covers afforested stands. This economic class includes two subclasses.

- Subclass (J2)- covers afforested stands of coniferous species. This subclass occupies an area of 2,342.85 ha, with a timber volume of 284,067 m^3, a total current increment of 10,161 m^3 and an average increment of 7,727 m^3. Selective thinning is performed in these stands.
- Subclass (J3) - covers afforested stands of mixed species. This subclass occupies an area of 40.17 ha, with a timber volume of 4,323 m^3, a total current increment of 176 m^3 and an average increment of 124 m^3.

- Economic class (K) - covers forest plantations. This economic class includes two commercial subclasses.

- Subclass (K2)- covers forest plantations of conifers. This subclass occupies an area of 423.30 ha, with a timber volume of 1,253 m^3, a total current increment of 234 m^3 and an average increment of 96 m^3. Measures of cleaning, care and spacing are applied in this subclass.
- Subclass (K3) - covers forest plantations of deciduous and coniferous species. This subclass occupies an area of 37 ha, with a timber volume of 1,269 m^3, a total current increment of 104 m^3 and an average increment of 93 m^3. This economic subclass represents forest plantations at a young age and thus tending measures are not taken yet.

- Economic class (N) - covers beech coppice stands. This economic class includes two subclasses.

- Subclass (N1) – covers quality beech stands on good site conditions. They occupy an area of 459.51 ha, with a timber volume of 82,302 m^3, a total current increment of 1,206 m^3 and an average increment of 1,396 m^3. Besides the pure beech coppice plantation, this subclass includes a small part of mixed plantings with Austrian and Scots pines, where the beech is the dominant species. As a silvucultural measure indirect conversion or gradual transfer of low stem into high stem tree plantations through thinning should be executed in these plantations.

- Subclass (N2) – covers low quality beech stands on good site conditions. They occupy an area of 1,024.40 ha, with a timber volume of 140,798 m³, a total current increment of 1,410 m³ and an average increment of 1,823 m³.

- Economic class (M) - relates tolow-stem Sessile oak stands. This economic class includes three subclasses.

  - Subclass (M1) - covers quality low stem Sessile oak stands on good site conditions. They occupy an area of 79.36 ha, with a timber volume of 10,839 m³, a total current increment of 93 m³ and an average increment of 154 m³. As a silvucultural measure in these plantations, an indirect conversion or gradual transfer of low stem into high stem tree plantations through thinnings will be applied.
  - Subclass (M2) - covers low quality low stem sessile oak stands on good site conditions. They occupy an area of 373.18 ha, with timber volume of 27,931 m³, a total current increment of 496 m³ and an average increment of 444 m³. Depending on the stand's age, a low stem coppice management system should be applied through clear cutting and in the plantations over 50 years of age, while the young plantations should be left without any measures.
  - Subclass (M3) - covers low quality low stem sessile oak stands with penetration of Austrian pine. They occupy an area of 168.30 ha, with a timber volume of 10,255 m³, a total current increment of 258 m³ and an average increment of 258 m³. As a silvucultural measure, an indirect conversion or gradual transfer of low stem into high stem tree plantations through thinnings will be applied in these plantations. The sessile oak trees should be removed, and the Austrian pine trees will be left and encouraged for expansion in the stands.

- Economic class (L) - covers the remaining low stem oak stands with other deciduous trees. This economic class includes three subclasses.

- Subclass (L1) - covers low stem oak stands composed of Hungarian oak, Turkish oak and other tree species. They occupy an area of 129.60 ha, with timber volume of 5,108 m³, a total current increment of 167 m³ and an average increment of 140 m³. Clear cuttings are planned here.
- Subclass (L2) - covers low stem and low quality Hungarian oak stands on good site conditions. They occupy an area of 1,071.60 ha, with a timber volume of 219,392 m³, a total current increment of 1,887 m³ and an average increment of 3,172 m³.
- Subclass (L3) - covers low stem and low quality Hungarian oak stands on poor site conditions. They occupy an area of 213.70 ha, with a timber volume of 20,072 m³, a total current increment of 301 m³ and an average increment of 304 m³.

- Economic class (C) - covers shrublands composed of common juniper, rosehip, hawthorn and other species in which Austrian and Scots pine gradually expand through natural succession. They occupy an area of 103.40 ha.

2. AREA NAME

In any special forest management plan a brief name description is provided of each forest management unit. The name usually coincides with the mountain where the forest is widespread or some specific landmarks and cultural features in the area where the forest management unit is located.

2.1. Location

The region of Malesh is located in the eastern part of Macedonia. It is a plateau that is surrounded from all sides by several mountain ranges such as Vlaina, Maleshevski Mountains and Obozna.

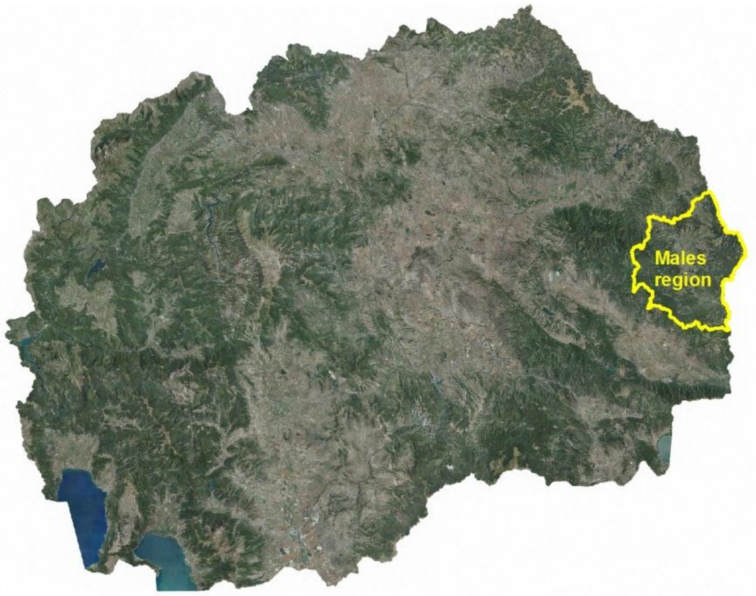


Figure 1. Location of the Region of Malesh

2.2. Forest boundaries

The boundaries of the Malesh area generally extend along the ridges or are drawn through watercourses and ravines. In establishing the forest boundaries there is a rule to follow watercourses or watershed limits.

The boundary of the Region of Malesh, from the north side, starts on elevation of 941 meters at the place called Karaula. From here it goes on in a northeast direction through Drenov Dol rising at the place called Saraevo trigonometer to an elevation of 1,223 meters. This is where the eastern frontier begins and through the trigonometer of 1,336 meters it goes on southeast direction and passes through Piskaliski Rid, the place called Plandishte, rising at the place called Kadiica to an elevation of 1,932 meters. Then it follows through the 1,793 meters of trigon metertrigon meter at the place called Kadin Bunar. From here, the boundary slightly changes its direction to the east, passing through the place called Ajduchki Rid, at an altitude of 1,615 meters and rising at the place called Gola Chuka with an altitude of 1,803 meters. From here, the boundary changes its direction towards the southeast, passing through the place called Chengino Kale where the route passes through the southwest, at the place called Bukva and moves along the borders between Macedonia and Bulgaria. Further morw, it separates from the border at the place called Kolovski Chukar, with a trigonometer of 1,358 meters, where the eastern boundary ends. From this point, until the place called Chenlija, through the village of Dvorishte and in the wider catchment area of River Crvilska, there is a larger area of unregulated forests. They are mostly privately owned and are not covered by separate plans for forest management, so their boundaries are not specified.

The southern boundary begins from a place called Chenlija and moves along the ridge passing through the place called Karamatlija at an elevation of 1,549 meters, continuing through Ograzhden at an altitude of 1,745 meters, still going through a trigonometer of 1,637 meters it reaches an elevation point of 1,312 meters where the boundary ends on the southern side.

The western boundary starts at an elevation of 1,312 meters and passes through the place called Karadjovica, further through the trigonometer of 1,245 meters and the trigonometer of 1,214 meters and the locality Palazlija, and the trigonometer of 1,214 meters passes through the place called Gusta Gora and the ridge Obeshenik and exits at the place called Dva Kamena at an elevation of 1,285 meters. From this point on, the boundary line begins to descend in a north direction passing through a place called Rakach and reaches the Bezgashteska River watershed. From here on, the western boundary of the forest again began to climb and going through a place called Gavran at an elevation point of 1,051 meters, making a bow towards the right at a place called Mal Gavran and exits on the saddle at a place called Karadzuzlija. It then continues northward to a place called Mechkov Kamen with the trigonometer of 1,090 meters and with a small bow around a place called Gramadica it continues to a place called Groshec, climbing a place called Gromad, with a trigonometer of 1,339 meters. From this trigonometer, the boundary is irregular and passes almost in the riverbeds of Zajachka River and Maleshevska River, after which it comes out on the saddle of Obozna at an elevation of 831 meters. From this point, through the place called Stara Kula, it comes down in the river Bregalnica at the elevation point of 721 meters where the western boundary ends. From here, the northern boundary starts and climbs to the top Bajaz Tepe at an elevation of 1,348 meters and then it comes down to the river Zhelevica, which flows towards north, and through the villages Pancharevo and Star Istevnik and through Drenov Dol it climbs to a place called Saraevo.

2.3. Area

According to the Law on Forests, the areas of forest management units covered by the Specific forest management plans cannot be larger than 5,000 ha if the high-stem forest stands account over 60% of the area or 10,000 ha if low-stem forest stands account for over 40% of the area.

The area in the forest management plan is shown including forest and non-forest area.

The forest area is defined as the area used for forest management (forest and currently non-forested land) and other areas which are directly related to forest management (forest roads, nurseries, watersheds, etc.).

Non-forest area represents all areas that are considered for forest management and used for other purposes (agricultural farmland, pastures, orchards, large water reservoirs, public roads, settlements, etc.).

Within the forest management unit, the forest is divided into sections and, depending on the forest structure, it is further divided into sub-sections. The unit size of high stem forest stands is up to 60 ha and for the low-stem forest stands it is up to 100 ha. The area of the units and sub-units is determined by planimetric methodology from topographic maps or using other more modern methods.

The basic method applied in forestry management units in the region of Malesh to calculate areas and their internal elements are as follows:

- Sections, subsections, bare land and other areas are assessed through planimetric methodology from topographic maps;
- GIS technique is not applied thus far;
- This contemporary technique in the development of specific plans for forest management in Macedonia started to be applied from 2012, but still there is no management plan in the Region of Malesh that has been done using a technique of this kind.

Table 2 displays the figures for the land area structure covered with all nine (9) forest management units in the region of Malesh.

Table 2. Land area structure in the nine management units of Malesh (2013)

Type of land	Area*	Share
Single unit	**(ha)**	**(%)**
Natural Forests	**33**	**86.2**
Forest plantations	**455**	**1.2**
Forest land (currently not forested)	**1,227**	**3.2**
Unfertile land	**108**	**0.3**
Land for other uses (within the forest management area)	**343**	**0.9**
Private land, non-forest area	**3,092**	**8.2**
Total	**37,895**	**100.0**

**rounded to 1 ha*

The data displayed in Table 2 shows that the forest management units in the region of Malesh cover a total area of 37,895 ha, out of which 32,670 ha or 86.2% are forests, 455 ha or 1.2% are forest plantations and 1,227 ha or 3.2% is forest land. Within the boundaries of the forest management units there are other types of land such as bare land with a total area of 108 ha or 0.3%, land for other uses with 343ha or 0.9% and private non-forested area with 3,092 ha or 8.2%.

The land area structure in the specific plans for forest management are shown in the tables of the second part of the plan under Form-I.

2.4. Land ownership

The boundaries of forest management units mainly cover the state land, but almost all forest management units have privately owned land. Another characteristic is that privately owned lands are numerous, with relatively small area (usually less than 1ha) and mixed with state lands.

In some parts of forest management units, where the cadastral records are advanced and there is solid data on land ownership, the same is used and incorporated into the forest management plans. However, in most of the area there is no delimitation done between the state and privately owned land.

3. NATURAL CONDITIONS

During the preparation of specific plans for forest management there is a description given on natural conditions for each forest management unit. Since this paper summarizes the nine forest management units, the description given here is at the level of the Maleshhevo area.
The choice of methods in forest management is always correlated with the natural conditions that can be found in a region and has great influence in finding the best opportunities for rational and sustainable management.

3.1. Orographic conditions

The orographic conditions are expressed through relief, altitude, slope of terrain (inclination) and exposure on the ground. They represent one of the most important natural conditions that have a great impact on microclimate and mesoclimatic conditions of each area.

In order to gett a better idea of the orographic factors and their influence, they are described in detail regarding the configuration of terrain with an accurate idea of the exposureof the hills and valleys in the area, i.e. within the frame of this area and for their place names, altitudes, inclinations and exposures.

3.1.1. Relief

The relief of the Region of Malesh is quite widespread, intersected with many ravines that rise above the lower and higher sides of the hills and mountains that extend generally from west to the east and northeast. The most expressed relief forms in the region of Malesh are the following:

Relief forms of Vlaina mountain

They represent the main ridge of the mountain Vlaina, after passing the national border between Macedonia and Bulgaria, and have a direction from the north towards the south. From there, to the west, the river Zhelevica more short ridges descend which have steep slope in the upper part and moderate to slightly steep slope in the lower part. Most famous and most prominent among them are:

- Gurguti Valok - located on the north end of the forest management unit "Bukovik – Bajaz Tepe", starting from the top of Saraevo (1,223 meters a.s.l.) and dividing the waters between Dren and Leskov Dol. Parties over both dales are steep, rutted, eroded and cut through a lot of dales and gullies. Those who fall towards Drenov Dol have a western exposure, while the parties to Leskov Dol have a southern exposure.

- Mitrinchev Valok - that forms from the top of Saraevo (1,223 meters a.s.l.) and a watershed between Leskov Dol and a nameless dale. The crest of the ridge is moderately steep, while their sides are somewhat steeper. Exposure to Leskov Dol is to the west and of the nameless dale is to the south. At the bottom, this ridge is called Karaula.

- Vojnichki Valok - which like the previous two ridges, forms at the top of Saraevo and represents the watershed between the two nameless dales. The crest of the ridge, at the bottom part towards the River Village, is slightly inclined, the middle section is steep and the upper part they are moderately steep. Parties over gullies are somewhat steeper and under the crest they are moderately steep. The exposure to the valley on the right is west and the one on the left is south.

- Lukova Ridina and Karadzhev Valok - two short crests formed under the place called Mehmed Bor, separated by three steep dales. The ridges at both crests are moderately steep to steep. The parties that descend to the valleys have the same slope. Their exposure is towards the south and southwest.

- Bandi Valok - represents a watershed between Kushev Dol and the dale Dolga Chesma. It is formed from the place called Pushkaliski Rid (1,337 meters a.s.l.) and ends at the junction of the valleys. From the junction of the valleys and up it is steep and the upper part is moderately steep and slightly inclined. The party over Kushev Dol is with western and north-western exposure and those over Dolga Chesma are with south to southwest exposure.

- Grchki Rid – it is formed out of the place called Vrabchik (1,384 meters a.s.l.) and descends towards the southwest to the village Pancharevo. The bottom part is somewhat steep, while the upper part is moderately steep. The sides facing the dale Dolga Chesma are very steep, rutted with many small and short dales and gullies with overflowing character and with western exposure.

- Stajchevica - As a ridge it is formed out of the place called Plandishte (1.371 meters a.s.l.) and represents a watershed between two nameless dales. The crest of the ridge at the bottom is moderately steep, steep in the middle, and the upper part is slightly inclined. Parties over gullies are somewhat steeper in respect of the same under the brim. One side has a western exposure and the other a southwest exposure.

- Rosobor – it is a ridge that is a branch of Kunilov Rid. It's going in the southwest direction to Smolechka River. At the bottom it has a steep slope, while the upper part is moderately steep. Parties are steep, eroded with western and southern exposure.
- Kunilov Rid - is formed from a place called Tutorovica (1,423 meters a.s.l.). It descends southward to Smolechka River. The slope at the crest, and on the sides is steep. Parties from both sides are cut through with more deep and short dales that have an overflowing character. The right side has the western and south-western exposure and the left has east and south-east exposure.
- Zanoga - A ridge that is formed out of the border ridge at the place where the border stone number 57 lies. Moving to trigon meter with an altitude of 1,423 meters a.s.l., it spreads towards the northwest and then, as a result of an erosion phenomena, it is divided into several smaller ridges of which the most remarkable are Krivi Rid and Orlovi Chuki.
- Ostri Rid - ridge that forms the trigon meter with an altitude of 1,577 meters a.s.l. and a watershed between two nameless dales. The crest of the ridge has a steep to very steep slope. It is descending towards the west. The sides above the dales are very steep and have northwest and southwest exposure.
- Okno - is formed fromthe place called Ponornica and is a watershed between a nameless dale and a Blatechka River. There are stretches in the direction towards the west. The crest of the ridge with a steep slope, and the parties are cut through with more glens by the sides that have erosive character. The page has over Blatechka River southwest exposure, while the other, nameless Dole has over northwestern.
- Obajata - ridge that is a watershed between Blatechka River and Vinicka River. It is formed out of a nameless peak located between a trigon meter with an altitude of 1,708 meters a.s.l. and 1,814 meters a.s.l. It's going in the direction towards the west, northwest to the flow of Blatechka River and Vinicka River. The upper crest of the ridge is steep. Also, the parties that descend into dales are with steep slope. The part that is over Blatechka River have north and northwest exposure while the one over the Vinicka River has southwestern exposure.
- Vrteshka - A ridge that is formed from the elevation point of 1,862 meters a.s.l. and descends until Zhelevichka River. It is a watershed between Vinicka River and Zhelevichka River. There are stretches in the eastern direction towards the west with a slight bend to the northwest in the lower part. The slope of the ridge is moderately steep and the sides are steep. The parts over Vinichka River have northern exposure while those over Zhelevichka River have southwest exposure.
- Bezimen Rid – it is formed from the top of Orlovec (1,723 meters a.s.l.) and a watershed between Zhelevichka River and Negrevska River. From the place called Gramada (1,241 meters a.s.l.), it divides into two branches. One turns to the southwest and it’s named

Sredni Rid and the other has a direction towards the west and it is named Cherene. The upper part has a steep to moderately steep slope and a north-westerly direction of extension. Parties towards Zhelevichka River have a northern exposure, while those towards Negrevska River have a southwestern exposure steep slope.

- Bukovik - A ridge that is larger and more massive than the others. It occupies the area between the Negrevska River and Pehchevska River. It is formed from the top of Kadiica (1,932 meters a.s.l.) and, through Treshchen Stone (1,822 meters a.s.l.) and Orlovec (1,723 meters a.s.l.), it descends to the village Chiflik. There are stretches in the direction east towards the southwest. The bottom has mild to moderately steep slope and the upper has a steep slope. Parties that descent Negrevska River have western exposure and a steep slope, and those over Pehchevska River have southeast exposure with steep to very steep slope.

- Gushterica - A ridge that forms out of the place called Kadan Bunar (1,793 meters a.s.l.) and is a watershed between the Pehchevska River and Bregalnica River. Its direction is from the east and extends towards the southwest. The upper part has moderately steep to steep slope and the bottom part is slightly steep. It's going down to the place called Treschena Poljana.

Relief forms of Gramada mountain

- The main relief form on this mountain ridge is Grbavec. This ridge is a watershed between the waters that gravitate directly in river Bregalnica and those that flow into the river Zhelevica. It is formed from the place called Robovski Brichak (1,317 meters a.s.l.). Coming down in the southeast direction, it passes through places called: Kaludzer (1,239 meters a.s.l.), Velev Chukar (1,081 meters a.s.l.), Kitka (1,014 meters a.s.l.), Mogilata and Sveta Petka (1,084 meters a.s.l.). The crest of the ridge is a mild slope and in some places it is moderately steep. The parties that descent to the river Bregalnica are moderately steep to steep and cut through many valleys and gullies with erosive character, whereas those towards the river Zhelevica have moderate to slightly moderate slope, especially in the upper part. From the main corp of the ridge, both catchment areas are a number of short cliffs that give the landscape crisscrossed character.

Relief forms that gravitate towards river Bregalnica

There are four distinctive ridges in the catchment area of river Bregalnica:

- Bezimen Ridge – it is formed from the place called Sveta Petka (1,084 meters a.s.l.) and is a watershed between the dales Leskovec and Todorichev. The ridge has a way of spreading from the north towards the south. Parties are moderately steep to slightly inclined.

- Umlenski Ridge –it is formed from the place called Velev Chukar (1,081 meters a.s.l.) and ends above the village Umlena. Crest of the ridge is moderately steep, and the parties are somewhat steeper and more cut through with gullies.

- Jasli - A ridge that forms out of the place called Kaludzer (1,239 meters a.s.l.) and ends above the village Robovo. Crest of the ridge is moderately steep and slightly inclined, and the parties towards dales are somewhat steeper.
- Golemo Prisoe - a ridge that is formed out of the place called Robovski Brichak (1,317 meters a.s.l.) and then runs through places called: Bojanka (1,102 meters a.s.l.), Golema Poljana (1,036 meters a.s.l.) and Golemo Prisoe and it comes down to where Golem Dol flows into the river Bregalnica. Same as the others, this ridge keeps the route from the north toward the south. The slope of the ridge is moderately steep. Regarding the parties, they are very steep, especially over the dale, cut through with many gullies that makes the terrain eroded. Mainly its exposure is to the east.

<u>Relief forms that gravitate towards the river Zhelevica</u> – the following are the more dominant ridges in the catchment area of river Zhelevica:

- Balevichki Rid - ridge that is formed out of the place called Kitka. Its route stretches from the southwest toward the northeast. The slope of the hill is moderately steep, while the upper part has a slight slope. Parties towards dales are somewhat steeper and their exposure is towards the north-west and southeast.
- Volchi Rid - is formed out of the place called Bilo (1,298 meters a.s.l.) and has a direction and spreading towards the east. The upper part of the ridge has a moderately steep slope while the most part has a slight slope. The side towards Gramadski Andak has southern exposure, and is moderately steep and has numerous very short gullies. The side facing towards the Volchi Andak has northern exposure and is steeper and less eroded.
- Adjiski Rid - a ridge that represents the northwest external border of the forest-management unit “Bukovik Bejaz-Tepe”. It’s formed out of the top Bejaz Tepe (1,348 meters a.s.l.) and it comes down eastward, specifically to Zhelevica, where it passes through places called: Bazhdarova Chuka (1,239 meters a.s.l.) and Irinec (931 meters a.s.l.). The same side of the ridge, which descends towards Volchi Andak, has a southern exposure and has numerous dales and gullies that have a moderately steep slope.

<u>Relief forms that gravitate towards Maleshevski Mountains</u> – The more dominant relief forms that characterize the configuration of the terrain are as follows: Bukva - Breza - Grkov Chukar - Prljak, Diva - Shirinata – Debeli Rid and Plachica - Kolovski Chukar - Babin Chukar - Bilo - Kasha.

- The Bukva - Breza - Grkov Chukar - Prljak ridge starts from the main range of Maleshevski Mountains and stands at the border between Macedonia and Bulgaria, more precisely, at the locality Bukva or trigon meter 1,569 meters a.s.l. The direction of extension of this hill is from east toward the south and to the north-west to the riverbed of Bregalnica, i.e. to the bridge on the asphalt road Berovo - Border cross. The hill is mild to moderatelye steep with ridges and plains and there are few smaller hills coming out of it with steep to moderate steep slopes.

- Diva - Shirinata – Debeli Rid is a ridge that stands out from the main range of the Maleshevski Mountains on the border with Bulgaria, in the area Ploshchica, trigon meter 1,356 meters a.s.l.. This ridge descends towards the west, then southwest and finally descends towards the south in the basin of the river Klepalska, near the lake. This hill separates the watersheds of Zamenichka River and Klepalska River. The top and bottom of the slope is slightly milder, ranging from 5-7%, and in the middle part 5-10% with mild to moderate steep sides. There are several smaller hills coming out of it with high steep sides.

- Ploshchica - Kolovski Chukar - Babin Chukar - Kasha is a hill that starts out of Ploshchica trigon meter 1,356 meters a.s.l. and separates the watersheds Zamenichka River and Dvorishka River. The direction of the hill is east - west, then towards the northwest, and eventually descends to the north at Ratevska River, in the area of Kasha. There are several smaller hills coming out of it. The slope of the hill is from 8 to 12%.

<u>Relief forms that gravitate towards the mountains of Goten and Ograzden</u> – The significant relief forms that give the terrain characteristic of the mountains Goten and Ograzden are the following: Gavran crest, which lies along the southern border and Goten crest, i.e. the whole branch of Goten, located in the westernmost part of the forest management unit of "Goten - Shiroki Dol". On the northern side, there are crests with mild slopes. Among them the most significant crests are:

- Petrovski Rid, which is formed at the place called Kasaplija, or trigon meter 1,256 meters a.s.l., and a watershed between Petrovski andak and one nameless gully. There the route stretches from the northeast toward the southwest and passes through the elevation of 1,157 meters a.s.l. and ends at the banks of Bariichka River. On the entire extension it has moderately steep sides. The length of the crest is 3.8 km. The highest point is 1,256 m and the lowest 750 m. The height difference is 506 m with an average slope of 13%.

- Kamenica Rid is formed from a place called Kamenica or trigon meter 1,319 meters a.s.l. It is a watershed between Petrovski andak and Leskarevski andak. Its route stretches from the northeast towards the southwest, which passes through trigon meter 1,188 meters a.s.l., where it changes its direction of extension towards the south and passes through the trigon meter 979 meters a.s.l., ending at the banks of Bariichka River. After all its extension, it has moderately steep sides except at the bottom where the sides are steep. The length of the crest is 5 km. The highest point is 1,319 meters and the lowest 700 meters. The height difference is 619 meters with an average slope of 14%.

- Kochanski Rid is formed at the trigon meter 1,351 meters a.s.l. and is a watershed between Kochanski andak and Leskarevski andak. The direction of the extension is from northeast towards southwest, passing through the elevation point of 1,290 meters a.s.l., trigon meter 1,183 meters a.s.l., Trigon meter 893 meters a.s.l. and ends up on the banks of Bariichka River. Along the entire extension, it has moderately steep sides except at the bottom where the sides are steep. The length of the hill is 5 km. The highest point is

13,57 meters and the lowest 700 meters. The height difference is 657 meters with an average slope of 13%.

- Rid Buroshka Krshla, a crest that is formed at a place called Djizoldje, trigon meter 1,361 meters a.s.l. and represents a watershed between Kochanski andak and Burovski andak. The direction of its extension is from northeast toward the southwest and passes through the elevation point of 1,169 meters a.s.l., trigon meter 1,099 meters a.s.l., at an elevation point of 1,004 meters a.s.l. and ends up on the banks of Bezgashchovska River. It has steep sides on its entire extension. The length of the hill is 5 km. The highest point is 1,357 meters and the lowest is 700 meters. The height difference is 657 meters with an average slope of 13%.

- Omarovec Rid, a crest that is formed on the trigon meter 1,312 meters a.s.l. at the place called Petlec and represents a watershed between Madevski andak and Stolski andak. The direction of its extension is from the north towards the south, while passing through trigon meter 1,101 meters a.s.l., trigon meter 1,002 meters a.s.l. and ends up on the banks Bezgashchovska River. Along its entire extension, this crest has steep sides. The length of the crest is 4.4 km. The highest point is 1,312 meters and the lowest 670 meters. The height difference is 642 m, with an average gradient of 14.6%.

A general feature for the terrain's configuration in the region of Malesh is that the relief is quite crisscrossed with larger and smaller ridges that extend to almost all exposures. Out of the ridges there are more crests formed, and many dales and rivers make up the smaller and larger catchment areas. The configuration of the area is rather complex with steep sides and deep valleys that make it difficult to build forest roads in the lower parts of watersheds, while the hills with a milder slope are passable.

3.1.2. Altitude

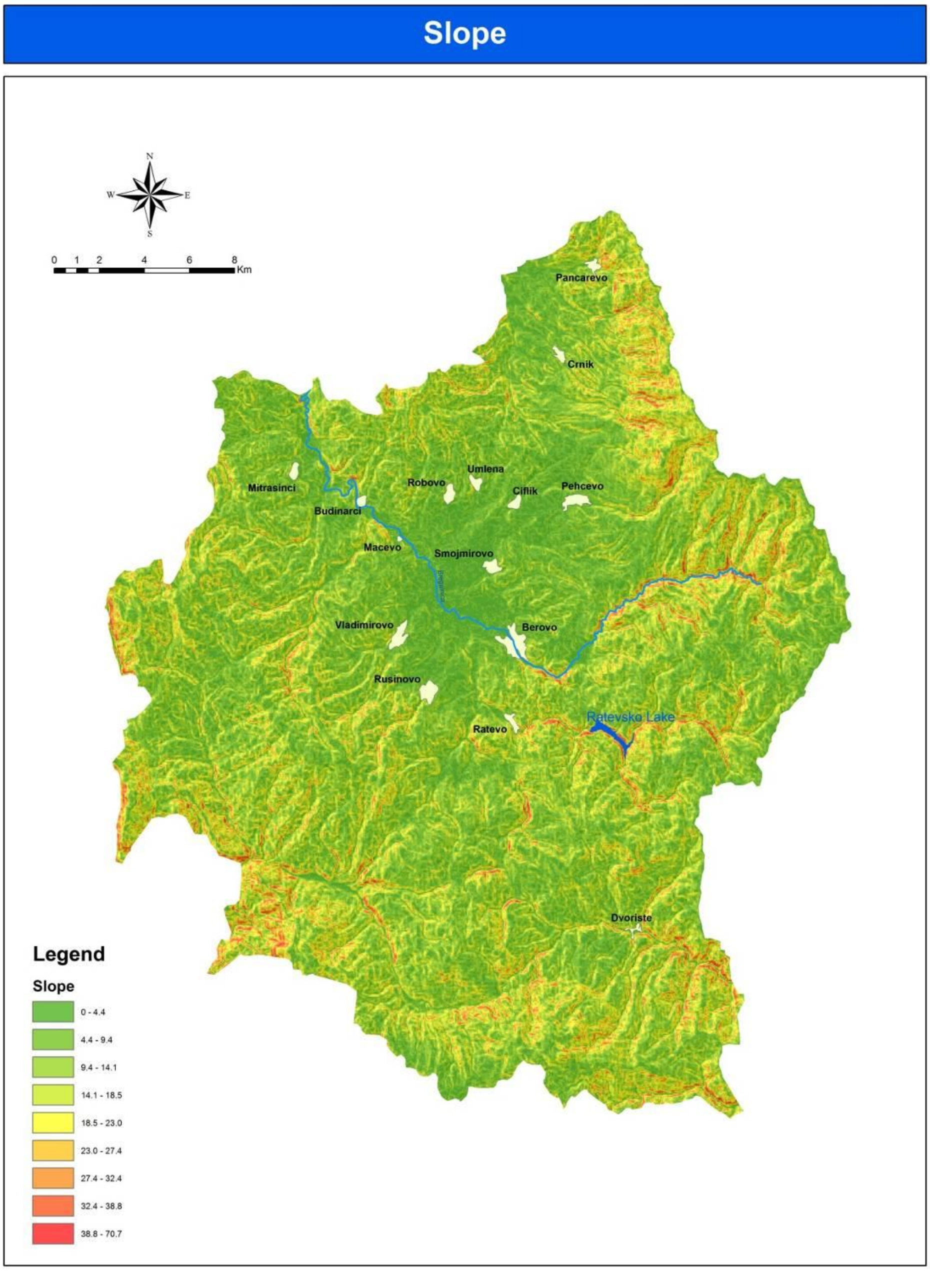
The altitude is one of the main causes of climate factors influence (air temperature, relative humidity, light, amount and type of precipitation and wind strength), as well as for the structure of terrain and the conditions for forest management. So these are described in detail in any particular plan for forest management.

The lowest point in the Region of Malesh is located in the bed of Bezgashchovska River and is 660 meters a.s.l. and the highest point is located on top of Vlaina Mountain (Kadiica 1,932 meters a.s.l.). The upper limit of the forest extends to 1,746 meters a.s.l.. Vertical and altitudinal forest widespread is 1,086 meters.

The highest points and peaks that characterize the region of Malesh are: Kadiica (1,932 meters a.s.l.), Gola Chuka (1,803 meters a.s.l.), Kadin Bunar (1,793 meters a.s.l.), Chengino Kale (1,745 meters a.s.l.), Ograzhden (1,745 meters a.s.l.), Ajduchki Rid (1,615 meters a.s.l.) Kolovski Chukar (1,358 meters a.s.l.), Karamatlija (1,549 m) and Palazlija (1,214 m).

3.1.3. Slope

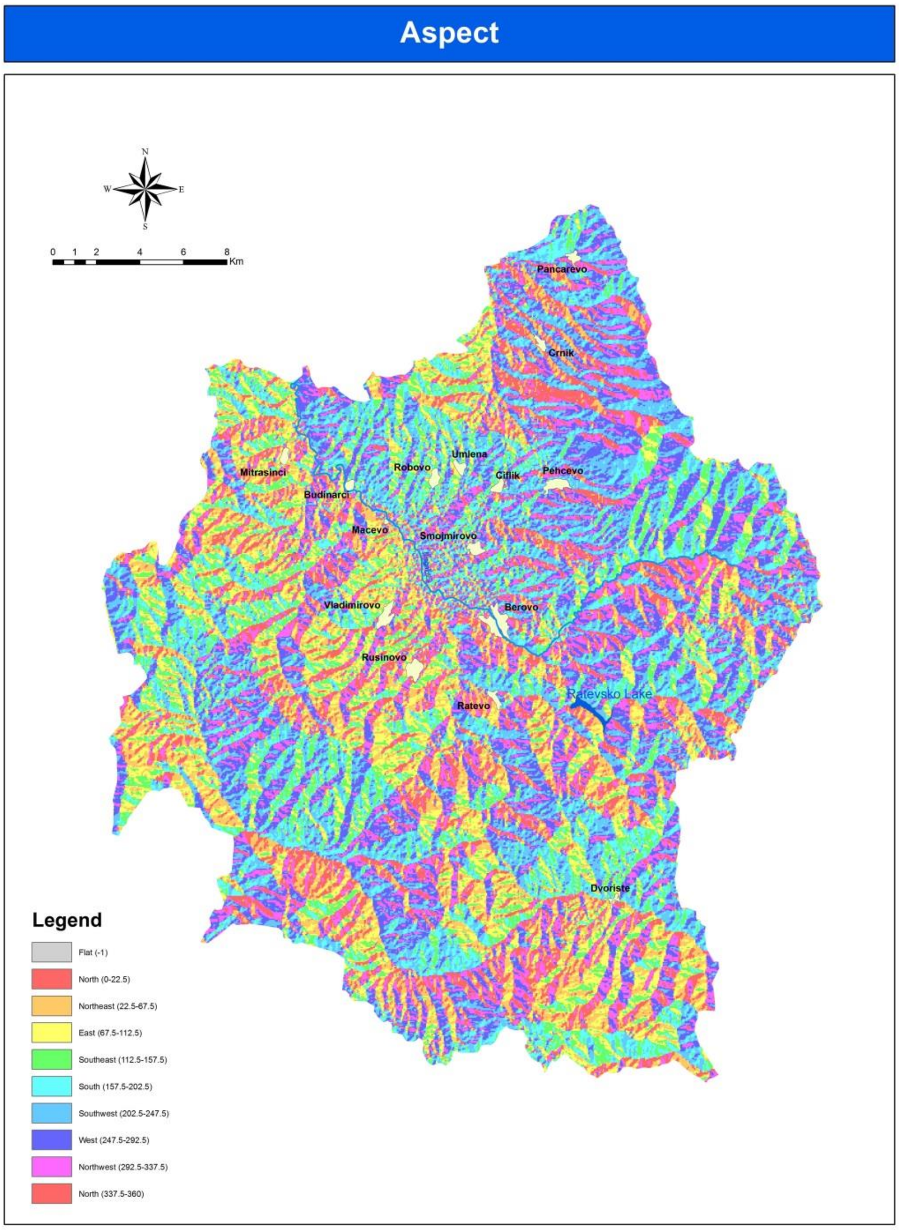
The slope or inclination of the terrain is tilted at an angle on which all other natural conditions in a given environment largely depend. The rising slope of the terrain increases the risk of erosion, increases the intensity of leakage of surface and ground waters, so the amount of moisture in the soil decreases and the soil depth and layers are reduced. At the places where the slope is greater the soils are shallower because of increased erosive wateraction, they are drier due to faster leakage of surface and groundwater and poorer because of the intense washing of mineral and organic matter. Lower inclinations create favourable conditions for the development of vegetation and so forest conditions are more favourable.



Map 1. Slope of terrain in the region of Malesh

Natural conditions that are influenced by the slope are very important for determining the silvicultural measures in the forest. In the forest stands located on steep terrain special felling measures with lower harvesting intensity are planed.

From the condition of the slope in the region of Malesh, it can be noticed that most of the terrain has moderately steep slopes up to steep and very steep slopes. This suggests that large inclinations hamper forest management activities. The possibilities for road construction are reduced and harvesting of timber, firewood and non-timber forest products are hampered in such areas. In addition, there are locations with increased risk of erosion. So when planning, tending and other silvicultural measures, which condition the slope or inclination of the terrain, should be considered.



Map 2. Exposure types of the terrain in the region of Malesh

3.1.4. Exposure (Aspect)

Exposure or aspect generally refers to the horizontal direction to which a mountain slope faces. Because it has an impact on other environmental factors, as well as the occurrence of various types of forest in a certain area, it is described separately for each subsection in the specific plans for forest management. The choice of species measures is influenced by the exposure of the terrain. As already explained in the former section, all types of exposure are met in the region of Malesh.

3.2. Hydrographic conditions

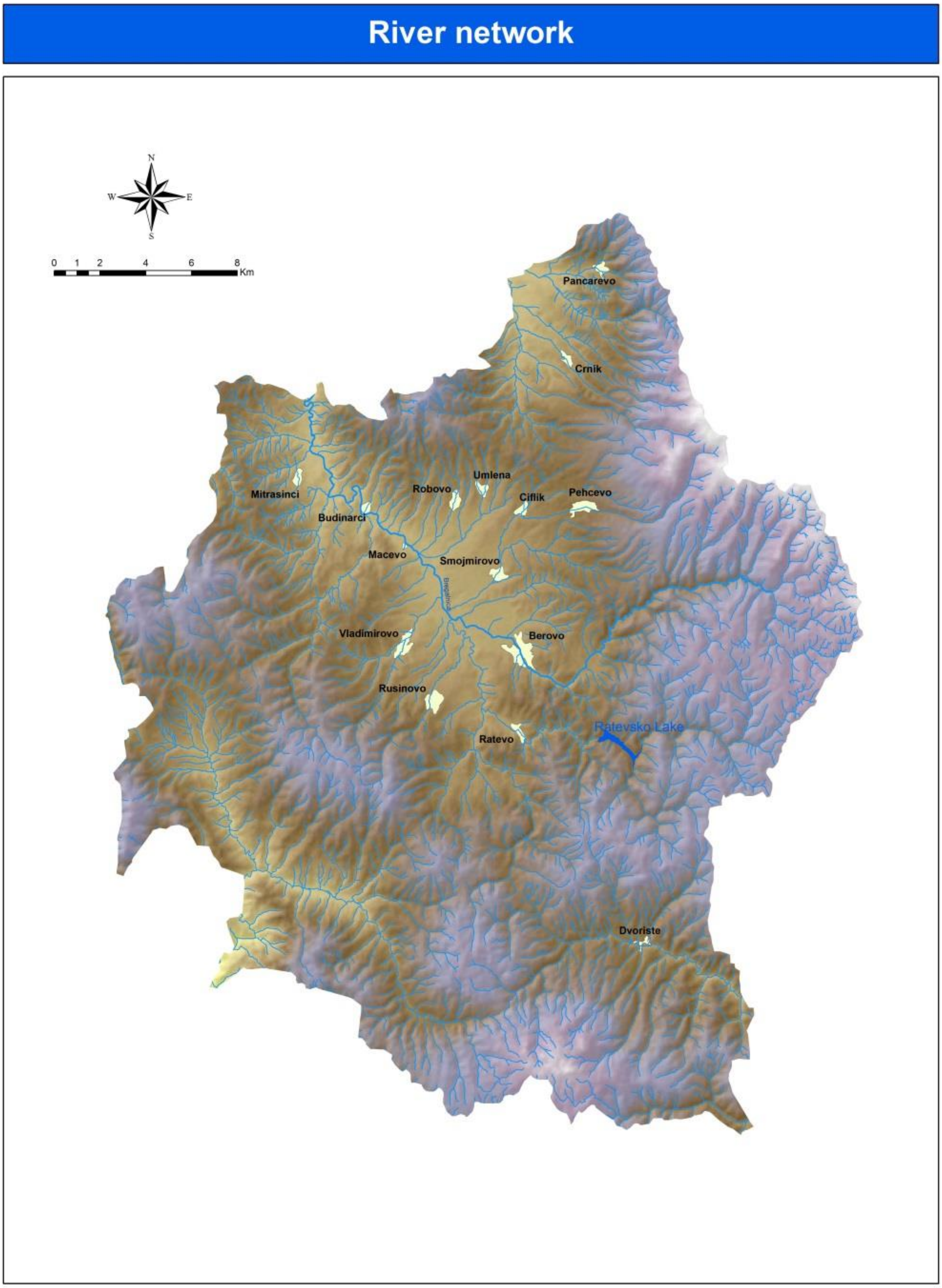
As relief and exposition determine, the region of Malesh is region characterized by a complex hydrographic network. The waters in the region of Malesh belong to the watershed area of two rivers: Bregalnica and Strumica, which further flow in the Aegean watershed.

A major recipient of all the waters in the region of Malesh is the Bregalnica River. Most of the rivers are carrying water throughout the year, but occasional streams can be found that often have an erosive character. The largest and most important natural hydrographic facility is the Bregalnica River and its larger and smaller left and right tributaries.

The river Bregalnica is formed from many small sources under the slopes of Chengino Kale. In its river flow it has different parts. In the upper flow, from the spring until Berovo, it has quite a fall of nearly 38%, which in the other part of Berovo to Budinarci is significantly reduced to 3%. In its flow, the Bregalnica River bare more streams with permanent watercourses, among which the most significant are: Ravna River, Klepalska River, Zamenichka River, Ratevska River and Pehchevska River. The artificial accumulation is created from the waters of Ratevska River and is called "Ratevsko Lake" or "Berovsko Lake" after which the name is well known among the people. The waters of this lake supply the town and surrounding villages of Berovo, and serves as a resort for recreation, as well as a complement to Kalimanci Lake where the irrigation is done for Kochansko Pole and Ovche Pole.

The catchment area of the river Bregalnica covers mainly the higher mountainous region. The slope of the watershed is steep, where the right side is more developed, i.e. has more tributaries. Major tributaries of Bregalnica River in the Region of Malesh are: Ravna River, Ratevska River, Klepalska River, Zamenichka River, Rusinska River, Kamenichka River, Lenishka River and Zhelevica.

Ravna Reka is formed from several streams under the locality Ajduchki Kladenec near the Macedonian-Bulgarian border. Together with Kriva River, which collects the waters from Ljutachka River, Mlechnachka River, Srednjachka River, Zhtachka River, Trebomirska River and other smaller tributaries, it establishes the Bregalnica River. Ratevska River is the largest tributary of Bregalnica River in the Region of Malesh. It rises at an altitude of 1,100 meters and flows into the Bregalnica River before the town of Berovo, at an elevation of 803 meters. It has a length of 24 km, with a total drop of 747 m.



Map 3. River network in the region of Malesh


Figure 2. Ravna River, one of the most important rivers that form the Bregalnica River


Figure 3. Water streams in the upper part of the Bregalnica River

Figure 4. Lake on the locality “Chengino kale” (1,745 meters of altitude)

Figure 5. Artificial accumulation "Ratevsko Lake" or "Berovsko Lake"

Klepalska River is formed in the forest management unit of "Maleshhevski Mountains II - Ratevska River", beneath the Macedonian - Bulgarian border and flowing from east towards west and then towards the south. It flows in the "Berovsko Lake". The river bed is mild to medium inclined and, on both sides of the river, there are smaller dales flowing into it. It has water throughout the year, but by the summer the amount of water is greatly reduced. The total length is about 12.80 km. The average slope of the river bed is around 6-10%.

Zamenichka River emerges underneath the locality of Kolovski and Vlaov Chukar and flows from east towards the northwest. It has water all year round and flows into “Berovsko Lake”. The river bed is suitable for construction of forest roads. Its length is approximately 4.60 km.

Rusinska River is formed beneath the localities Golem Jastrebec and Kovchegarec. It flows towards northeast. The river bed is mild to medium inclined, and on both sides of the river there are smaller dales flowing into it. It has water throughout the year, but in the summer the amount of water is greatly reduced. The total length of the river is 5.30 km, and the average slope of the river bed is 6-10%.

Kamenichka River is formed beneath the locality Gramadna and runs from west to east. It flows into the river Bregalnica, near the village Budinarci. The river bed is mild to medium inclined and on both sides of the river they are smaller dales flowing into it. It has water throughout the year, but in the summer the amount of water is greatly reduced. The total length is 8.30 km, and the average slope of the river bed is 6 - 10%.

Lenishka River is formed beneath the locality Gramadna. It receives several smaller rivers and gullies. It flows from west to east into the Bregalnica River. It has water mostly through winter and spring. The river bed is suitable for construction of forest roads. The length is approximately 7.80 km and the inclination of the river bed is 8 - 12%.

Selska River - emerges from under the top Tuturovica 1,423 meters a.s.l. In the upper part, precisely in the source part, it is called Pravi Andak, and in the bottom part, after its merger with Suva River, it is called Panicherska River. From its source part, until the estuary with Panicherska River, its length is 5.30 km. In the upper part, the river bed is steep and hard for penetration, while in the middle and lower part it has a slight slope. On the right side of Suva Reka the following estuaries are as follows: Dren Dale, Hazel Dale, Kushev Dol and the dale named Dolga Cheshma, and on the left side it is only Desni Dale. All these dales are short and steep, densely overgrown with native vegetation and hardly penetrable.

Suva River - is formed from two water flows, namely from Rachevica River and Asanov Dale. Rachevica River emerges from the top of a place called Zanoga. Until the Rose Dole, it is called Smolechka River and from that point till the end, it is known as Rachevica. The length of this river is 4.80 km. The upper river bed has a steep slope, with dense vegetation and hardly passable, while the lower part is moderately mild. Asanov Dale is formed from multiple streams that originate from a place called Zanoga and place called Ponornica. From its source to the confluence with the river Rachevica, its length is 4.20 km.

Blatechka River - is formed in the upper part under the mountain ridge Vlaina, in particular between the two minor ridges (Oknoto on the right side and Obajata on the left), which descend to north-west. From its source part to the Zhelevica estuary, the river has a length of 9.70 km. In the upper side, the river bed has a steep slope, with dense vegetation, hardly passable and with a torrential character. The lower part has a mild slope and a wide river bed.

Vinichka River - is formed from several streams at the top of a place called Obajata, at an altitude of 1,535 meters a.s.l. In the upper course, the river bed has a steep slope, while the middle and lower parts are slightly steep and have a mild slope. Its length is 9.70 km. The river has a heavy torrential character. Cutting down the Vinichki Reed and Crveni Bregove, it enters the village Crnik and then flows into Zhelevica River.

Zhelevica River - emerges from the place called Trshchen Kamen, at an altitude of 1,822 meters a.s.l. The upper river bed is very steep and difficult to cross. It merges with the Machkatica River. Its length is 9.60 km.

Machkatica River - in the upper part of its river bed, it is called Svrdlite and it is formed near the trigon meter with an altitude of 1,034 meters a.s.l. It receives more dales and gullies on both sides. The river bed is moderately steep. The regional road that connects the towns of Pehchevo and Delchevo is built on the right side.

Negrevska River - emerges under the place called Orlovec, at an altitude of 1,723 meters a.s.l. Until the village Negrevo the river bed is steep, rugged with torrential character and further it has a slight slope and flows into Pehcevska River. Its length is 8.70 km.

Pehcevska River - emerges in the place called Kadan Bunar. Only in the highest spring part, the river bed is with a steep slope, while the other part has a slight slope and is suitable for road construction. From its source until its confluence with Bregalnica River, its length is 12.80 km.

Umlenska River - is formed from two large, nameless dales, of which one starts from a place called Stojanova Cheshma and the other from a place called Stojanov Chukar. It has extremely torrential character. Dales are densely overgrown with native vegetation and hardly passable. This river flows into Bregalnica River.

Tesnata River – is formed by many dales and gullies that unite below the Robovo village and together they flow into the Bregalnica River. The upper river bed is rugged, steep and hardly passable, while in the lower part it has a slight slope.

Golem Dale - a watercourse which rises under a place called Robovski Brichak. More small dales and gullies are formed out of it. The upper river bed is steep to moderately steep, and the bottom part has a slight slope. In the immediate vicinity of the village Machevo, it flows into the Bregalnica River. The total length of the watershed is 5.80 km.

Gramadski Andak - is formed from under the saddle between Robovski Brichak, at an altitude of 1,317 meters a.s.l. and the top Bilo at an altitude of 1,298 meters a.s.l. It flows towards east, towards the river Machkatica, gathering the waters from more nameless dales and gullies. The length of this water flow is 4.20 km. Although the slope of the river bed is not big, due to the rocky terrain overgrown with native vegetation, it is hardly passable.

Volchi Andak - emerges on top of Bajaz Tepe, at an altitude of 1,348 meters a.s.l. It flows towards east, to the river Zhelevica. The length of this water flow is 4.00 km. The upper part of the river bed has a steep to moderately steep slope and, in the lower part, it has a mild slope. Although the slope of the river bed is not big, due to the rocky terrain overgrown with native vegetation, it is hardly passable.

The following waterways flow at the confluence of river Strumica in the region of Malesh:

Bariichka River - is a river that in the upper part is called Shiroki Dale. It’s formed from more mountain dales on the mountain range of Goten. It flows in a northeastern direction, then turns east and passes through an elevation of 804 meters a.s.l., then goes through an elevation of 784 meters a.s.l. and turns in a southern direction. In the Bariica locality, Bariichka River flows into the Bezgashtevska River. In the upper elevations, it receives water from the Ognjanska River and, Sprezhinski Andak and, above that, collects water from the watershed area in the locality of Karadzuzlija.

The river beds in the upper part, which make up Shirok Dale, are with a steep and very steep slope, while the lower parts have a slight slope nearly flat, about 3-5°, which lasts until the confluence with the Bezgashtevska River. Beside the river bed, a truck dirt road spreads and connects the road Vladimirovo - Radovish.

On the right side, more nameless, short and very steep dales flow in Bariichka River, from the ravines of Mali Garvan and Garvan. On the left side Bariichka River collects waters from Petrovski Andak, Ognjanska River and several other smaller and shallow nameless dales.

The lower parts of the river, before flowing into Bezgashtovska River, pass through a gorge with large and pronounced slopes on the left side of the river. The total length of the river, from the sources of the dales in the upper part until the estuary with Bezgashtevska River, is 15 km.

Bezgashtovska River emerges in the Ograzhden Mountain. It has a slight longitudinal slope nearly flat and very wide river bed. There are many private properties (fields and meadows) extending near its river bed. In the part where the river bed narrows, the slope increases and laterally rises with very steep rocky slopes. It gathers the waters of the eastern part of the forest management unit "Ograzhden". Bezgashtevska River flows into Strumica River, which continues eastward in Bulgaria and there it flows into the Struma River, which recipient is the Aegean Sea.

Figure 6. Waterfalls on Ljutachka River

3.3. Geological features

The geological layers for the Region of Malesh are determined by the basic geological maps: leaf K 34-82 and leaf 34-94 Strumica and geological interpreters for these sheets prepared by the Geological Institute in Skopje. The geological surface is silicate, and it consists of the following formations:

- Marsh-lake creations,
- Gravel and sand,
- Quartzlatites,
- Granodiorites,
- Sodium-hokoleukocrate aplitoid granites,
- Amphibole gabbro,
- Metamorphosed rhyolite,
- Metagabbro-diabase,
- Epidote-chlorite amphibolite- schists,
- Quartz-chlorite-sericite schists,
- Two-mica striped gneiss,
- Leukocrate schist granites,
- Micaschists,
- Amphibole schists,
- Epidote-quartz-sericite chlorite schists,
- Amphibolites,
- Proluvium,
- Clays, sands and suglini,
- Aplitic granites,
- Epidote-quartz-sericite chlorite schists and amphibolites,
- Biotite porphyritic granites,
- Muscovite leukocrate granites.

Marsh-lake creations - are based in the central lowest parts of the area, in the deeply cut water streams in the surrounding area of Spikovo, Negrevo and Crnik villages or western slopes of

Bukovik Mountain, and east and south-east of the town of Pehchevo. It is characterized by a large piling with a height of up to 170 m, with a yellowish-red and cleared colour. They are presented with parts of gravel and fragments of breccias composed of granite, gneiss, gabbro-diabasse, quartzlatite and quartzite, which swim in the sandy, clay material, poorly connected. Genetically, these deposits represent lake' type creations that occurred during the withdrawal of the two-quarter lake, coinciding with the curvature of the material.

Gravel and sand - are represented by Pliocene sediments within the forest-management unit "Bukovik – Bajaz Tepe". They occupy areas near the villages Robovo, Umlena, Crnik and Pancharevo. By origin, these sediments are lacustrine and they have two facies (rock bodies): facia of clays, sands and suclays, and sandy-gravel facia, which is lesser. This lithological composition characterizes the upper Pliocene deposit, built by coarse gravel which is locally glued in conglomerates with sand.

Quartzlatites - are important volcanic breaches of these rocks within the forest-management unit "Bukovik – Bajaz Tepe", near the surroundings of the village of Crnik. They have light grey, grey-green and rarely pale-violet colour. They consist of the following minerals: sanidine, plagioclase, quartz, and amphibole-biotite.

Two-mica striped gneiss – they belong to highly metamorphic rocks from the Precambrian age. They occupy a semicircular belt south of the mountain top Dzhizeldzhe, under the leukocrate schist granites. The two-mica striped gneiss represent a middle grain to small grain, grey to dark grey coloured rocks, they often express stripe texture. Their structure is lipidogranoblastic, and rarely profiroblastic. Based on model analysis, it is determined that quantitative individual ingredients vary in wide limits. The two-mica striped gneiss makes a special transition into other metamorphic Precambrian rocks.

Epidote-quartz-sericite chlorite schists – are well schisted with phyllitoid appearance. Their colour varies in grey-green tones. They have a leaf and slate texture and a lepidoblastic structure. They consist mainly of sericite, chlorite, epidote, coisite and quartz. The presence of quartz is variable. As accessories they have pyrite and magnetite.

Epidote-chlorite amphibolite- schists - are characterized by grey-green colour phyllitoid appearance. Their structure is lepidoblastic and granoblastic. The texture is leafy and slate. Their main ingredients are: epidote, ciosite, chlorite, and rarely quartzite - sericit. These rocks belong to the series of green schists.

Quartz-chlorite-sericite schists - rocks that are characterized with phyllitoid appearance, grey-green colour, internally coarsed grained and quite thick. The structure is lepidogranoblastic and in some places it is nematoblastic and lepidoblastic. In the lower parts of these schists, there are chlorite schists, which in some places go along with metamorphic diabase and diabase tuffs, and rarely with albitizied schists. Their important ingredients are: siricite, quartz, chlorite, epidote, ciosite and limonite matter.

Amphibole gabbro – are smaller masses that are found at the village of Pancharevo. They are embedded in granites (granodioritite), while great masses of these rocks are also found near the top Bajaz Tepe. Gabbro show sharp border to granites. They are fresh massive rocks with fine coarsed, gabroid structure. Their colour is grey-green to dark green. The structure is grainy. They are built exclusively from plagioclasses and amphiboles. They have an indeterminate age.

Metamorphosed rhyolite – They are found in small masses north of the villages of Budinarci, Robovo and Umlena and the Bajaz Tepe. They are chlorocrystal rocks, pretty hard, with light grey to yellow and pink colour. The texture is schisty, where the surface is covered with limonite scrames. Microscopically, they show a porfiric or oligofiric structure. As phenocrystals they have quartz, orthoclase, plagioclase and rarely microcline.

Sodium-hokoleukocrate aplitoid granites - are located northeast of the village Umlena. They have light green to white colour, and are very grainy and broken rocks. The structure of these rocks is grainy allotriomorphic; the size of the component is up to 1 mm. The main components are quartz, albite and rarely orthoclase and microcline.

Granodiorites - are rocks that are present in the mountains Vlaina and Gromada. They are mainly associated with volcanogenic creations from the Cambrian period. They are hard and compact, locally decayed rocks, with more fine grained structure than those of biotic granites. The colour varies from grey-yellow to grey-green. The structure is grainy, alotriomorphic to hipodiomorphic. They consist of quartz, plagioclase, K - felspad, biotite, rarely muscovite and chlorite.

Aplitic granites - are magmatic heterogeneous granites. These volcanic rocks are creations from the early Paleozoic. They are compact and homogeneous and come in many types, depending on the composition. They are known as “Delchevo granite” due to the many similarities such as petrologic, structural, genetic and geological. In this area, they come as sodium-hokoleukocrate aplitoid granites. Their colour is lightly yellow-green to white; they have fine grain and broken structure. They consist of: quartz, albite and rarely orthoclase and microcline, muscovite and chlorite.

Amphibole schists – belongs to metamorphic rocks from the Precambrian age. They extend in the form of tracks with length of several kilometers and an average power of up to 100 meters. These rocks have a dark green colour, clear schist texture and local stripe look. Their structure is nematoblastic to granoblastic with relics of blastopsamit. They consist of: quartz 20-45%, hornblende 40-73%, biotit up to 5%, epidote and feldspat. As secondary, they are: sfen, titanomagnetit, garnet and apatite.

Amphibolites - are dark green coloured, with striped, medium grained, nematoblastic structure. In their contact parts with granite, these rocks have bands and lenses of leucocratic material in the form of lit-par-lit texture. They consist mainly of amphibole, feldspar, and less quartz. Their secondary ingredients are epidote, ciosite, sfen, titanomagnetit and garnet. Their model composition consists of: quartz 3 to 8%, hornblende 35 to 48%, plagioclase 32 to 42%, epidote-coisite about 7%, accessory 3 to 5%. Therefore, it can be seen that hornblende is the most abundant mineral of these rocks.

Plagioclases are also quite common, but with some smaller amounts in respect to hornblende. There are two generations of feldspar, including an older one that is altered and filled with inclusions and a younger one that is smaller and purer. Younger plagioclases probably were created by alteration of the original basic plagioclases. Measurements show plagioclases as a secondary content of around 35%, meaning that they are represented by andenzine. Primary plagioclases are more and often presented with bitovnite (75%). Quartz is a rare ingredient in these rocks and usually tied to the transitional parts of gneiss and micaschists. Also, in the immediate vicinity of the granitoide rocks, there is a high content of this mineral. In this case, it builds a striped or lensed piling. The minerals from the epidotic group usually group in piles or they appear in isolated grains, caused by decomposition of amphibolite and plagioclases.

Micaschists - are highly metamorphic rocks that belong to the Precambrian age. They are always clear and schist with grey-green to silver or gray color. Their structure is lepidoblastic or granoblastic, rarely blastopsamitic. They are composed of quartz, muscovite and biotite and minor parts of zircon, titanit (sfen), garnet, sagenite, titan magnetite and tourmaline. The following are among the minerals that occur in the individual zones: feldspar, amphibole, epidote and ciosite. The modal composition of micaschists is: quartz 17-66% and muscovite 20-50%.

Leukocrate schist granites - are metamorphic rocks from the Paleozoic age. These rocks are pressed into two-mica striped gneisses showing a gradual transition. They are quite schist and parallel to the gneiss foliation. The leukocrate schist granites have light grey to yellow-white colour. Their surface is heavily decayed. The structure is alotriomorphic, grainy, locally porhiroid. They consist of salsic minerals represented with quartz, albite, microcline, and rarely micropertite and muscovite. Minor ingredients include garnet, epidote, ciosite, klinociosite and apatite. The presence of quartz is 47%, feldspar 45%, muscovite 4.5%, biotite 1%, epidote 5%, and accessory minerals beneath 1%. Feldspars are not widespread because they are quite decayed.

Epidote-quartz-sericite chlorite schists - belong to the group of Paleozoic metamorphic rocks and magmates. They cover the area between Gubenechki Andak and mountain range Gubenek. These rocks are well pointed with a phyllitoid look. Their colour varies in grey-green tones. They have schist texture and lipidoblastic structure. They consist mainly of sericite, chlorite, epidote, ciosite and quartz. The presence of quartz is variable, and pyrite and magnetite are coming as secondary elements.

Proluvium – is found in the valley of Shiroki Dol at an altitude of 800-900 meters a.s.l. It is located on an erosive accumulation terrace, composed of weakly bound and partially processed gravels and sands, poorly sorted and mixed with sandy clay material. Their estimated thickness is around 25 meters. They have been formed during the period of Quarter.

Biotite porphyritic granites- are large granular to medium granular, partly schist rocks. When fresh, their colour is light-grey, but largely decayed and converted in gruss. The amount of coloured minerals varies, but usually mezocrate. These rocks show alotriomorphic to hipidiomorphic granular structure, with the presence of very large feldspars, which gives the porphyroide appearance. They consist mostly of quartz, orthoclase, microcline, plagioclase and biotite from the femic minerals.

Feldspars - are usually preserved with very little change in clay products along cracks. The micropertitization is quite common among them. In the large grains of potash feldspars there are often integrated grains of quartz, and plagioclase biotite.

Plagioclase - are albites with the average percentage composition of 6%. The edges of the grains have micropegmatitic buildup. Biotite quantity varies from 10 to 30%. It is fresh, intense, and polychromic and occurs individually or in piles. Besides biotite, these rocks contain muscovite, the amount of which is not greater than 1 to 2%. According to its chemical analysis, these granites belong to calcium-alkaline group, adamelitic type.

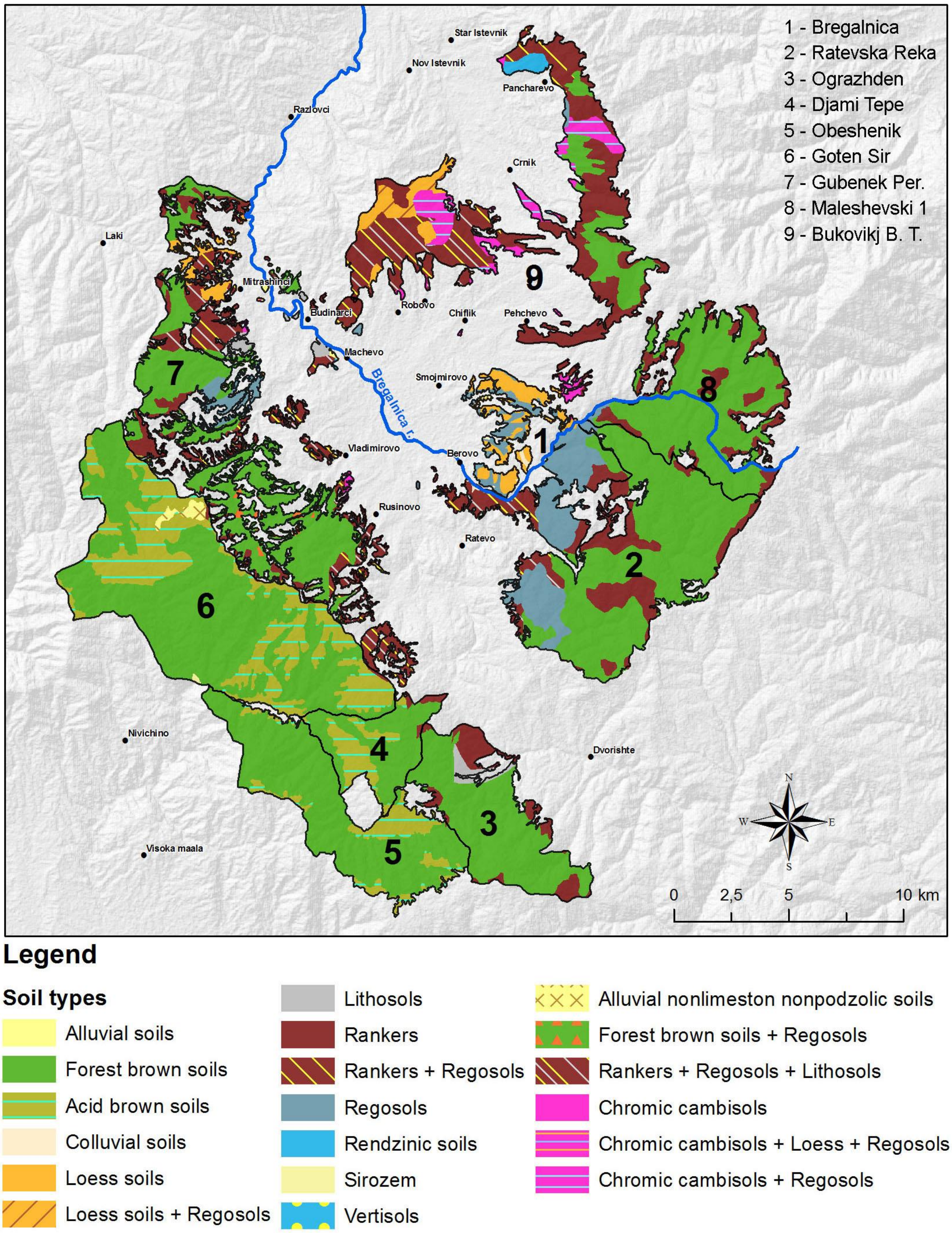
Muscovite leukocrate granites - are actually a continuation of the two-mica striped gneisses. The biotite in these rocks is almost completely lost, while muscovite dominates or it is only present. In addition to these granites, there have been increased presences of potash feldspars (microcline), which prevail in large presence over plagioclase. Two-mica and muscovite granites have a common case to the edges of microclines to have micropegmatitic buildup of quartz and feldspars. Obviously these granites belong to more acid types, which are in accordance with the chemical analyses that show greater acidity, decreased presence of Mg and Fe oxides, and an increasing K-component. According to the modal analysis, the potassium feldspars (microcline and orthoclase) horrendously prevail over plagioclase (albite). The presence of mica is quite small, but rather muscovite and biotite, and sometimes only muscovite. Also, the presence of quartz is up to 50%.

Clays, suclays and sands – they are sedimentary rocks from the Cenozoic age and in this area, they have a thickness of 140 m. These rocks consist of grey-green sandy clays, calcium carbonate clays and sandstones. All these compounds are shifting in horizontal and vertical direction. They can also occur as quality ceramic clay, with thickness of up to 100 m.

3.4. Soil conditions

In each Special plan on forest management of Region of Malesh, the types of soils are specifically described for different forest associations within each forest management unit. Thus, the region of Malesh includes five types of soil:

- Sierozem on loose substrate (Regosols)
- Cinnamon Soils
- Humus-Silicate Soils (Rankers)
- Brown Forest Soils (Cambisols)
- Rocky Soils (Lithosols)



Map 4. Soil distribution in different parts of the region of Malesh and within the forest management units

3.4.1. Sierozem on loose substrate (Regosols)

Regosols occur in different places within the region of Malesh and at altitudes of up to 1,100 meters a.s.l. They are formed by erosion of other soil types. Given that erosion is present in almost all soil types, regosols appear mixed, so they are shifting in small areas. Thus, regosols in these terrains are presented either pure or in complex layers (rankers + regosols and ranker + regosols lithosols).

Genesis and formation conditions reflect the very erosive processes expressed in the hilly and mountainous terrains. Those processes are completely eroding the solum (surface and subsoil layers) part of smolnica soils, rendzina soils, cinnamon soils, luvisol soils and lower part of brown forest soils and rankers. These soils occur in terrains with a much steeper slope. They are formed on classic sediments and on residual regolith of compact rocks that easily decompose.

Regosols are not climatogenic soils. In the higher zones, where they occur, the climate is drier, the forest regeneration is weak, and the rains often have torrential character and cause erosion. They also occur in the oak belt area where they are more fertile, at lower altitudes; forests in these areas are mostly destroyed in order to obtain land for agricultural cultivation. Today, regosols occur in much steeper terrain, where the oak belt forest communities are highly degraded, or completely destroyed, and where small patches or single trees remain.

- Morphological properties of regosols

Soil profile horizontal differentiation is very weak and often unremarkable. Horizon (A) is little or no different from horizon (C). The signs of biological activity are obvious (root system of grass vegetation, traces of activity of fauna). They are not different in colour or hardly different from the horizon (C). It usually has light brown colour and rarely yellowish-grey. No structure or developed signs occur at the beginning of the formation of the grain structure, when under grassland vegetation. The mechanical composition is heterogeneous. The horizon(C) is very heterogeneous (different tertiary sediments, grus, decomposed shales and other compact rocks).

- Mechanical composition of regosols

Table 3. Regosols Mechanical composition in the Region of Malesh

No.	Depth	Skeleton	Coarse sand	Soft sand	Dust	Clay	Clay+Dust	Hygroscopy
profile	horizon	>2 mm	0.2-2 mm	0.02-0.2 mm	0.002-0.02 mm	<0.002 mm	<0.02 mm	moisture
89	**A** (0-20)	15.44	36.14	57.06	6.80	0.00	6.80	4.60
89	**C** (20-30)	10.89	49.00	44.20	6.88	0.00	6.80	

The data presented in Table 3 displays that these soils are sandy. The skeleton fraction is medium represented and with the increase of depth, its content decreases. The coarse sand content is small, relative to the soft sand. As for the soft sand, its content is increasing with depth decrement. The fraction of clay + dust is 6.80%, where there is no clay at all. This type of soil, by its texture and according to its mechanical composition, belongs to the class of sandy loam. Hygroscope moisture is high, 4.60%.

- Regosols chemical properties

Table 4. The regosols chemical properties in the region of Malesh

Horizon	Humus	N	p	H	Eqmmo	1/100 g	Soil	B	Available	Nutrients
cm	%	%	H_2O	nKCL	S	T-C	T	%	P_2O_5	K_2O
(A) (0-20)	2.06		5.90	4.60	1.64	3.38	5.02	32.76	12.70	7.40
C (20-30)	1.01		5.90	4.30	1.24	2.34	3.57	34.59	4.40	3.00

The data presented in Table 4 displays that these soils are non-calcareous and poor in humus, the content being only 2.06%. They are poorly humus soils. These soils are poor with readily available potassium and low in readily available phosphorus. Soil reaction is weakly acidic. The degree of alkaline saturation is low.

3.4.2. Cinnamon soils

The cinnamon forest soils are deep and formed on the loose sediments.

Most of these soils were converted into agricultural land by the destruction of natural forest vegetation. Part of the soils is distributed under hilly, xerophytic pastures, and some under pioneering vegetation (pines, spruce, etc.).

- Cinnamon soils morphological properties

These soils have clearly differentiated profile on the horizon A, B and C, with the variable properties and power of these horizons in various subtypes and varieties. Under the forest and pastures, these soils have coarse grain structure, rarely fine grain structure. By its mechanical composition, they are mainly illite. They don't contain new formations, but have admixtures of skeletal particles.

- Mechanical composition

The data presented in Table 5 displays that these soils are poorly skeletal and going more in depth, the skeleton decreases. The fraction of sand is almost identical to the fraction of clay + dust. The percentage of clay is higher in horizon B, than in horizon A.

Table 5. Mechanical composition of cinnamon forest soils in the region of Malesh

Profile number	Horizon depth	Skeleton >2 mm	Coarse sand 0.2-2 mm	Soft sand 0.02-0.2 mm	Dust 0.002-0.02 mm	Clay <0.002 mm	Clay + Dust <0.02 mm
288	**A** (0-16)	10.60	17.90	42.30	27.50	11.80	39.30
	(B) (16-35)	5.28	17.50	37.50	26.70	18.30	45.00
	(B) (35-57)	9.56	20.90	37.70	24.00	18.30	42.30
	C (57-75)	11.40	15.00	41.40	34.80	8.80	43.60

- Cinnamon soils chemical properties

Table 6. Cinnamon soils chemical properties in the region of Malesh

Horizon	Humus	N	p	H	eqmmo	1/100 g	soil	*B*	Availability	Nutrients
cm	%	%	**H_2O**	**nKCL**	**S**	**T-S**	**T**	%	**P_2O_5**	**K_2O**
(A) (0-16)	2.57		6.00	5.00	14.28	3.72	18.01	79.30	4.01	31.99
(**B**) (16-35)	1.54		6.30	5.00	20.87	2.69	23.57	88.56	2.91	28.48
(**B**) (35-57)	1.05		6.50	5.20	19.77	2.15	21.12	90.19	3.62	28.45
(**C**) (57-75)	0.72		7.70	7.00	-	-	-	-	5.41	23.09

The data presented in Table 6 displays that cinnamon soils are moderately supplied with humus in horizon A, while in horizon C they are low in humus. According to the pH factor, these soils are low acidic to neutral. The capacity ions adsorption is high and is closely related to the composition of clay minerals, humus content and texture differentiation. With regards to the nutrients, these soils are poorly supplied with phosphates, and at the same time well supplied with easily accessible potassium.

3.4.3. Humus-silicate soils (rankers)

Humus silicate soils (rankers), as soil type, occupy a relatively large surface within the region of Malesh and are relatively young soils.

Geological substrate has great significance for ranker creation that represents the first stage in the evolution of silicate lithosols and regosols without profound changes in mineralogical composition of the substrate. This soil type is formed on a silicate geological surface. It is distributed at almost all elevation zones, but dominates in the area of oak and pine. They have the most characteristic appearance in the highest zone, above the tree line border.

- Morphological properties

These soils have regolitic horizon profile with A-AC-C-R. The humus-accumulative horizon A occurs in two modifications: AMO (eutric rankers) and AUM (distric rankers). Horizon A is with a different power (18-60 cm). It is grey-brown, brown, dark brown, black and brown to black. The structure is fine grain, dusty, powder-grainy, grainy and very rarely been-grainy.

Regolitic rankers are characterized by weak AC horizon, which can be of varying power (up to 32 cm). The colour of the transitional horizon is always brighter. It is characterized by less humus and more skeleton. It features a poorly expressed grainy structure and poorly expressed powder structure.

Below the horizons A and AC lies substrate R (compact rock) and C (decomposed physical substrate) of various rocks.

- Mechanical composition

Table 7. Rankers mechanical composition in the region of Malesh

Profile number	Horizon depth	Skeleton >2 mm	Coarse sand 0.2-2 mm	Soft sand 0.02-0.2 mm	Dust 0.002-0.02 mm	Clay <0.002 mm	Clay + Dust <0.02 mm
288	**A** (0-20)	14.58	35.03	40.17	21.40	3.80	24.80
	A (20-24)	37.22	27.33	49.37	20.50	2.80	23.30
	AC (42-65)	43.07	33.38	40.32	24.50	1.80	26.30

The data presented in Table 7 displays that these soils are strong skeletal and the skeleton increases when going more in depth. Rankers in this area are characterized by an average content of clay, which also decreases with depth. One of the main features of the mechanical composition of rankers is the high content of total sand. These soils are characterized with good water permeability, poor water retention and frequent drought in the summer.

- Chemical properties

Table 8. Rankers chemical properties in the Region of Malesh

Horizon	Humus	N	p	H	eqmmo	1/100 g	soil	*B*	Availability	Nutrients
cm	%	%	**H_2O**	**nKCL**	**S**	**T-S**	**T**	%	**P_2O_5**	**K_2O**
A(0-20)	7.91	0.399	5.80	4.90	12.52	7.98	20.50	61.08	11.6	11.2
A (20-42)	4.00	0.134	6.20	5.20	11.22	5.11	16.34	68.71	1.0	7.4
AC (42-65)	3.23	0.066	6.10	5.20	12.45	4.41	16.86	73.85	<1	5.0

The data presented in Table 8 and the analysis of the chemical properties of rankers, displays that they are well supplied with humus, which content decreases with the depth increment. According to the pH factor, these soils are moderately to weakly acidic. The ions' adsorption capacity is high and closely related to the composition of clay minerals, humus content and texture differentiation. Rankers are poorly supplied with nutrients such as phosphates, but well supplied with easily accessible potassium.

3.4.4. Brown forest soils (kambisols)

Brown forest soils (kambisols) in the Malesh area are found in a very wide area and elevation starting from 940 up to 1,750 meters a.s.l. In this area, they are found together with regosols, litosols and rankers. In the main altitudinal area of their distribution, the mountainous climate prevails, which is moderately cold and humid with mean annual temperature of 4-8 °C, with rainfall of up to 799-1,200 mm, with high humidity in the air and a thick snow cover in winter. They have their most typical form in the beech forest belt, under the sub-mountainous beech forest and mountainous beech forest. This soil type is divided into eutric and distric kambisol.

- Morphological properties

A common feature of kambisols is mandatory presence of humus-accumulative horizon A, kambic horizon (B)v and substrates C or R.

Morphologically speaking, acid-brown forest soils have clearly set off genetic horizon with subhorizons O_L, from uncomposed organic matter (forest litter) and O_F, from semi-composed and decomposed organic material associated with the mineral part of the soil through hyphae. The A genetic horizon is clearly differentiated and has a depth of 10-25 cm. It has a dark brown, chocolate colour, fine to medium grain structure, densely interwoven with root cores and well aerated. Kambic (B) genetic horizon is significantly deeper than A horizon. Given that it has a lower percentage of humus, the colour is light yellowish-brown, with poorly expressed column structure, significantly larger part of the skeleton, especially in the lower part.

- Mechanical composition of district kambisols

Table 9. Distric kambisols mechanical composition in the region of Malesh

Profile number	Horizon depth	Skeleton >2 mm	Coarse sand 0.2-2 mm	Soft Sand 0.02-0.2 mm	Dust 0.002-0.02 mm	Clay <0.002 mm	Clay + Dust <0.02 mm
111	**A** (0-10)	17.81	47.70	35.00	13.70	3.60	17.30
	(B) (10-45)	17.50	54.50	26.00	11.70	7.80	19.50
	(B) (45-75)	14.44	45.10	21.60	21.00	2.30	23.30

The data presented in Table 9 displays that, in these soils, sand fraction (82.70%) dominates over the skeleton (17.81), where the proportion of sand decreases with depth and the skeleton increases. There is absolute domination of dust over the clay. Dust fraction is much higher than the clay fraction.

- Mechanical composition of eutric kambisols

Table 10. Eutric kambisols mechanical composition

Profile number	Horizon depth	Skeleton >2 mm	Coarse sand 0.2-2 mm	Soft sand 0.02-0.2 mm	Dust 0.002-0.02 mm	Clay <0.002 mm	Clay + Dust <0.02 mm
90	**A** (0-22)	16.60	36.09	43.21	16.80	3.90	20.70
	(Б) (22-50)	19.40	24.86	40.14	28.20	6.80	35.00
	(Б) (50-70)	32.57	24.57	39.63	29.00	6.80	35.80

The data presented in Table 10 displays that, in these soils, sand fraction (79,30%) dominates over the skeleton fraction (16,60), where the proportion of sand decreases in depth and the skeleton increases. There is absolute domination of dust over the clay. Dust fraction is much higher than clay fraction.

- Chemical properties

The data presented in Table 11, and the analysis of the chemical properties of distric kambisols, show that they contain 5.52% humus in A horizon, which drastically decreases with depth. The soil reaction, i.e. the pH factor, is acidic in accordance with detitrate on which these soils are formed. They show low adsorption capacity and low base content. They are well provided with readily available K_2O and are low in readily available P_2O_5.

Table 11. Distric kambisols chemical properties

Horizon	Humus	N	p	H	eqmmo	1/100 g	soil	B	Availability	Nutrients
cm	%	%	H_2O	nKCL	S	T-S	T	%	P_2O_5	K_2O
A (0-10)	5.52	0.091	5.30	4.00	5.86	9.89	15.75	37.22	<1	11.40
(**B**)v (10-45)	2.29	0.064	5.40	4.20	4.27	5.89	10.16	42.02	<1	5.80
(**B**) C (45-75)	2.24	0.043	5.30	4.20	3.42	5.20	8.70	39.31	<1	6.20

Table 12. Eutric kambisols chemical composition

Horizon	Humus	Nitrogen	p	H	eqmmo	1/100 g	soil	B	Availability	Nutrients
cm	%	%	H_2O	nKCL	S	T-S	T	%	P_2O_5	K_2O
A (0-22)	5.18	0.215	6.10	5.10	17.99	4.39	22.38	80.36	14.00	4.00
(**B**)v (22-50)	3.49	0.121	6.10	4.30	17.16	5.10	22.26	77.09	10.70	3.00
(**B**) C (50-70)	1.76	0.073	6.30	4.10	20.58	4.31	24.84	82.69	10.70	2.00

The data presented in Table 12, and the analysis of the chemical properties of eutric kambisols, show that they contain 5.52% humus in A horizon, which drastically decreases with depth. The soil reaction, i.e. the pH factor, is moderately acidic. They show low adsorption capacity and low base content. They are well provided with readily available K_2O, and low in readily available P_2O_5.

All soil types in the Malesh area are established exclusively on silicate geological surface.

As a result of the harmful effects of the zoo-anthropogenic factor (intensive occurrence of illegal felling, cattle grazing and the frequent occurrence of fires), in some places there are visible signs of the appearance of surface and depth erosion, which contributes to the washing of surface soil layer.

According to the description of soils, it can be concluded that their importance to the forest is directly related to their quality. The places where the conditions contributed to form richer soils with better properties, there is development of better tree stands that have more timber volume and growth. These are forests of beech forest belt, where soil types are richer and more preserved. In the oak forest belt, the soils are poorer and more under the influence of zoo-anthropogenic factor, so these forests are of inferior quality.

3.5. Climate

The climatic conditions in the Malesh area are followed through the Berovo meteorological station located at an altitude of 824 meters a.s.l. This paper provides climate data for the period from 2001 to 2010.

3.5.1. Air temperature

The air temperature is an important climatological data because it has a great influence on the occurrence, duration and end of the vegetation. These data are usually outlined for 10 years and they estimate the average values of temperature for the ten-year period. Because meteorological stations are not installed in the forest, data are taken from the nearest weather station, and then by interpolation, the approximate data is obtained for various forest belts and altitudes. Mean monthly temperatures and average annual temperature expressed in °C for a 10-year period is shown in Table 13.

Table 13. Mean temperatures in °C for the region of Malesh

Month/ Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean Annual
2001	1.5	1.4	8.1	8.0	13.9	17.2	20.2	20.1	14.4	10.7	2.8	-5.8	9.4
2002	-2.8	3.2	6.1	8.1	13.8	18.5	19.9	17.3	13.0	9.2	5.5	1.2	9.4
2003	0.9	-4.4	2.1	6.2	16.1	18.7	19.6	19.5	12.4	9.3	5.7	-0.5	8.8
2004	-2.1	0.6	4.3	9.6	11.5	16.7	19.0	18.2	14.7	11.3	4.7	2.4	9.2
2005	-0.4	-1.9	3.3	8.3	14.3	16.5	19.6	17.9	14.4	8.5	2.6	0.3	8.6
2006	-3.4	-1.5	4.0	9.3	13.4	16.4	17.9	18.5	14.2	10.0	3.2	0.2	8.5
2007	1.9	2.6	4.9	8.6	14.5	18.8	21.9	19.1	12.6	9.3	2.9	-1.2	9.7
2008	-1.1	1.0	5.2	9.2	12.7	17.4	18.9	20.4	13.1	9.6	5.2	1.8	9.5
2009	-0.1	0.0	3.1	8.8	13.7	17.2	19.1	18.4	19.9	9.7	5.7	3.9	10.0
2010	0.4	1.7	4.0	8.9	13.7	16.9	19.1	20.5	14.1	8.0	8.7	1.5	9.8
Mean Monthly	**-0.5**	**0.3**	**4.5**	**8.5**	**13.8**	**17.4**	**19.5**	**19.0**	**14.3**	**9.6**	**4.7**	**0.4**	**9.3**

The data presented in Table 13 displays that average monthly temperatures, over a period of one year can, range from -0.5°C to 19.5°C, i.e. the coldest month of the year is January and the month with the highest temperature is July. Mean annual average air temperature is 9.3°C.

Since the meteorological station where from temperatures data are extracted is located at an altitude of 824 meters a.s.l., the transformation of mean monthly and mean annual temperatures for higher altitudes is performed using a temperature gradient, where the temperature decreases by 0.5 to 0.6°C every 100 meters, depending on the altitude. This transformation is performed according to the formula:

t = 9.3 - 0,42N - 0,008N2 where,
t - mean annual temperature of certain altitude,
H - altitude expressed in hectometers.

The data on transformed mean monthly and mean annual temperatures, for different altitudes, are shown in Table 14.

Table 14. Mean monthly and mean annual temperatures for different altitudes

Alt. m.a.s.l.	Mean monthly transformed temperatures in degrees °C												Mean ann. temp
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
824	-0.5	0.3	4.5	8.5	13.8	17.4	19.5	19.0	14.3	9.6	4.7	0.4	9.3
972	-1.4	-0.6	3.6	7.6	12.9	16.5	18.6	18.1	13.7	8.7	3.8	-0.5	8.4
1,172	-2.6	-1.8	2.4	6.4	11.7	15.3	17.4	16.9	12.5	7.5	2.6	-1.7	7.2
1,372	-3.8	-3	1.2	5.2	10.5	14.1	16.2	15.7	11.3	6.3	1.4	-2.9	6.0
1,572	-5	-4.2	0	4	9.3	12.9	15	14.5	10.1	5.1	0.2	-4.1	4.8
1,746	-6.2	-5.4	-1.2	2.8	8.1	11.7	13.8	13.3	8.9	3.9	-1	-5.3	3.6

The data presented in Table 14 displays that with increasing altitude the air temperature decreases according to the model. The data needs to be taken with care and needs to be confirmed by concrete measurements. According to the model, the mean annual temperature ranges from 3.6°C at 1,746 meters above sea level (model) to 9.3°C at 825 meters a.s.l. (data from the weather station).

3.5.2. Absolute maximum and minimum air temperatures

The absolute maximum and minimum air temperatures have great significance for the development of forest vegetation. Their values are shown in each plan for each forest management unit. This paper provides data on the absolute maximum and minimum values of air temperature for the period 2001-2010.

Table 15. Average air temperatures and extreme max and min temperature in the region of Malesh

altitude	mean monthly values °C												mean annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	temperature
T	-0.5	0.3	4.5	8.5	13.8	17.4	19.5	19.0	14.3	9.6	4.7	0.4	9.3
t_{min}	-5.1	-4.9	-1.0	2.4	6.6	9.6	11.2	11.2	7.3	3.7	-0.9	-3.7	
t_{max}	5.2	6.5	11.2	15.3	20.9	24.5	27.3	27.4	21.7	17.5	12.3	5.7	

The data presented in Table 15 displays that the absolute monthly annual maximum is 27.4°C, while the absolute monthly annual minimum is -5.1°C.

3.5.3. Precipitation

Precipitation, same as air temperature is an important climatological element that has a major impact on the development of forest vegetation. Therefore, the specific plans for forest management also include data for precipitation. Data are taken from the nearest weather station.

Table 16. Mean monthly and mean annual sum of rainfall in mm

Month/ Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual sum
2001	52.2	29.5	18.7	106.2	100.0	43.7	41.7	97.0	38.4	8.3	34.0	70.4	640.1
2002	20.2	9.6	54.1	65.5	81.6	18.2	138.1	150.4	153.0	75.3	41.9	100.9	908.8
2003	81.0	22.3	3.5	51.2	101.6	85.0	27.0	55.7	18.2	138.5	50.3	66.6	700.9
2004	41.1	13.1	34.6	51.3	58.5	93.8	26.0	16.8	57.4	40.0	80.5	56.0	569.1
2005	28.7	78.5	44.5	35.3	55.2	29.7	48.0	146.1	32.9	49.2	42.0	84.9	675.0
2006	34.5	40.2	82.6	63.6	61.4	88.7	102.8	65.4	26.4	83.7	30.7	29.0	709.0
2007	30.8	24.2	28.0	13.7	66.7	49.7	4.8	114.1	58.7	91.4	99.3	35.5	616.9
2008	20.7	9.6	45.0	79.2	67.7	101.6	50.2	2.7	75.1	40.7	38.7	93.7	624.9
2009	107.3	23.2	67.7	41.8	52.6	80.9	45.0	63.5	18.6	65.2	38.9	115.9	720.6
2010	34.5	84.4	61.2	80.6	32.9	130.7	61.0	4.4	18.4	166.5	59.2	94.4	828.2
Mean Monthly	45.1	33.5	44.0	58.8	67.8	72.2	54.5	71.6	49.7	75.9	51.6	74.7	699.4

Table 16 displays data on the quantities of rainfall (mean monthly and mean annual) measured at the Meteorological station of Berovo for the period 2001 to 2010.

The presented data displays that the mean monthly sum of rainfall for the period 2001-2010 ranged from 33.5 mm in February to 75.9 mm in October. Mean annual precipitation is 699.4 mm.

Since these data are related to the meteorological station in Berovo, located at 824 m above sea level, they are transformed for the corresponding altitudes where the forest vegetation is located in the region of Malesh. For this purpose, the pluviometric gradient is used, according to which at every 100 meters, precipitation increases by 40 mm. These data, which have to be taken with great care, are presented in Table 17.

It can be expected that, in higher altitudes, there is a greater amount of precipitation and it reaches values of above 1,000 mm of rainfall, respectively snowfall.

Besides the amount of precipitation, their schedule during the year by seasons is of great importance, since precipitations outside the vegetation period have much less significance than those during the vegetation. Therefore, Table 18 displays the amounts of precipitation by seasons and for altitudes.

Table 17. Mean monthly and mean annual precipitation at altitudes in mm (model data)

altitude	mean monthly and mean annual precipitation at altitudes in mm												annual
meters	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	sum
824	45.1	33.5	44.0	58.8	67.8	72.2	54.5	71.6	49.7	75.9	51.6	74.7	699.4
972	50.2	38.6	49.1	63.9	72.9	77.3	59.6	76.7	54.8	81	56.7	79.8	759.4
1,172	56.9	45.3	55.8	70.6	79.6	84	66.3	83.4	61.5	87.7	63.4	86.5	839.4
1,372	63.6	52	62.5	77.3	86.3	90.7	73	90.1	68.2	94.4	70.1	93.2	919.4
1,572	70.3	58.7	69.2	84	93	97.4	79.7	96.8	74.9	101.1	76.8	99.9	999.4
1,746	77	65.4	75.9	90.7	99.7	104.1	86.4	103.5	81.6	107.8	83.5	106.6	1079.4

Table 18. Amount of rainfall by seasons

Altitude	Amount of rainfall by seasons in mm				annual
meters	Autumn	Winter	Spring	Summer	sum
824	177.2	153	170.6	198.3	699.4
972	192.5	168.6	185.9	213.6	759.4
1,172	212.6	188.7	206	233.7	839.4
1,372	232.7	208.8	226.1	253.8	919.4
1,572	252.8	228.9	246.2	273.9	999.4
1,746	272.9	249	266.3	294	1079.4
%	22.6	24.5	27.7	25.3	100.0

The data presented in Table 18 displays that most of the rainfall is falling in spring (27.7%) and summer (25.3%), while in other periods the rainfall is almost uniform. From this it can be concluded that the rainfall is well distributed throughout the year, because during the vegetation, there is a greater amount of precipitation that positively reflects on forest vegetation.

The appearance of snow is regular in the region of Malesh. The snow cover is thicker at higher elevations. The duration of the snow cover in different years is different, but mostly it is present in the period from December to February and only at higher altitudes in the months of March, April and May. In certain parts of the region of Malesh, there are snow damages as snow felling, snow breaks, especially in places where the soil is shallower and steeper. Both beech and Scots pine are susceptible to damages caused by snowfall, in particular wet snow.

3.5.4. Wind

Wind as a climatic element has a major role in the survival and development of forest vegetation. It has an influence on the basic life processes of plants, such as pollination, seed dissemination, fructification, air and soil moisture, development of the tops of trees, etc. Therefore, its impact is taken into account when planning all forest management activities.

The winds in the region of Malesh appear from all eight directions, but the prevailing are north and northwest winds. The north wind is with an average annual incidence of 147 ‰, average annual speed 2.4 m/sec and maximum speed of 19.0 m/sec. Its average monthly speed during the year ranges from 2.0 to 2.5 m/sec. This wind occurs throughout the year, with a maximum in January, February and March. The northwest wind is with an average annual incidence of 103 ‰, an average annual speed of 2.0 m/sec and a top speed of 12.3 m/sec. It occurs in all months of the year, with an average monthly speed of 1.7 to 2.2 m/sec.

With approximately the same frequency are the southeastern and southwestern winds, with an average annual incidence 64 ‰ and 60 ‰, theaverage annual speed is 2.5 m/sec and the maximum speed reaches 16.0 m/sec.

The south wind has an average annual incidence of 56 ‰, with an average annual speed of 2.7 m/sec and a maximum speed of 23.0 m/sec. The northeast wind has an average annual incidence of 40 ‰, an average annual speed of 1.5 m/sec and a maximum speed of 7.0 m/sec. Western and eastern windshave average incidence. The western wind has an average frequency of 23 ‰, with an average speed of 1.7 m/sec and a maximum speed of 12.3 m/sec. The eastern wind has an incidence of 13 ‰, with an average annual rate of 1.7 m/sec and maximum speed of 9.3 m/sec.

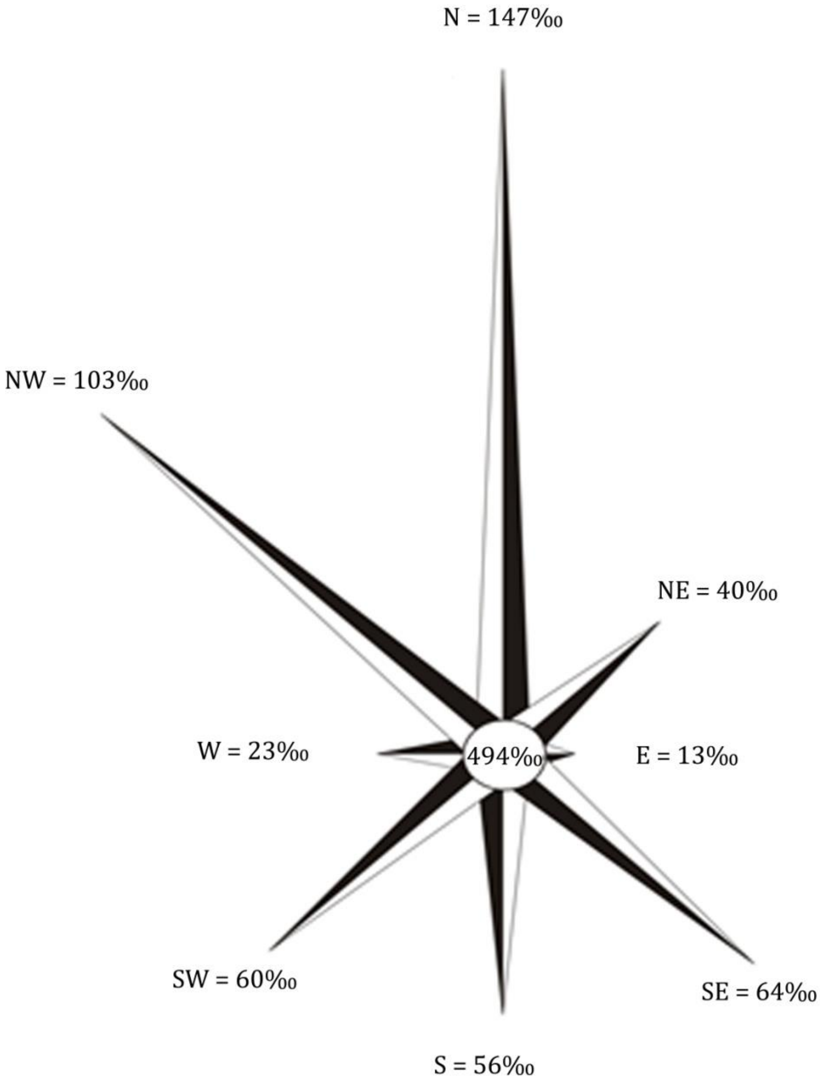
The average annual incidence of calmness is 494 ‰, with a maximum in September of 553 ‰, then in October 546 ‰ and in December 544 ‰. The months of March and April are with the lowest frequency of silence, i.e. the windiest months in the region of Malesh.

The average annual frequencies of wind and calmness in ‰, from eight directions, are shown in table 19 and graph 1.

Table 19. Average annual frequency of winds and silences

Frequency in promiles	Winds direction									total
	N	NE	E	SE	S	SW	W	NW	silences	
‰	147	40	13	64	56	60	23	103	494	1,000

It can be said that the values and incidences of the winds in the region of Malesh are favourable and provide good conditions for the development of forest vegetation. These optimal conditions complement the values of silence that are present about half of the total time of the year and contribute to the retention of moisture in the air and soil. Also, the small maximum speeds of the winds enables correct development of the tops of the trees, pollination, the transfer of seeds and other plant life functions, therefore damages from the wind are minimal.



Graph 1. Wind rose for Berovo

3.5.5. Rainfall factor by Lang

To get a better idea of the climate conditions in the region,the rainfall is estimated by Lang (1920). It is the ratio between the average annual amount of precipitation and average annual air temperature and is calculated by the following formula:

DF = V / T where,

DF - rainfall factor,
V - average annual amount of precipitation,
T - average annual air temperature.

In cases when the result is less than 40, the climate is arid, between 40 and 60 is semiarid, between 60 and 80 is semihumid, between 80 and 160 is humid and above 160 is perhumid. So the calculated rain for corresponding elevations is as follows:

- At 824 meters a.s.l., the RF = 647.2 / 8.6 = 75.2 semihumid
- At 972 meters a.s.l., the RF = 719.2 / 7.8 = 92.2 humid
- At 1,172 meters a.s.l., the RF = 802.7 / 6.7 = 119.8 humid
- At 1,372 meters a.s.l., the RF = 886.8 / 5.7 = 155.5 humid
- At 1,572 meters a.s.l., the RF = 963.5 / 4.6 = 209.5 perhumid
- At 1,746 meters a.s.l., the RF = 1,033.5 / 3.7 = 279.3 perhumid

The high stem beech forest stands, with good quality, are mostly represented in the humid and perhumid climate belts, and rarely Aspen and Scots pine forest stands can be seen here. Tree species like Douglass fir, Silver fir, Norway spruce and Austrian pine are also developing well in this climate belt.

Data for rainfall factor per Lang are shown in Table 20.

Table 20. Rainfall factor by Lang at different altitudes

altitudes meters	Average annual rainfall sum mm	Average annual temperature ^{o}C	Rainfall factor
824	699.4	9.3	75.2
972	759.4	8.4	90.4
1,172	839.4	7.2	116.6
1,372	919.4	6	153.2
1,572	999.4	4.8	208.2
1,746	1,079.4	3.6	299.8

From the data presented in the above table, it can be concluded that, with increasing altitude, the average amount of precipitation increases and the average annual temperature decreases.

3.5.6. Index drought after De Martone

The relationship between the average values for the amount of precipitation from individual months of the year and average values of air temperature is an index of drought. For the needs of the Specific plans for forest management, the drought index is calculated by the De Martone's formula (1926), which reads:

I = V / T + 10 where,

I - drought index,
C - annual amount of precipitation at different altitudes,
T + 10 - average annual temperature at different altitudes increased by a factor of 10.

If the resulting drought index ranges from 20-40, it indicates that forests are xerophilous, and if the index has a value over 40, then the forests are mesophilous.

According to the given formula, the drought index for different altitudes is:

- At 824 meters a.s.l., the RF = 647.2 / 18.6 = 34.8 xerophilous
- At 972 meters a.s.l., the RF = 719.2 / 17.8 = 40.4 mesophilous
- At 1,172 meters a.s.l., the RF = 802.7 / 16.7 = 48.1 mesophilous
- At 1,372 meters a.s.l., the RF = 886.8 / 15.7 = 56.5 mesophilous
- At 1,572 meters a.s.l., the RF = 963.5 / 14.6 = 65.9 mesophilous
- At 1,746 meters a.s.l., the RF = 1,033.5 / 13.7 = 75.4 mesophilous

The calculated drought index values show that forests at altitude of 830 meters a.s.l. are xerophilous and at the higher altitudes the forests are mesophilous. The description of the site conditions are based mainly on the drought index, but a full and accurate picture of what type of forest and site conditions are present, the other factors such as exposure, soil, geological substrate and slopeshould be taken into consideration as well.

The values of the drought index by De Martone for region of Malesh are presented in Table 21.

Table 21. Index drought by De Martone at different altitudes

altitudes meters	Average annual rainfall sum mm	Average annual temperature C+10	Drought index
824	699.4	19.3	36.2
972	759.4	18.4	41.3
1,172	839.4	17.2	48.8
1,372	919.4	16.0	57.5
1,572	999.4	14.8	67.5
1,746	1,079.4	13.6	79.4

The data for the drought index by De Martone, presented in Table 21, displays that most of the forest stands in the region of Maleshare distributed at higher altitudes and they belong to the category of mesophilous forests.

3.6. Type and extent of erosion

The occurrence of erosion is determined by several factors, especially the degree of vegetation cover, the terrain inclination, profusion and intensity of precipitation, and the impact of zoo-anthropogenic factor.

Erosion processes in the region of Malesh are not represented anywhere under the same degree and intensity. The lower parts of the area, and those near the rural settlements, are more affected with erosion. This area include the oak forest stands, which is also influenced by intense zoo-anthropogenic pressurein the past.

In the past, the oak forest stands were trimmed (coppiced) here and managed through clear cuts, so the erosion has a more pronounced degree. In these places, the erosion contributed to the depletion of soil nutrients, washing out the smallest nutrient particles, so the soils became poorer. At the same time, the erosion was assisted with cattle grazing in forests and the reduction of forest at the expense of extensive agriculture. In the last few decades, with the ban on keeping goats, there are observations that the forest cover improved and the soils start covering with organic litter, thus reducing the erosion processes.

The type and extent of erosion have affected the planning of forest management activities. So,the silvicultural and regeneration measures does not contribute to the occurrence of erosive processes.

4. FOREST ECOLOGY

The content of Specific management plans for each forest management unit includes information on the state of forests in respect to site condition and description of forest associations. Additionally, the second tabular part (in Form-II and Form-IIa) provides information about site conditions and forest associations for each unit and subunit separately.

In this paper, they are summarized for the entire region of Malesh.

4.1. State of forest

The state of the forest covers a description of the site conditions, description of stands, timber volume determination, wood increment and the value of stands, and a description of the underlying assets, which are permanently attached to the forests.

4.1.1. Description of site conditions

Three types of site conditions are formed within the region of Malesh, as a result of relief development, slope diversification, terrain expositions, geological substrate, climatic conditions and the impact of zoo-anthropogenic factor, as follows:

- thermophilous site condition, where the oak forest stands are developing,
- thermo-mesophilous site conditions, where oak-beech forest stands are developing with a single representation of aspen, European hornbeam and pine forests on secondary site conditions, and
- mesophilous site condition, where beech forest stands are developing with single representation of aspen and Scots pine forests on secondary site conditions.

4.1.1.1. Thermophilous site condition

This type of site condition stretches on terrains covered with oak vegetation, from the lowest altitude up to the beech belt, which builds mesophilous site condition. The relief is intersected by many dales and gullies, with steep to moderate steep sides, with moderate inclination of the terrain at different exposures.

The climate of this type of site condition is hot continental. The average annual air temperature is around 8.5°C and the average annual amount of precipitation is around 610 mm.

The geological substrate is silicate, on which the sirozems is formed on top of the bulk substrate (regosols), cinnamon soils and humus-silicate soils (rankers), shallow to medium deep and deep in places (depending on the inclination of the ground), low to medium productive.

The forest stands in these site conditions are different, ranging from pure and mixed Austrian pine stands to coppice oak and hornbeam forests. Parts of oak stands are extremely degraded, brought to the stage of bushes and shrubs. The forest stands, in this type of site condition, consist of Hungarian oak, Turkey oak, Oriental hornbeam, Manna ash, hazel, Austrian pine, Common juniper and other tree species.

Erosive processes, such as line and surface erosion, are present at this type of site condition, causing the washing of fertile soil layer and, therefore, the soils are poorer, which reflects on the increment reduction of trees and stands.

4.1.1.2. Thermo-mesophilous site condition

This type of site condition is represented on several smaller areas in central parts of the region of Malesh, between thermophilous and mesophilous site condition, where the mixed forest stands of oak and beech are formed. These are usually higher parts of the transition between the oak and beech forest vegetation. Silicate geological substrate is present, where deep secondary acid brown forest soils, medium wet, with sandy texture, are formed and covered with a thick layer of humus and organic litter.

The climate in this type of site condition is moderate continental, with cooler winters and summers and slightly larger amounts of precipitation than the thermophilous site condition. The average annual air temperature is around 7.6 ° C, and the average annual amount of precipitation is around 750 mm.

The geological substrate is silicate and the soil is light brown, medium deep, dry, covered with a layer of humus and organic litter.

The areas covered with forests, at this type of site condition, have moderately steep to very steep slope; the exposure is usually toward the northwest and southeast.

The quality of trees from these forest stands is better. Only those individual trees that have been trimmed in the past, at a height of 2-5 meters are of low quality. This type of site condition includes mixed forest stands of Beech, Turkey Oak, Hungarian oak, Sessile oak, Oriental hornbeam and Austrian pine.

Erosive processes are present, but with lower intensity.

4.1.1.3. Mesophilous site condition

This type of site condition is represented on the slopes covered with beech forest, where Aspen and Scots pine appears individually or in smaller band. Altitudinal, it builds over thermo -mesophilous site condition and is covered with pure high stem beech forests, pure Scots pine forests and mixed forests of beech, Scots pine, Austrian pine, aspen, etc.

It has silicate geological substrate where acidic brown forest soils are formed, deep or medium deep, wet or medium wet and crisp, with grainy bulk structure and covered with a thick layer of humus and organic litter.

The relief is characterized by very long steep slopes and deeply incised valleys, which keeps the water throughout the year.

In this site condition, the climate is cooler, summers are fresher and winters are colder. Precipitation is greater and the snow cover retain for longer period. The average annual air temperature is around 5.5°C and the average annual amount of precipitation is around 800 mm. This type of mesophilous site condition develops the highest quality of high forest stands. The stems are straight, filled with wood to greater height, about one third of the branches are clean and have a large percentage of high quality sawn timber.

Erosion processes are present only in those stands diluted canopy and a very steep slope. The erosion is minimal on a greater surface.

4.2. Biogeoclimatic ecosystem classification and vegetation typology

The Republic of Macedonia has a total of 8 separate climate-soil-vegetative regions (Rizovski *et al.* 2006):

I - Sub-Mediterranean (modified Mediterranean) region, (50-500 meters a.s.l.);
II - Continental-sub-Mediterranean region (500-600 meters a.s.l.);
III - Warm continental region (600 do 900 meters a.s.l.);
IV - Cold continental region (900-1,100 meters a.s.l.);
V - Sub-montane continental region (1,100-1,300 meters a.s.l.);
VI - Montane continental region (1,300-1,650 meters a.s.l.);
VII - Subalpine region (1,650-2,250 meters a.s.l.); and
VIII - Alpine region (above 2,250 meters a.s.l.).

Out of these, five are represented in the Region of Malesh as follows:

- Warm continental region,
- Cold continental region,
- Sub-montane continental region,
- Montane continental region, and
- Subalpine region.

Figure 7. Scots pine trees in the upper forest belt

Figure 8. Mountain meadows in the upper stream of Bregalnica River

4.2.1. Forest communities description

The forest associations are described according to the phytocoenological background displayed by associations and sub-associations by tree floors, shrub floors and low vegetation or ground vegetation.

Under the influence of heterogeneous site conditions and other environmental factors, the following forest associations are formed in the Region of Malesh: forests of Hungarian oak and Turkey oak (***Quercetum frainetto-cerris*** Em), forests of Hungarian oak, Turkey oak and Austrian pine (***Quercetum frainetto-cerris*** subas. ***pinetosum nigrae*** Em), forests of Sessile oak (***Orno-Quercetum petraeae*** Em), forests of Sesile oak, Manna ash and Austrian pine (***Orno-Quercetum petraeae*** subas. ***Pinetosum nigrae*** Em), secondary Austrian pine forests on beech site conditions (***Fago-Pinetum nigrae*** Em), sub-montane beech forest (***Festuco heterophyllae-Fagetum*** Em), montane beech forest (***Calamintho grandiflorae-Fagetum montanum*** Em) and shrubbery of Common juniper (***Juniperus communis***).

4.2.1.1. Forests of Hungarian oak and Turkey oak (**ass. *Quercetum frainetto-cerris***)

These forests represent the climate zonal forest association that occurs on thermophilous site conditions in warm parts of the continental region. Forest stands of this forest association are with varying degrees of degradation, making it difficult to find preserved complexes. At the same, until recently, there was an intensive cattle grazing, therefore the composition of the ground floor vegetation has changed, thus more visible plant species resistant to drought and grazing are prevailing.

However, it is important to emphasize that in this forest association, Austrian pine intensively spread in secondary formations, dominating some forest stands, forming the sub-association ***Quercetum frainetto-cerris*** subas. ***pinetosum nigrae***, occurring at altitudes of 800-1,100 meters a.s.l.

The geological substrate is silicate, where the humus-silicate soil (ranker) is formed. It is shallow to medium deep. The floristic composition is represented mainly by thermophilous plant species, but also the mesophilous plant species can be seen.

Other trees that are seen here are: ***Quercus frainetto***- Hungarian oak, ***Quercus cerris***- Turkey oak, ***Fraxinus ornus*** – Manna ash and ***Pinus nigra*** - Austrian pine.

The shrubs that are seen here are: ***Juniperus communis*** – Common juniper, ***Corylus avellana*** - Hazelnut, ***Cornus mas*** - Dogwood, ***Crataegus orientalis*** – Oriental hawthorn and other species.

The following species are seen on the ground floor: ***Sesleria holostea***, ***Campanula trachelium***, ***Hedera helix*** - ivy and others.

Figure 9. Forests of Hungarian oak and Turkey oak

4.2.1.2. Forests of Sessile oak (**ass. *Orno-Quercetum petraeae***)

The Sessile oak forests in the Region of Malesh constitute the highest climatic zonal oak belt same as they did anywhere in the country. Depending on the terrain exposure, they occur from 920-1,300 meters of altitude. The geological substrate is silicate, on which the light - brown forest soil of eutric kambisol type is formed. It is a medium deep to deep and shallow in some places. Regarding the floristic aspect, this is a quite rich forest association, where the following tree species are distributed: ***Quercus petraea*** – Sessile oak, ***Quercus confferta*** – Hungarian oak, ***Fraxinus ornus*** – Manna ash, ***Carpinus orientalis*** - Oriental hornbeam, ***Ostrya carpinifolia*** - Hop hornbeam, ***Pinus nigra*** - Austrian pine and other tree species.

The shrubs that are seen here, are as follows: ***Corylus avellana*** - Hazelnut, ***Cornus mas*** - Dogwood, ***Ligustrum vulgare*** – Wild privet, ***Crataegus monogina*** - Common hawthorn, ***Evonymus verrucosus*** - Spindle, ***Malus pumila*** – European apple, etc.

On the ground floor, the following species are seen: ***Festuca heterophylla***, ***Lathyrus niger***, ***Lathyrus venetus***, ***Campanula persicifolia***, ***Melica uniflora***, ***Pulmonaria officinalis***, ***Cyclamen neapolitanum***, ***Scilla bifolia***, ***Lathyrus inermis***, ***Poa nemoralis***, ***Sanicula europaea***, ***Stellaria media*** and others.

In the past, these forests have been subject to strong exploitation by the local population, so now, for the most part, they are converted into coppice.

Figure 10. Forests of Sessile oak

4.2.1.3. Forests of Sesile oak, Manna ash and Austrian pine (**ass. *Orno-Quercetum petraeae* subas. *pinetosum nigrae***)

This forest association, depending on the terrain exposure, occurs from 790-1,180 meters of altitude. The geological substrate is silicate, on which two types of soils are formed including: humus-silicate soil (ranker) and cinnamon forest soil. Rankers are shallow soils, while cinnamon forest soils are deep. Floristic composition of this forest association is quite extensive and mainly dominated by thermophilous species.

As a result of successive natural processes in this forest association, secondary, but intensively the Austria pine spread, were forming sub-association ***Orno-Quercetum petraeae*** subas. ***pinetosum nigrae***.

Following tree species are distributed: ***Quercus petraea*** – Sessile oak, ***Quercus confferta*** – Hungarian oak, ***Fraxinus ornus*** – Manna ash, ***Carpinus orientalis*** - Oriental hornbeam, ***Ostrya carpinifolia*** - Hop hornbeam, ***Pinus nigra*** - Austrian pine and other tree species.

The shrubs that are seen here are: ***Corylus avellana*** - Hazelnut, ***Cornus mas*** - dogwood, ***Ligustrum vulgare*** – Wild privet, ***Crataegus monogina*** - Common hawthorn, ***Evonymus verucosus*** - Spindle, ***Malus silvestris*** - European apple, etc.

On the ground floor, the following species are seen: ***Festuca heterophyllia***, ***Lathyrus niger***, ***Lathyrus venetus***, ***Campanula persicifolia***, ***Melica uniflora***, ***Pulmonaria officinalis***,

Cyclamen neapolitanum, ***Scilla bifolia***, ***Lathyrus inermis***, ***Poa nemoralis***, ***Sanicula europaea***, ***Stellaria media*** and others.

4.2.1.4. Secondary Austrian pine forests on beech site conditions (**ass. *Fago-Pinetum nigrae***)

These forests, within the region of Malesh, occur at an altitude of 1,100 - 1,550 meters a.s.l. where the Austrian pine dominates, while in the higher belt, the Scots pine is seen. They develop on dry to fresh, skeletal soils as light brown and acid brown forest soils (eutric and distric kambisol) formed on silicate geological substrate. These are forests of recent (new) origin and over time will be suppressed by climatogenous representatives.

The main tree species in this forest association is ***Pinus nigra*** - Austrian pine.

Among other tree species found here, almost regularly and abundantly, is ***Fagus moesiaca*** Balkan beech, and somewhat less is ***Pinus silvestris*** (Scots pine). All individuals in this forest association are successfully developing and the trees reach a height up to 30 meters. The stems are straight and with full trunks, free of branches to almost 1/3 of the height.

The shrubs that are seen here are: ***Juniperus communis*** – Common juniper and ***Corylus avellana*** - Hazelnut. The floor of the ground vegetation is abundantly represented by ***Galium vernum***, ***Brachypodium pinnatum***, ***Calamagrostis arundinacea***, ***Pteridium aquilinum***, and other plant species significant for the oak associations.

4.2.1.5. Sub-montane beech forests (**ass. *Festuco heterophyllae-Fagetum***)

Sub-montane beech forests build a compact forest belt. They are seen on places with an altitude of 950-1,300 meters and terrains with steep inclination. The geological substrate is silicate, where the acidic brown forest is formed, medium deep to deep, moderately moist and fresh.

Besides the beech ***Fagus moesiaca***, which has a dominant place in the composition of these forests, other tree species are seen, such as: ***Pinus nigra*** - European pine, ***Populus tremula*** - Aspen, ***Carpinus betulus*** – European hornbeam, etc.

The shrubs that are met here are: ***Cornus mas*** - Dogwood, ***Prunus avium*** - Wild cherry, ***Sorbus torminalis*** - Wild service tree and other types of oak belt.

The ground floor vegetation is composed of: ***Primula acaulis***, ***Cyclamen neapolitanum***, ***Lathyrus inermis***, ***Pulmonaria officinalis***, ***Danna cornubiensis***, ***Festuca heterophylla*** and others.

Figure 11. Secondary Austrian pine forests on beech site conditions

Figure 12. Sub-montane beech forests

4.2.1.6. Montane beech forests (**ass. *Calamintho grandiflorae-Fagetum***)

This forest association occurs in the forest belt between 1,360 – 1,750 meters of altitude, in mesophilous site conditions. The geological substrate is silicate, where the acidic brown forest soil is formed. These are medium deep soils, fresh, well supplied with humus, and with acidic reaction.

Besides the Balkan beech ***Fagus moesiaca***, which has a dominant place in the composition of these forests, other tree species occur, such as: ***Populus tremula*** - Aspen, ***Prunus avium*** - Wild cherry, ***Salix caprea*** **-** Goat Willow, and other tree species.

The shrubs include the following species: ***Rubus idaeus*** - Raspberry, ***Daphne mezereum*** - Mezereon, ***Evonymus latilifolius*** - Spindle, ***Lonicera caprifolium*** - Perfoliate honeysuckle.

The ground floor vegetation is composed of: ***Calamintha grandiflora***, ***Lamium galeobdolon***, ***Epilobium montanum*** (***Chamaenerion angustifolium***), ***Aremonia agrimonoides*** etc.

Figure 13. Montane beech forests

4.2.1.7. Scots pine forests on secondary on secondary site conditions (**ass. *Fago-Pinetum silvestris***)

This forest association is found in places with different altitudes, from 1,300-1,750 meters, which shows that it can be found both in the sub-montane and in the montane forest belt. The geological substrate is mainly silicate, where the acidic brown forest soil is formed. Due to the light demand of Scots pine forests, these stands have been formed on the secondary site conditions and are seen on the sites exposed with more sun such as the eastern, northeastern and southeastern.

The dominant tree is ***Pinus silvestris*** - Scots Pine, while the others are: ***Fagus moesiaca*** – Balkan beech, ***Populus tremula*** - Aspen, ***Pinus nigra*** - Austrian pine, ***Salix caprea*** – Goat willow.

The shrubs include the following species: ***Vaccinium myrtillus*** - Blueberry, ***Rubus idaeus*** - Raspberry, ***Crataegus monogina*** – Common hawthorn, ***Juniperus communis*** – Common juniper, and others.

The ground floor vegetation is represented by: ***Luzula sylvatica***, ***Dactylis glomerata***, ***Fragaria vesca***, ***Luzula maxima***, and others.

Figure 14. Scots pine forests on secondary site conditions

4.2.1.8. Shrubberies of Common juniper (***Juniperus communis***)

The shrub forests, within the region of Malesh, appear on abandoned fields and pastures, both in the oak and the beech zone, up to 1,500 meters of altitude. Usually, they cover the slopes with shallow and eroded soils, which represent the initial stage in the progressive development of forest vegetation. They have a high value in respect to biodiversity, in particular for pollination and avifauna.

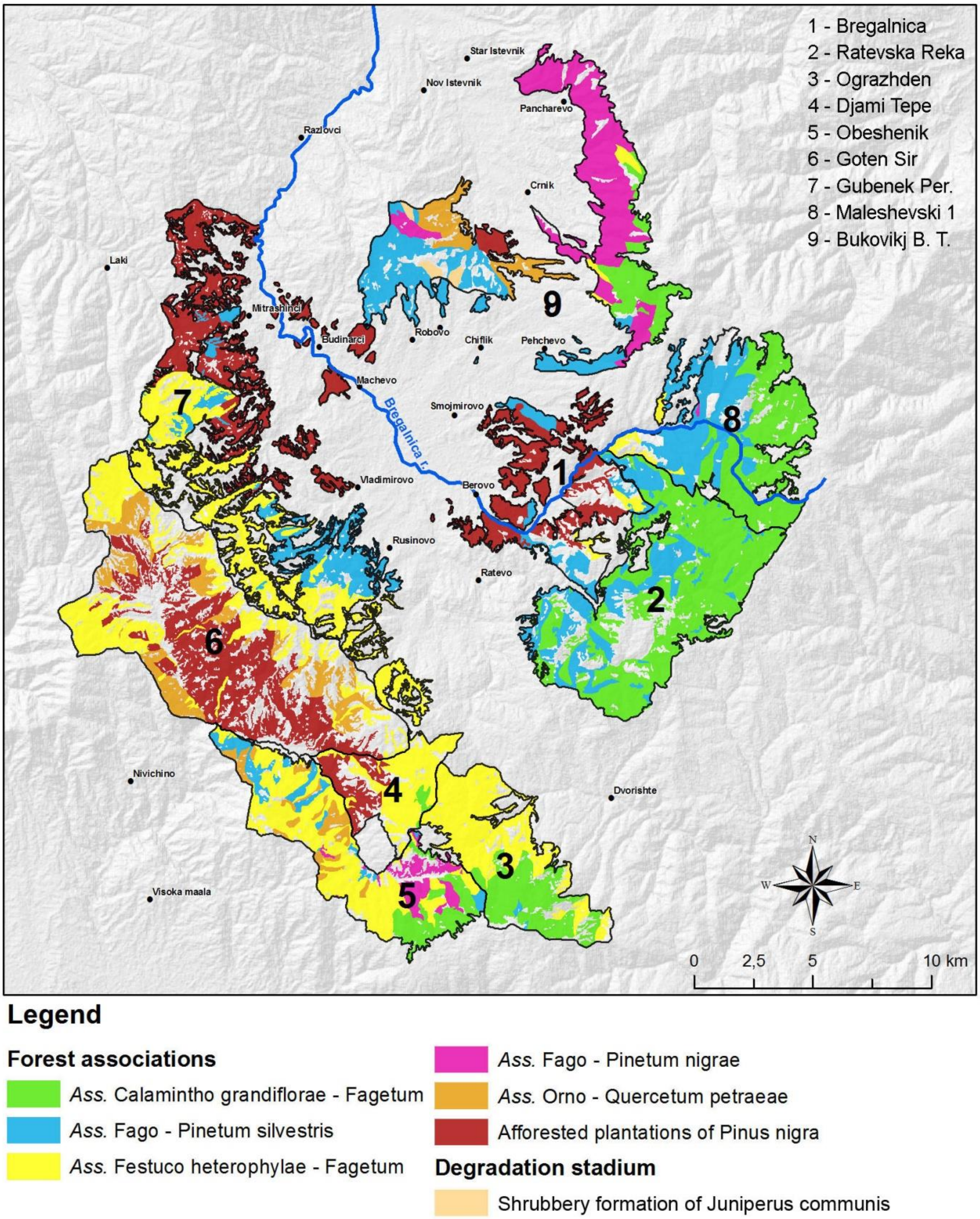
For the floristic development of this forest association, of importance are some thermophilous species that are common in the pine forests of eastern Macedonia. Of all these, the most significant are: ***Juniperus communis*** – Common juniper, ***Rosa canina*** – Dog rose, ***Crataegus orientalis*** - Oriental hawthorn, ***Cytisus leucanthus***, ***Genista carinalis***, ***Thymus serpyllum*** - Thyme, ***Plantago carinata***, ***Euphorbia cyarissias***, ***Achillea millefolium*** – Yarrow, and others.

The even warmer site conditions, i.e. lower elevations red juniper appears (***Juniperus oxycedrus***), being another case of climatic-zonal vegetation.

It is necessary to say that the Common juniper shrub stands are potential areas where the Austrian pine performs a natural succession (i.e. conquering those areas) when the influence of zoo-anthropogenic factors is decreased. Table 22 displays forest communities' representation in the Region of Malesh according to their surface, timber volume and timber increment.

Table 22. Forest communities representation in the Region of Malesh according to their area, timber volume and timber increment

Forest community		area	timber volume	timber increment	
		ha	m³	current	average
1	**ass.** ***Calamintho grandiflorae-Fagetum***	5,262	1,545,953	30,443	2,340
2	**ass.** ***Festuco heterophyllae-Fagetum***	8,306	2,148,231	27,614	8,009
3	**ass.** ***Quercetum confertae-cerris***	5,421	695,345	7,513	4,526
4	**ass.** ***Fago-Pinetum silvestris***	8,913	2,046,086	39,108	22,382
5	**ass.** ***Fago-Pinetum nigrae***	3,020	585,322	12,252	6,982
6	**ass.** ***Orno-Quercetum petraeae***	1,705	245,026	2,923	898
7	**ass.** ***Juniperus communis***	103			
8	**ass.** ***Orno-Quercetum petraeae*** **subas.** ***pinetosum nigrae***	265	19,163	547	454
9	**ass.** ***Quercetum confertae-cerris*** **subas.** ***pinetosum nigrae***	130	5,108	167	140
	TOTAL	**33,125**	**7,290,234**	**120,567**	**45,731**



Map 5. Forest communities in the region of Malesh

5. FOREST STANDS DESCRIPTION ACCORDING TO SILVICULTURAL SYSTEMS (PRACTICES)

As outlined in the various chapters before, forest stands in the region of Malesh consist of a variety of tree species, endemic and introduced, such as beech, Austrian pine, Scots pine, Sessile oak, Hungarian oak, Turkey oak and other. Some of these species build pure forest stands, but also mixed forest stands are widespread throughout the region.

The timber volume of stands is determined for all trees at breast height (1.30 meters), with diameter over 10 cm for high-stem forest stands and 5 cm for low-stem forest stands. It is determined for the units and sub-units through the method of trial areas with full measurement (for high-stem forest stands), timber increment and growth tables (for low-stem forest stands) or ocular assessment (for degraded forest stands, and shrub stands), and depending on management significance, form, composition and condition of trees.

The timber volume of those forest tree species, which participate with less than 10% in the total timber volume of the stand, can be determined together with the timber volume from related forest tree species.

The current increment by timber volume is determined for the units and sub-units, and for the forest tree species including: forest stands where timber is completely determined by full measurement with a control method, and forest stands where timber is determined by the method of trial areas with a help of drilling into stems (method of increment by thickness, method for switching and retention and the method of percentage of the increment by timber volume). In the forest stands, where timber volume is determined by assessment, the increment is determined by assessment as well.

5.1. Forest stands description according to the silvicultural form

The forest stands description contains information on: the silvicultural form, the management form (by area, timber volume and increment), composition, purpose, structure, overgrowth, height, rating, age, forests vulnerability from harmful influences, health, quality of trees, maintenance, as well as data on the condition and type of regeneration.

According to the silvicultural form in the region of Malesh in all nine management units, there are high-stem ("high forest") and low-stem ("coppice forest") stands. Due to the compliance with the Rules on preparing Specific plans for forest management, Special plans for silviculture and protection of forests and Annual Performance Plans (Official Gazette of RM No. 48/98), the middle-stem forest stands ("Mittelwald") are not provided, so they are not taken into consideration here, even though in reality they exist in the region of Malesh. Their further management depends on the creativity of the engineers who prepared the plans.

Forest stands description according to the silvicultural form is presented in Table 23.

Data presented in Table 23 displays that the total forest area is 33,125 ha, where 28,506 ha or 86% are high-stem forest stands, and 4,619 ha or 14% are low-stem forest stands. The total timber volume is 7,290,234 m³, where the high-stem forest stands have 6,776,473 m³ or 93%, and the low-stem forest stands have 513,761 m³ or 7%. The current increment in the high-stem forests is 4.03 m³/ha, and the average increment is 1.40 m³/ha. The current increment of the low-stem forest stands is 1.26 m³/ha and the average increment is 1.24 m³/ha.

Table 23. Overview of the Forest stands according to the silvicultural form

Silvicultural form	Area		Timber volume			Current increment			Average increment		
	ha	%	m³	m³/ha	%	m³	m³/ha	%	m³	m³/ha	%
High stem	28,506.0	86.1	6,776,473	237.72	93.0	114,747	4.03	95.2	39,991	1.40	87.4
Low stem	4,619.1	13.9	513,761	111.23	7.0	5,820	1.26	4.8	5,740	1.24	12.6
Total	33,125.1	100.0	7,290,234	220.08	100.0	120,567	3.64	100.0	45,731	1.38	100.0

5.2. Forest stands description according to the management form

According to the management form, the forest stands are divided into: high-stem uneven aged, high-stem even aged, forest cultures and low-stem forests. The overview of forest stands according to the management form is given in Table 24.

The data presented in Table 24 displays that the total area of forest is 33,125 ha, of which 12,853 ha or 38.8 % are high-stem uneven aged forest stands, 15,193 ha or 45.9% are high-stem even aged forest stands, 460.30 ha or 1.4 % are forest cultures and 4,619.10 ha or 13.9 % are low-stem forest stands. The total timber volume is 7,290,234 m³, the high-stem uneven aged forest stands have 4,112,741 m³ or 56.4 %, and the high-stem even aged forest stands have 2,662,254 m³ or 36.5 %, the forest cultures have 1,478 m³ or 0.1 %, and the low-stem forest stands have 513,761 m³ or 7 %. The current timber increment at the high-stem uneven aged forest stands is 5.42 m³/ha, at the high-stem uneven aged forest stands is 2.96m³/ha, at the forest cultures is 0.44 m³/ha, and at the low-stem forest stands is 1.26 m³/ha. The biggest timber volume and the highest current increment is at the high-stem uneven aged forest stands, that although they occupy 38.8 % of the total area, they have 56.4% of the timber volume and 57.8% of the current increment.

Table 24. Overview of forest stands according to the management form

Management form	Area		Timber volume			Current increment			Average increment		
	ha	%	m³	m³/ha	%	m³	m³/ha	%	m³	m³/ha	%
High-stem uneven aged forest stands	12,852.69	38.8	4,112,741	319.99	56.4	69,637	5.42	57.8	0	0	0
High-stem even aged forest stands	15,193.01	45.9	2,662,254	175.23	36.5	44,906	2.96	37.2	39,882	2.63	87.2
Forest cultures	460.30	1.4	1,478	3.21	0.1	204	0.44	0.2	109	0.24	0.2
Low-stem forest stands	4,619.1	13.9	513,761	111.23	7.0	5,820	1.26	4.8	5,740	1.24	12.6
Total	33,125.1	100.0	7,290,234	220.08	100.0	120,567	3.64	100.0	45,731	1.38	100.0

Figure 15. Afforestation of Scots pine and Austrian pine in the beech forest belt

The small share of timber volume from forest cultures, as well as the low current increment, is a result of their young age of much of the forest cultures so their timber volume and current growth is not calculated in the Special forest management plans.

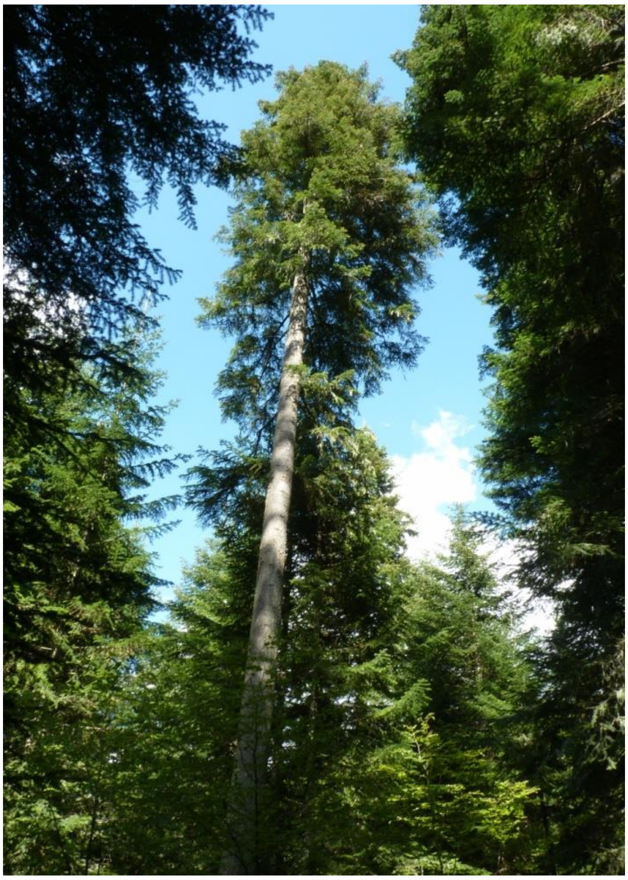


Figure 16. Natural Silver Fir forest in the beech forest belt

5.3. Forest stands description according to the composition

The forest stands according to the composition are divided into pure forest stands (in cases where the main forest tree species is represented with over 90% of the total number of trees in the forest stand) and mixed forest stands (in cases where the main forest tree species is represented up to 90% of the total number of trees in the forest stand).

Forest stands description according to the composition is presented in the Table 25.

Table 25. Overview of forest stands according to the composition

Composition	Area		Timber volume			Current increment			Average Increment		
	ha	%	m³	m³/ha	%	m³	m³/ha	%	m³	m³/ha	%
Pure forest stands	20,228.46	61.1	4,282,568	211.71	58.7	64,998	3.21	53.9	30,011	1.48	65.6
Mixed forest stands	12,896.64	38.9	3,007,666	233.21	41.3	55,569	4.31	46.1	15,720	1.22	34.4
Total	33,125.1	100.0	7,290,234	220.08	100.0	120,567	3.64	100.0	45,731	1.38	100.0

The data presented in Table 25 displays that out of the total forest area, 20,228 ha or 61.1 % are pure forest stands and 12,897 ha or 38.9 % are mixed forest stands. The pure forest stands have 4,282,568 m³ or 58.7 % of the total timber volumes, while the mixed forest stands have 3,007,666 m³ or 41.3 % of the total timber volume. The current increment in the pure forest stands is 3.21 m³/ha, while in the mixed forest stands it is 4.31 m³/ha.

The mixed forest stands have greater timber volume and higher current increment per unit area than pure forest stands.

The data presented in Table 26 displays that out of the total area under pure forest stands, 16,979.96 ha or 83.9 % are high-stem forest stands and 3,248.5 ha or 16.1 % are low-stem forest stands. In the pure forest stands, the greatest area or 49.2 % is occupied by the Beech, then 27.4 % by the pines, 15.5 % by the Hungarian oak, 4.7 % by the Scots pine, and 3.2 % by the Sessile oak. Most of the area in the low-stem forest stands or 61.6% is occupied by the Hungarian oak, then 28.4 % by the Beech, 8.6 % by the Sessile oak, 1.2 % by the Hazelnut, and 0.2 % by the Black locust. Most of the timber volume in the pure forest stands, or 2,789,679 m³, is concentrated in the pure high-stem beech stands, then in the pure pine stands or 624,261 m³, and pure Hungarian oak stands or 381,793 m³. Most of the timber volume in the pure low-stem forest stands is concentrated in the oak stands with 202,094 m³ and in the beech stands with 110,820 m³.

The pure beech stands have the highest current increment with 4.73 m³/ha, then the Scots pine stands with 3.50 m³/ha and Austrian pine stands with 3.0 m³/ha.

The current increment in the pure low-stem forest stands is considerably lower than the one in the pure high-stem forest plantations.

Table 26. Overview of the pure forest stands by species composition

Type of forest stand	**Area**		**Timber volume**			**Current increment**		
	ha	**%**	**m³**	**m³/ha**	**%**	**m³**	**m³/ha**	**%**
	Pure high-stem forest stands							
Beech	8,346.46	49.2	2,788,679	334.11	70.6	39,478	4.73	64.1
Hungarian oak	2,633.84	15.5	381,793	144.96	9.7	4,198	1.59	6.8
Sessile oak	540.14	3.2	89,320	165.36	2.3	915	1.69	1.5
Scots pine	801.00	4.7	64,687	80.75	1.6	2,802	3.50	4.5
Austrian pine	4,658.52	27.4	624,261	134.00	15.8	14,204	3.05	23.1
I. Total high-stem forest stands	**16,979.96**	**83.9**	**3,948,740**	**232.55**	**92.2**	**61,597**	**3.63**	**94.8**
Type of forest stand	Pure low-stem forest stands							
Beech	922.30	28.4	110,820	120.16	33.2	1,296	1.41	38.1
Sessile oak	279.40	8.6	20,914	74.85	6.3	274	0.98	8.1
Hungarian oak	2,000.00	61.6	202,094	101.05	60.5	1,831	0.92	53.8
Hazelnut	38.80	1.2	0	0	0	0	0	0
Black locust	8.00	0.2	0	0	0	0	0	0
II. Total low-stem forest stands	**3,248.5**	**16.1**	**333,828**	**102.76**	**7.8**	**3,401**	**1.05**	**5.2**
	Pure forest stands (high-stem + low-stem)							
III.Total	**20,228.46**	**100.0**	**4,282,568**	**211.71**	**100.0**	**64,998**	**3.21**	**100.0**

Table 27. Overview of the mixed forest stands by species composition

Type of forest stand	**Area**		**Timber volume**			**Current increment**		
	ha	**%**	**m³**	**m³/ha**	**%**	**m³**	**m³/ha**	**%**
	Mixed high-stem forest stands							
Beech-Scots pine	3,138.90	27.8	998,101	317.98	35.0	21,031	6.70	39.5
Beech-Austrian pine-Scots pine	296.40	2.5	92,404	311.75	3.2	1,796	6.06	3.4
Beech-Austrian pine	2,566.07	22.0	654,853	255.20	22.9	10,912	4.25	20.5
Beech-Austrian pine-Aspen	65.90	0.6	10,620	161.15	0.4	317	4.81	0.6
Beech-Austrian pine-others	66.94	0.6	16,155	241.34	0.6	301	4.50	0.6
Beech-Silver fir	33.30	0.3	9,734	292.31	0.3	172	5.17	0.3
Beech-Sessile oak-Aspen	210.99	1.8	58,607	277.77	2.1	869	4.12	1.6
Beech-Aspen	440.70	3.7	124,154	281.72	4.4	1,707	3.87	3.2
Beech-Sessile oak	1,427.83	12.2	333,937	233.88	11.7	4,436	3.11	8.3
Beech-Sessile oak-Hungarian oak	289.35	2.4	49,168	169.93	1.7	629	2.17	1.2
Beech-Sessile oak	661.18	5.6	130,948	198.05	4.6	1,765	2.67	3.3
Beech-Hungarian oak-Aspen	132.60	1.1	34,524	260.36	1.2	504	3.80	1.0
Beech-Common hornbeam	8.00	0.1	1,438	179.75	0.1	17	2.13	0.04
Austrian pine-Beech-Sessile oak	143.92	1.2	38,723	269.06	1.4	635	4.41	1.2
Austrian pine-Beech-Sessile oak-Aspen	192.90	1.6	47,877	248.20	1.7	881	4.57	1.7
Austrian pine-Sessile oak	85.49	0.7	8,556	100.08	0.3	212	2.48	0.4

Austrian pine-Beech-Scots pine-others	40.30	0.3	12,213	303.05	0.4	225	5.58	0.4
Austrian pine-Beech-Aspen	181.60	1.5	47,639	262.33	1.7	727	4.00	1.4
Austrian pine– Scots pine	1,046.62	9.0	106,457	101.72	3.7	4,235	4.05	7.9
Austrian pine – Norway spruce -Silver fir - Douglass fir - Birch	25.00	0.2	1,110	44.40	0.03	89	3.56	0.2
Scots pine – Austrian pine – Sessile oak – Hungarian oak	16.60	0.1	2,014	121.33	0.06	65	3.92	0.12
Scots pine – Macedonian pine	3.90	0.1	277	71.03	0.01	22	5.64	0.04
Sessile oak – Hungarian oak	333.20	2.8	41,737	125.26	1.4	861	2.58	1.6
Hungarian oak – Turkey oak	118.80	1.0	14,426	121.43	0.5	254	2.14	0.5
Douglass fir – Austrian pine – Scots pine	102.8	0.8	18,431	179.29	0.6	523	5.09	1.0
I. Total low-stem forest stands	**11,629.29**	**90.2**	**2,854,103**	**245.42**	**94.9**	**53,185**	**4.57**	**95.7**
Type of forest stand	Mixed middle-stem forest stands							
Beech-Austrian pine-other	26.41	4.0	4,832	182.96	5.7	89	3.37	6.4
Beech-Austrian pine	216.00	32.8	37,686	174.47	44.4	571	2.64	41.4
Beech – Austrian pine	118.90	18.0	26,994	227.03	31.8	296	2.49	21.4
Sessile oak – Austrian pine	168.30	25.5	10,255	60.93	12.1	258	1.53	18.7
Hungarian oak –Turkey oak – Austrian pine	129.60	19.7	5,108	39.41	6.0	167	1.29	12.1
II. Total middle-stem forest stands	**659.21**	**5.1**	**84,875**	**128.75**	**2.8**	**1,381**	**2.09**	**2.5**
Type of forest stand	Mixed low-stem forest stands							
Beech-Hungarian oak	247.10	40.6	27,418	110.96	39.9	341	1.38	34.0
Beech-Sessile oak	141.66	23.3	16,553	116.85	24.1	260	1.84	25.9
Beech-Common hornbeam	16.40	2.7	1,896	115.61	2.8	28	1.71	2.8
Beech-Sessile oak –Hungarian oak	50.20	8.3	6,028	120.08	8.8	90	1.79	9.0
Beech-Sessile oak -Aspen	114.60	18.8	12,901	112.57	18.8	209	1.82	20.8
Beech-Aspen	38.18	6.3	3,892	101.94	5.6	75	1.96	7.5
III. Total low-stem forest stands	**608.14**	**4.7**	**68,688**	**126.10**	**2.3**	**1,003**	**1.65**	**1.8**
	Mixed (high-stem + middle-stem + low-stem)							
IV.TOTAL	12896.64	**100.0**	3,007,666	233.21	**100.0**	55,569	4.31	**100.0**

The data presented in Table 27 displays that out the total area occupied by mixed forest stands, 11,629 ha or 90.2 % are high-stem forest stands, 659.21 ha or 5.1 % are middle-stem forest stands, and 608.14 ha or 4.7 % are low-stem forest stands.

Most of the area in the mixed high-stem forest stands or 27.8 % are Beech-Scots pine stands, then 22.0 % are Beech-Austrian pine stands, and 12.2 % are Beech-Sessile oak stands. Other types of mixed forest stands occupy less than 10 % of the high-stem forest stands total area.

Some mixed forest stands, such as: Beech-Silver fir stands, Austrian pine – Norway spruce - Silver fir - Douglass fir – Birch stands, Scots pine – Macedonian pine , Douglas fir – Austrian pine –Scots pine and part of Austrian pine and Scots pine stands, are raised artificially.

Mixed middle-stem forest stands occupy an area of 659 ha or 5.1 % of the total area under mixed forest stands. Most of them are Beech-Austrian pine stands or 32.8 %, and Sessile oak-Austrian pine stands or 25.5 %.

Mixed middle-stem stands occupy an area of 608 ha, and represent 4.7 % of the total area under mixed forest stands. Most of them are of Beech-Austrian pine or 40.6 %, followed by Beech-Sessile oak or 23.3 %, and Beech-Sessile oak-Aspen or 18.8 %. Other types of mixed forest stands occupy less than 10% of the total area under mixed forest stands.

Most of the timber volume of mixed forest stands is concentrated in the high-stem forest stands with 2854103 m³ or 94.9 %, then in mixed middle-stem forest stands with 84,875 m³ or 2.8 %, and least in the mixed low-stem forest stands with 68,688 m³ or 2.3 %.

Most of the timber volume of mixed forest stands is concentrated in the Beech-Scots pine forest stands with 998,101 m³ or 35 % of the total timber volume of mixed high-stem forest stands, then in the Beech-Austrian pine forest stands with 654,853 m³ or 22.9 %, and in the Beech-Sessile oak mixed forest stands with 333,937 m³ or 11.7 %. The share of other forest stands in the total timber volume of mixed forest stands is less than 5%.

Most of the timber volume of mixed middle-stem forest stands is within the Beech-Austrian pine stands with 37,686 m³ or 44.4 %, followed by Beech-Scots pine forest stands with 26,994 m³ or 31.8 %, and in the Sessile oak-Austrian pine stands with 10,255 m³ or 12.1 %.

Most of the timber volume of mixed low-stem forest stands is concentrated in the Beech – Hungarian oak stands with 27,418 m³ or 39.9 %, followed by Beech-Sessile oak stands with 16,553 m³ 24.1 % and in the Beech-Sessile oak-Aspen with 12,901 m³ or 18.8 %.

In terms of timber volume per unit area, Table 25 displays that the greatest timber volume is within the Beech-Scots pine mixed high-stem forest stands with 317.98 m³/ha, then Beech-Austrian pine-Scots pine mixed high-stem forest stands with 311.75 m³/ha, and Austrian pine, Beech, Scots pine and other high-stem forest stands with 303.05 m³/ha. The lowest timber volume per unit area is within the low-stem forest stands, as well as within the young middle-stem forest stands.

Forest stands that have the greatest timber volume per unit area at the same time have the highest current increment amounting to 6.70 m³/ha within the Beech-Scots pine mixed high-stem forest stands, then Beech-Austrian pine-Scots pine mixed high-stem forest stands with 6.06 m³/ha, and Austrian pine- Beech-Scots pine-other mixed high-stem forest stands with 5.58 m³/ha. This clearly indicates that these forest stands have the best quality structure. The mixed low-stem forest stands have the lowest current increment, and significantly lag behind the mixed high-stem forest stands and the few middle-stem forest stands occurring in the region.

5.4. Forests utilization

A separate plan for forests utilization is prepared as an integral part of the Specific plan for forest management of each forest management unit. This is included in the descriptive part of a Specific plan, and in the tabular part it is described in separate forms. Besides these, special logging maps are prepared for all units and sub-units and provided covered by the plan for forests utilization.

5.4.1. Plan for forests' utilization

The plan for forests' utilization consists of a logging plan and a plan for using other forest products.

5.4.1.1. Plan for major felling of forests

The logging type will be selected based on the silvicultural system, forest management, type of wood, age, goals of future management, type of stands, needs, opportunities to perform and other factors.

The main timber harvest in the region of Malesh is accomplished by performing the following logging types: group cutting, selective cutting, generative cutting and clear cutting.

Group and selective cuttings are performed in the high-stem uneven-aged forest stands, generative cuttings are performed in the high-stem even-aged, and clear cuttings are performed in the low-stem and degraded forest stands. Clear cutting areas can reach large dimensions of up to 100 ha and more (see beneath).

The main timber harvest (etat) for the high-stem uneven-aged forest stands are determined by control method, which is based on the total timber volume value, the increment, and the actual state of the forest. It is calculated according to the following formula:

Em = V x 0,0pk, where

V - is the total timber volume value,
pk - an annual intensity of use which value is 1 %

The intensity of use, is the total timber volume value in direct correlation with the amount of timber volume of 1ha and proportional to the size of it. Selective logging is applied by eliminating individual and group of trees. This type of logging is performed stepwise, as follows: first elimination of old, dominant, low quality, curved, branchy and diseased trees. The main timber harvest is realized from larger diameter classes (V, VI, VII and VIII), while amongst the smaller trees (lower diameter classes) only curved, repressed, and poor-quality trees are removed.
In the tabular part of the Specific plans for forest management, in form III (containing the plan for utilization and recording the uneven aged forest stands), forest stands are displayed where the grouped-selective logging should be applied. The allowed timber cut is shown

separately for each diameter class and in total for each forest stand. In the same way recording is done for the performed work.

Form III is used for planning and recording the quantities that should be realized with the application of selective cuttings. With selective management, the selection is done throughout the whole forest, in selective forest stands, by removing trees mainly from the higher diameter classes in order to obtain proper curve of forest stand, to encourage the regeneration, and to ensure increased diameter and height growth.

With selective logging in certain intervals, the most harvest ripened trees are removed, and followed by regeneration occurring in the open areas left post harvesting by the seeds coming from the surrounding trees. As a result of this regeneration method, uneven-aged forest stands are created, because trees are represented by different ages. As a result of various ages and sizes of trees, the canopy in the selective forest stands is vertical and staggered, such that these forest stands may be recognized from a distance. The regeneration process here is not limited in time, but it lasts and is continuous and all the mast years of the trees in the forest stand are used. It would be ideal to remove most harvest ripened trees each year, but this is practically only feasible in small area, while in large areas it is hardly feasible and economically not justified. Therefore, the whole forest complex is divided into smaller sections, so that the logging is performed only to a certain portion of the forest each year, and from this part, logging is done for the overall allowed timber volume across the entire forest complex. Depending on the number of sections, the rotation (turnover) period will be determined. In terms of intensive management, the rotation period is 10 years, and 20 years in a situation of extensive management (higher logging outputs per rotation).

Taking into account the general practice of forest management in the region of Malesh, the turnover is 20 years.

In the high-stem uneven aged forest stands, the selective logging is performed in 3 or 4 occasions and over a longer period, typically 20 years. The purpose of this method is to stimulate quality natural regeneration from the seeds of selected trees. Felling is planned to respect the convenient moment to remove seed trees, when protection of seedlings by the old trees will not be needed anymore. The removing of old forest stand with selective logging is done through the following cuts: preparatory cut, generative cut, additional cut and final cut.

The regeneration process starts with the preparatory cut. It is performed on 30% of the trees in a high forest stand. The selection is done through marking of curved, diseased and broken trees from class V according to Kraft, and part of the most dominant trees of class I according to Kraft. With the removal of these trees, better conditions for fructification are created for those trees that remained in the stand.

Several years after the preparatory cut is done, it is followed by the generative cut. Carefully another 50% of the remaining trees in the stand are cut. When selecting trees, special attention is paid to mark the most quality trees that belong to class II according to Kraft. Here, special attention is paid to the spatial arrangement of trees, which should be balanced. In cases where good site conditions prevail and where there is no problem with regeneration after the generative cut was done, the final cut is done. However, quite often there is a need to perform an additional cut, which will further open-up the forest stand and it will continue with the protection of young seedlings by the stem stand. This cut aims at removing 50% of the trees that remained after the generative cut.

The regeneration process ends with the final cut, which removes the remaining trees from the stand. It is performed after the natural regeneration is fully established, and when the young trees will be about 1 meter height. This is the case because later cutting of the remaining trees will cause major damage to the offspring.

With this type of logging, Beech and the Austrian pine pure even-aged forest stands should be regenerated.

The tabular part of the Specific plans for forest management, in the form III-a (containing the plan for utilizing and recording the even-aged forest stands), displays the stands where generative cut should be performed. The allowed timber cut (i.e. the allowed amount for logging) is shown separately for each sub-unit, management class and total for each forest stand. In the same form, the recording is done for all performed work. Form III-a also shows the forest stands where the clear cuttings should be performed, as well as their quantities and recordings. The allowed timber cut (i.e. the allowed amount for logging) is shown separately for each sub-unit, management class and total for each forest stand.

Clear cutting, as a method for natural regeneration, is applied in the low-stem and degraded forest stands and also as a sanitary felling. The terrains, where the clear cutting is applied, are mild to moderately steep, so there is no danger of erosion.

The allowed timber cut for the forest stands, in which the clear cutting is performed, is determined by the Surface method according to following formula:

$E = P / Yx10$ where,

P - is the area of subclasses,
Y - is the turnover of stands and it is 50 years.

On the terrains in the region of Malesh, the clear cutting is usually performed on large areas of up to 100 ha. Other types of clear cutting, such as: clear cutting in the shape of circles, in the form of fields or in the form of lines are not applied. It is mainly due to economic reasons in the logging works.

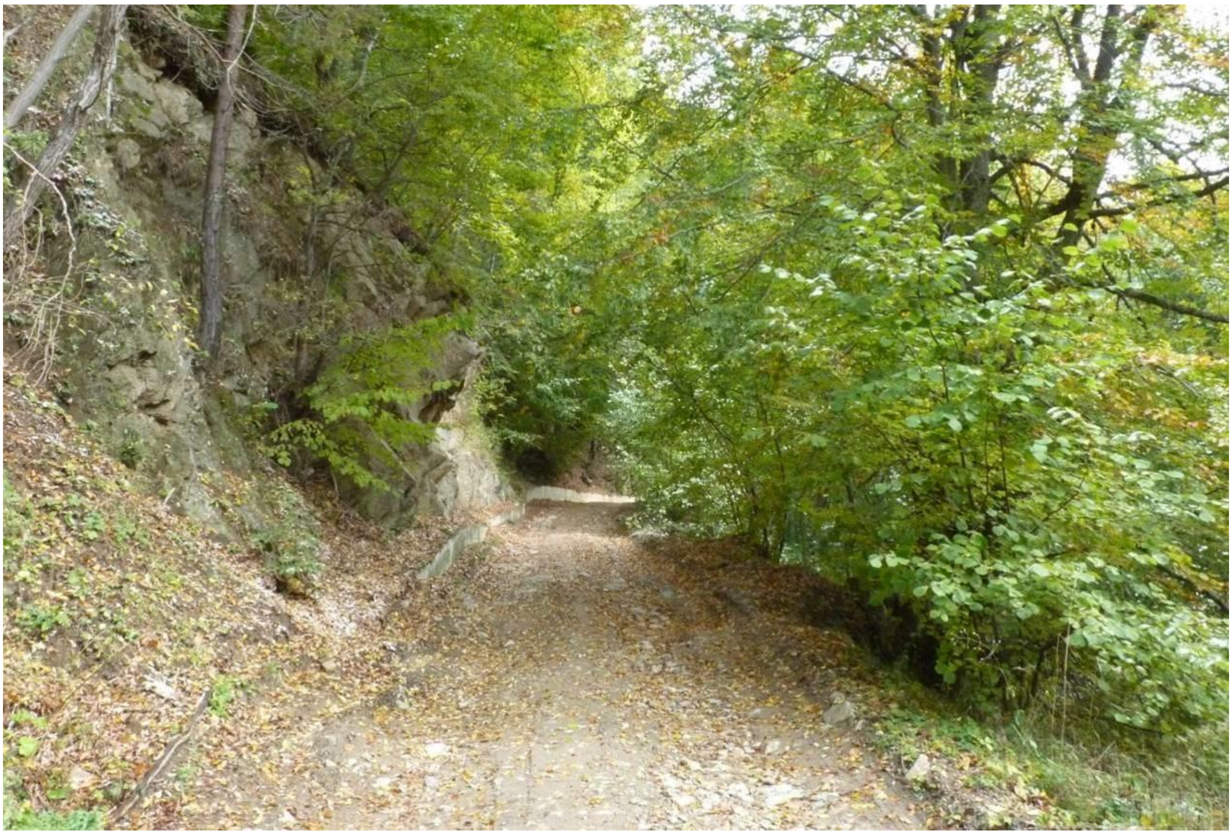


Figure 17. Forest trucks road at the locality “Ramna reka”

5.4.1.2. Plan for thinning

Thinning is an operation that reduces the number of trees growing in a stand with the aim of promoting the development of the remaining trees in a forest stand. The goal of thinning is to control the amount and distribution of available growing space. The altering of the stand density can influence the growth, quality, and health of residual trees. It also provides an opportunity to capture unhealthy or dead trees and remove the commercially less desirable, usually smaller and malformed, trees. Unlike regeneration treatments, thinning are not intended to establish a new tree stand or create permanent canopy openings. Mainly three types of thinning are used: low, high and selective.

With low thinning, the trees are extracted mainly from the existing floor. Stands cultivated with this method have a special look, because they have a horizontal canopy, thus creating one level forest stands.

With high thinning, the trees are not only removed from the existing floor, but also some living trees of IV and V class are left. The trees of group IV and V are left in the stand, on one side to protect the soil from weeds, and on the other side to clean the branches of the trees from the top level. Thus, the stand gets the look as it is composed of 2 and 3 levels. The trees from the existing floor facilitate the proper development of selected trees.

Selective thinning is performed in the selective forests. Selective forests are those where there are trees of all ages, from the youngest to the oldest. This method aims to help young well-developed trees that are overshadowed by others, to develop quicker and mature for harvesting.

The intensity of performing the thinning depends on many factors, which are interlinked and dependent on each other. Thinning intensity depends on: the state of the stand, the stand composition, shape, density of trees, age, site production capacity, timber demand, the transport conditions, the available labor force and other. It is therefore very difficult to specify the thinning intensity because it depends on many factors that need to be taken into consideration. Based on the specific requirements, the thinning intensity should be determined for each different forest stand.

For the forest stands in the region of Malesh, the thinning intensity ranges from 15 to 30% of the timber volume.

The thinning, as a basic silvicultural measure in the Specific plan for forest management plans, for each forest management unit are planned through a separate Plan for thinning and records of completed thinning contained in Form-V, as part of a Specific plan for forest management.

5.5. Determination of final turnover (age at which trees are removed)

The final turnover is a period of tree stand creation up to harvest maturity. Depending on the type of trees and silvicultural form, it is determined by Article 36 of the Rules of making special plans for forest management. For high-stem, even-aged forest stands, the turnover for some forest tree species is: 120 years for the beech, 100 years for the Scots pine and Austrian pine, and for the low-stem (coppice) forest stands it is 50 years.

5.6. Plan for the use of non-timber forest products

An integral part of a Specific plan for forest management is the Plan for the use of non-timber forest products. This plan anticipates the use of all other forest products that can be gathered from the forest management unit, such as fungi, herbs, cones, berries and others. They are specified in a special Plan for the use of non-timber forest products which represents an integral part of a Specific plan for forest management. The quantities and types of non-timber products that are planned for collection, are recorded in the Form-IV of this Plan.

5.7. Plan for silviculture (tending)

With the plan for silviculture, the place, the scope and intensity of work associated with the silvicultural (tending) measures are determined.

To improve the stand quality, it is necessary to implement appropriate silvicultural (tending) measures from a very early age, and also to implement protection from biotic, abiotic and zoo-anthropogenic damages.

This plan defines the measures for: reforestation, seeding, trimming, production of seeds and seedlings, silvicultural and sanitary felling and forest regeneration.

The planned activities are contained in a separate Plan for silviculture (tending) and records of the performed silvicultural work in the Form-VI, which is part of the Specific plan for forest management.

The sanitary cuttings are generally applied in situations when cleaning up the burned areas and areas that are affected by drying of the parts of stands (particularly for the Scots pine stands).

Sanitary cuttings are applied for removal of all trees damaged by fire and all those that have a reduced vitality or in a withering phase. These trees are removed as they pose a potential danger to the occurrence of various fungal diseases and increased occurrence of pest activity.

The Plan for silviculture (tending) also defines the protection of forest stands and natural regeneration of domestic and wild animals, which prohibits the grazing in parts of the forest that is in the regeneration phase.

6. FORESTS VULNERABILITY (FOREST HEALTH CONDITION)

Plant diseases have so far caused extensive damage and forests dieback, and to a lesser extent, are always present in the region of Malesh. Notable is the appearance of small wounds and decay on the beech trees and drying of branches as a result of physiological weakened trees.

Almost every year there is a regular occurrence of mistletoe on the oak and dieback of Scots pine stands around the artificial lake of Berovo.

The following are the most frequent causes of disease in the forests of region of Malesh:

Microsphera alphitoides, syn. ***Microsphera querciana,*** which attacks the leaves and young shoots of the oaks. It occurs early in May, on both sides of the leaves, with a light colour. The disease occurs in the form of mosaic spots with varying sizes. During its development, the disease physiologically weakens the tree which reduces in growth.

Enomonia quercina, spots on the oak leaves – it acts together with powdery mildew and causes defoliation, or within one month causes a full defoliation, which reduces the growth of the trees.

Armilaria mellea, root rot, attacks the roots and organic litter, both from broadleaf or coniferous tree species. The symptoms of infection appear in the crowns of infected trees as discoloured foliage, reduced growth, dieback of the branches and death. The most damage is caused on pine stands at the age of 5-10 years.

Fomes fomentaria, tinder fungus. The species produces very large polypore fruit bodies which are shaped like a horse's hoof and vary in colour from a silvery grey to almost black, though they are normally brown. It grows on the side of various species of tree, which it infects through broken bark, causing rot. The species typically continues to live on trees long after they have died, changing from a parasite to a decomposer. It often affects beech, hornbeam and poplar, and causes the decay and destruction of the trunk.

Trametes radciperda, rot - attacks pines of all ages. In early age, the attacked individuals quickly dye out, while the old trees remain. Typically, it attacks the root and lower part of the trees and it penetrates in the trunk. The occurrence of resin around infected places as an indicator of infection from this fungal disease. This parasite often occurs in coniferous forests.

Trametes pini, red rot on pines – it attacks all coniferous species, but mostly pines. It occurs in mechanically damaged places or broken branches, and causes decay of tree trunks.

Lophodermium pinastri, needle cast disease – it attacks mostly the Scots pine trees. The fungal spores disperse and infect the pine needles in late summer, which turn brown by the following spring and then fall off, thus physiological weakens the tree.

Dothistroma pini, needle blight - this disease first causes yellow and tan spots on needles that later turn red. The needles start dying from the top to the bottom of the tree, so that the entire stands receive a reddish colour. The needles begin to fall off the following year, which reduces the number of assimilation organs, thus physiologically weaking the tree.

Genangium ferruquinosum, pine branches dieback - this fungus attacks the terminal and side buds, then it expands on branches, where it damages the pine shoots. It causes mass dieback of pine stands.

To protect forests from fungal disease, the following measures are taken:

- Preventive measures consist of the production and use of healthy planting material, establishing mixed forest stands of coniferous and deciduous tree species, proper forest management, maintenance of forest order and others.
- Direct measures consist of removing diseased trees, or parts of these trees, and in case of mass occurrence, the use of chemicals.

Besides the harmful phytopathological effects on the forests in the region of Malesh, there are also pests that causes damage. These are various types of insects, which with their harmful action, are causing major damage to forests, especially after fires and if their appearance is with calamity.

The most common pests that causes of damage in the forest are:

Lymantria dispar, gypsy moth - is one of the most destructive pests of hardwood trees at the stage when caterpillars consume the leaves, and branches remain bare. With this, the assimilation apparatus is completely destroyed, so the tree growth is slowed and brought into a state of stagnation.

Euproctis chrysorroea, brown tail – same as the gypsy moth, it is harmful in the phase of caterpillar that feeds on the leaves of oak, and makes nets where it stays over the winter. The following spring it attacks the buds and shoots again, thus preventing their growth.

Taumatopea proccesionea, oak processionary – it damages the older trees. It is known by the white, silken webbing nests and trails, which caterpillars are building on the trunks and branches of oak trees. It makes the nests in the leaves and branches where it spends the day, while overnight it consumes the leaves. Physiologically weakens the trees and thus reduces the growth.

Tortrix viridana, oak leaf roller - this insect makes a lot of damage. It is a distinctive green moth

with larvae that feeds on tree leaves, especially oak. An infestation of the larvae can defoliate an oak tree. The adult female lays its eggs next to leaf buds which the larvae consume when they emerge. As the larvae grow bigger, they eat larger leaves and then roll themselves up in a full-sized leaf to pupate.

Platipus cylindrus, oak pinhole borer - This insect attacks the trunk making radial and vertical corridors. With its growth, the larva extends the corridors, which in turns reduces the value of technical timber. It also attacks the lumber in the warehouses.

Orhestes fagi, beech flea weevil - It makes small passageways in the leave mesoderm as larva, and in the imago stage, it makes small holes in the leaves.

Evetria buoliana, Pine shoot moth – it attacks pine stands at the aged of 3-15 years. It has a yearlong generation. The female lays eggs in the loops of needles or buds. The host plants of the larva include pines, like Pinus silvestris and Pinus nigra. It damages the central shoot of young trees, dies off, later one of the lateral shoots takes its place, resulting in a permanent "S"-shape in the tree trunk.

Thaumatopea pitiocampa, pine processionary – it is one of the most destructive species to pines. The urticating hairs of the caterpillar larvae cause harmful reactions in humans and other mammals. The species is notable for the behaviour of its caterpillars, which overwinter they live in tent-like nests high in pine trees, process through the woods in nose-to-tail columns, protected by their severely irritating hairs It usually attacks the pine stands with light canopy, and those that grow on poorer soils.

Diprion pini, pine sawfly - mostly attacking the pine stands. The damages are made in the stadium of caterpillar, which consumes the needles. A generation develops during one season in the same calendar year.

In case of outbreaks, there are three ways of control, such as a mechanical way by removing their nests and incineration, chemical treatment with chemical means in certain stages of development and biological control by release of the gregarious cocoon parasitoid. In practice, in the region of Malesh, mechanical and chemical means are used to control this pest. To prevent the pest outbreaks or mass of insects, preventive measures are taken that consist of regular monitoring of the development of the insect populations.

In order to protect the forest, a Plan on forest protection is elaborated as integral part of the Special Plan for Forest Management Plan.

This plan consists of a Plan on forest protection from plant diseases and pests and a Plan on protection of the forest from fires. In order to enhance a preventive action in Form-IX of the Specific plan on forest management, all stands with higher degree of endangerment are listed. This is done by Rules on special measures for protection of the forest from fires (Official Gazette of RM No. 69/2001).

It is of special importance to the forest health to monitor all changes related to: natural disasters, the occurrence of pests and diseases, illegal logging, the occurrence of extreme temperatures, fires and other phenomena that affect the health of the forest. For this purpose, in Form-X of the Specific plan on forest management there is a record of all mentioned phenomena.

7. FOREST CONSERVATION

7.1. Seed stands and seed orchards

The improvement of forest trees reflect the results of the evolutionary process directed by the man towards his purposes. The tree improvement process is based on the targeted use of genetic diversity through the selection process, which is to redirect its desirable characteristics through the process of conservation of individuals with specified characteristics. The goal of tree improvement is creation of adaptive reproductive material that will produce high-quality individuals.

The techniques of tree improvement, such as modern selection, tree improvement and selection methods, are important in the quest to improve the economic and environmental characteristics that are of interest to us. Important technical advances in the improvement of forest trees, which has been developed in recent years, are mainly focusing on the effective formulation of field trials, the effective cross generations of advanced processing, and many specialized techniques and tools for evaluating the characteristics of economic or environmental interest. It is believed that the program for selection, tree improvement and testing, represent the simplest and most efficient methods for improvement of forest trees that can meet the goals of conservation and cultivation in some realistic time frames. In most cases, only one generation of selection and testing can meet most of the goals, and the program can continue with the next consecutive important species.

It is well known that forestry will increasingly be pushed to sites with poor soil quality, due to the growth of the population on Earth, the growing demand for quality land for crops and conversion of land in urban areas. Therefore, we have to find different species and populations of trees that are adapted to these marginal habitats. By testing tree species and provenances, the tree improvement programs will aim to produce different populations of trees that can be adapted to different climate and soil conditions. This will have to develop new dimension for planning and management of forest genetic resources. The only way to achieve this is to have access to a wide range of genetic diversity, with relevant information on the distribution of species, genetic variability and understanding the biology of the species. In this sense, the research will continue to be an important part of our ability to manage forest genetic resources in the future. When it comes to the species which can initiate any type of research, whether in terms of molecular genetic research, either within or between the species research that will develop some good tree improvement opportunities, we may need to focus on maintaining the increment and production of wood instead of the conventional goal of improving and optimizing the increment. For example, a marginal improvement of certain properties, such as survival or resistance to pests, it may be important to improve growth.

In practice, there are different strategies for conservation of forest genetic resources. *In situ* (on-site) indicates the conservation and continued maintenance of the population in an environment where they are originally developed on the assumption that it is adapted to the site conditions (Frenkel 1976). This type of protection is commonly applied to wild populations that regenerate naturally in protected or managed forests, but also to artificial regeneration during sowing or planting without direct selection in the same area where the seed was collected. This form of conservation of genetic resources is probably the most important strategy, and sometimes the only viable approach. This is especially evident in developing countries, where resources allocated for conservation are small and lacks basic data for tree species and their distribution. In situ conservation is usually used as a strategy to preserve most of the wild plant species, and includes some of the wild relatives of crops, since it allows the covered populations to continue to be subject to evolutionary processes.

The advantage of in situ conservation is its function to preserve the ecosystems, and not only the species or genes. This means that programs for in situ conservation of selected species often result in successful conservation of a number of related animal and plant species. Most species cannot be conserved in ex situ gene banks or plantations due to biological and technical constraints and limited resources. Therefore, conservation of plant genetic resources multitude in the world relies on in situ conservation. At the beginning, it should be noted that in situ conservation of forest genetic resources relies mainly on gene reserve or genetic conservation of forests. In both cases, they have no direct connection to the system of strict nature protection. It should also be emphasized that the genetic conservation of forests is not much different from regular forest management. There are only three key requirements:

1. In accordance with the Pan-European minimum requirements for recognition of the area of forest genetic conservation of trees, each registered unit should be officially recognized by the competent national authority.

2. The minimum area is 1 hectare. The smaller area is allowed in case of rare, endangered and extremely valuable local populations.

3. Natural regeneration. If natural regeneration fails for any reason, it is allowed the use of reproductive material from the same unit for genetic conservation. Seedlings from natural regeneration of other parts of the same unit can be used for this purpose. Buffer zone: in order to prevent genetic contamination, only reproductive material originating from local provenance area can be used in the border of the area of genetic conservation site.

7.2. *In situ* conservation of genetic resources in managed forests

In situ conservation of forest genetic resources includes the following activities:

- Setting priorities by identifying priority genetic resources, usually at the species level. This should be based on current or potential socio-economic values of species and their conservation status of important ecosystem level.
- Determination of overall genetic structure of priority species.
- Assess the current level of protection of certain species and their populations.
- Identify specific priorities for conservation, namely, the individual species level population, and groups of species in the ecosystem, including identification of the geographical distribution of populations, which is included in the conservation.
- The strategy of conservation and identification of protection measures - Biological and economic options.
- Organization and planning of specific conservation action.
- Terms and development of guidelines for management.

Practical experience displays that the management of genetic resources involves two strategies that partially overlap, such as: management of natural forests, which pays attention to their genetic resources, and the establishment of a network of smaller areas for the conservation of genes, and other strategies. It does not mean that all species should be included in conservation of genetic resources in all natural and commercial forests, or in all forests under protection. To find balance and synergy between these two approaches is a challenge. This will depend on biological factors (composition, distribution and ecology), as well as current and future use of forests. In both types, special areas may be established for specific genetic resources. In addition, the general principles of management of natural forests and protected areas should take into account the protection of genetic resources.

Strategy 1. Sustainable management of natural forests which in practice leads to in situ conservation of genes. The majority of forest genetic resources can be conserved in managed natural forests, in specially designated areas for genetic conservation. It is therefore important to forest owners and those who run them, are well informed about how they can save, manage and benefit from forest genetic resources in managed natural forests.

Strategy 2. Protected areas as a key component of the program for conservation of forest genetic resources. In most countries, there is established network of protected areas. However, protected areas do not provide automatic conservation of forest genetic resources. First, there might be a lack of adequate representation of important populations. Second, sustainable populations may be present, and the usual changes may, without appropriate management measures to affect the species chosen for conservation. Protected areas often create "backbone", which later can form more specific networks of certain stands for conservation of priority species, including species that are not commercial.

7.3. *Ex situ* conservation and use of forest genetic resources

Ex situ conservation of genetic resources of forest trees mainly deals with causing and maintaining as much as possible genetic variability within and between populations of selected tree species. Forestry experts should greatly intervene when it comes to the process of *ex situ* conservation in any form of simple collections of seeds, storage or planting in the field or more intensive improvement of plants and better access. Unlike of improvement and selection of agricultural crops, forest trees improvement cannot also quickly produce a new variety, nor can quickly create a race for existing variations between populations. Therefore, the existing genetic variability in populations is important and fundamental to the conservation of forest genetic resources, particularly because it can affect the long-term maintenance of genetic diversity in viable populations. Special attention should be paid to the preservation of genetic variability within a species in the peripheral or isolated populations, in order to manifest a higher level features, such as resistance to drought, tolerance of different soil conditions (Sterne and Roche 1974), or features that will help protect from future climate change (Muller-Starck and Schubert 2001).

For a detailed program on the conservation of genes, it will be necessary to combine in situ and ex situ conservation. However, there are many situations in which ex situ conservation becomes the focal point of gene conservation programs. This is an extremely important component of many plans for conservation and gene networks for most species, but may also play an important role in forest trees.

Important facts for ex situ conservation of any wood species are:

- to be an important backup measure, if all other measures of *in situ* protection are impractical or unavailable,
- to ensure that a wide range of variability (phenotypic and genotypic) be available for species that are in the process of conservation, and
- to manage the regeneration beyond the scope of its original nature (origin), in a more controlled manner.

Available resources can play a key role when it comes to setting the strategy for the development of any program for ex situ gene conservation. Due to lack of technology and resources to evaluate a number of genetic variations available within, or populations, ex situ collections are mainly based on collections representing populations from different ecological regions or zones, as well as individuals within these populations, may represent typical or specific phenotypic variation in morphological traits. While it is desirable to take samples from populations for which we have knowledge of the species genetics, many of the principles of taking genetic samples are strong enough to capture the genetic diversity without such knowledge and previous data. In addition, different types of tissues or seeds that can be collected and then stored, archived, or sawed, play an important role in the ability to maintain an ex situ conservation of genetic diversity.

7.4. Forest ecosystems and tree species for which there is already some degree of *in situ* and *ex situ* protection

By applying mass selection in the natural stands from 1960 – 1970, on the territory of the Republic of Macedonia, seed orchards of major commercial tree species were established.

In the region of Malesh, in that period, 2 seed orchards were established, and their basic characteristics are presented in Table 28.

It should be noted that some of these seed stands don't exist anymore, or their area is reduced, due to non-compliance of forest enterprises that managing them with the prescribed norms and due to the long period of time.

The new Law on reproductive material of forest trees (Official Gazette of RM No. 55/07) and the Rules on the conditions for the recognition of basic material types, which came into force in 2007, started the re-registration of old seed stands and registration of new seed stands.

Table 28. *In situ* conservation of forest ecosystem by selection of seed stands in the region of Malesh (1960-1970)

No.	Municipality	Number of seed stands	Area (ha)	
			Total	Reduced
1.	*Pinus nigra* – Austrian pine			
	Berovo	3	38.5	24.0
	Pehchevo	1	10.0	8.0
	Total Austrian pine:	**4**	**48.5**	**32.0**
2.	*Pinus silvestris* – Scots pine			
	Berovo	2	21.0	16.8
	Pehchevo	1	5.0	4.0
	Total Scots pine:	**3**	**26.0**	**20.0**

Under this law, seed stands should satisfy the conditions for the recognition of basic material for getting SELECTED stand, by the following criteria:

- Seed material must have a determined origin.
- No stands should be near, or at a distance of 200 meters, which are dominated by trees with undesirable phenotypic characteristics.
- A seed stand should have an area greater than 1 hectare.
- A seed stand is composed of trees of that age, when they have regular seed production.
- Phenotypic characteristics of trees in seed stands to be assessed by collecting data, which will confirm the existence of a normal level of uniformity or small individual variability in terms of evaluating morphological features.
- Seed stand should be adapted to the environmental conditions, prevailing in the given climate-vegetation-soil area.
- Seed stand should have a good health condition.

- Seed stand productivity, or its timber volume, is higher than the average of the remaining trees in the stands of same species with similar ecological and management conditions.
- In the seed stand prevail trees with excellent morphological characteristics.

Seed stands in the region of Malesh which are proposed for re-registration or new registration, i.e. they are registered or are in the stage of registration under the Law on reproductive material of forest trees and the Rules on the conditions for the recognition of basic material types, are given in Table 29.

Table 29. Seed orchards in the region of Malesh

No	Municipality	Species	Elevation	age years	Forest Management Unit	section	total area (ha)	seed stand area (ha)
1.	Pehchevo	Douglass fir	1,030-1,225	46	Bukovik Bajaz Tepe	126 a	40.8	0.5
2.	Pehchevo	Douglass fir	1,060-1,110	35	Bukovik Bajaz Tepe	125 b	2.0	1.2
3.	Pehchevo	Larch	1,030-1,190	37	Bukovik Bajaz Tepe	125 a	28.0	0.1
4.	Berovo	Scots pine	1,190-1,250	-	Maleshevski planini 2 - Ratevska reka	38 b	8.6	4.0
5.	Berovo	Sessile oak	700-950	85	Maleshevski planini Obeshenik	69 a	24.7	4.5
6.	Berovo	Austrian pine	920-1,250	85	Maleshevski planini Gubenec	18 a	49.7	3.5
7.	Berovo	Scots pine	1,300-1,356	85	KO	-	-	16.5
8.	Berovo	Austrian pine	1,020-1,238	-	Maleshevski planini Obeshenik	17 a	40.0	5.0
9.	Berovo	Sessile oak	770-940	96	Maleshevski planini Obeshenik	61 a	10.5	3.0
10.	Berovo	Beech	1,140-1,300	-	Ograzhden	20 a	13.6	3.5
11.	Berovo	Douglass fir	1,140-1,300	35	Ograzhden	17 b	2.1	2.1
12.	Berovo	Silver fir	1,300-1,350	-	Maleshevski planini 2 - Obeshenik	26 b	8.3	4.0
13.	Berovo	Beech	1,140-1,330	100	Maleshevski planini Gubenec Paruca	54 a	66.8	6.0
14.	Berovo	Beech	1,210-1,440	-	Maleshevski planini 2 -	37 a	60.2	3.0

					Ratevska reka			
15.	Berovo	Beech	1,160-1,360	-	Maleshevski planini 2 -	68 a	34.4	8.0
16.	Berovo	Beech	1,160-1,360	-	Ratevska reka	34 a	69.5	4.0
17.	Berovo	Scots pine	1,160-1,365	-	Maleshevski planini 2 -	32 a	53.4	4.0
18.	Berovo	Austrian pine	920-980	55	Bregalnica	19 v	-	5.0
19.	Berovo	Austrian pine	900-1,083	60	Bregalnica	45 a	-	8.0
20.	Berovo	Scots pine	1,250	40-90	KO Dvorishte	-	-	-
21.	Berovo	Scots pine	1,190-1,250	30-80	Maleshevski planini 2 -	38 b	8.6	4.0
22.	Berovo	Beech	1,160-1,360	20-100	Ratevska reka	68 a	34.4	5.0
23.	Berovo	Austrian pine	920-1,060	85	Maleshevski planini Gubenec Paruca	18 a	49.7	5.0

With a total number of 23 seed stands, of which most are registered and others are in the process of registration, and a total area of 100 hectares in the region of Malesh and within the Republic of Macedonia, is the largest and most significant forest stands area for *in situ* conservation of genetic resources in managed forests, which should provide the greatest amount of quality reproductive genetic material with good features for the needs of forestry in the country.

The future management of these seed stands by the subsidiaries of PE Macedonian Forests in Berovo and Pehchevo will be a very important aspect. Through the principles of sustainable forest management, the selective thinning should be performed in these seed stands. With the thinning, the opportunity is given for the development of dominant trees, and removing the damaged trees that impede the development of quality and healthy trees called "trees of the future." They inevitably have to be removed from the seed stand, because their negative features, through pollination of trees in the stand, will be passed on to offspring, thus seeds containing properties both from good and bad phenotypes will be received, and while the goal is to get reproductive material (seeds) only with good genetic traits. Besides this, in the seed stand we remove any trees that have no meaning in any future development. These include dry, diseased, and physiologically weakened trees, which can contribute to diseases appearance.

It is also necessary to demarcate the border trees with a straight yellow line at chest height. Every tree on the border, at a distance of about 20 meters, is marked.

A panel table should be set at the seed stands approach with the following data: tree species name (Latin/scientific and common name), the type of parent material, origin, provenance, area, altitude and year of entry in the register of recognized basic material in the country.

Figure 18. Registered seed stand of beech *Fagus moesiaca* on the locality Prevedena, FMU "Ograzhden" – Berovo

Figure 19. Registered seed orchard of Austrian pine *Pinus nigra* on the locality Sveti Ilija, FMU "Bregalnica" - Berovo

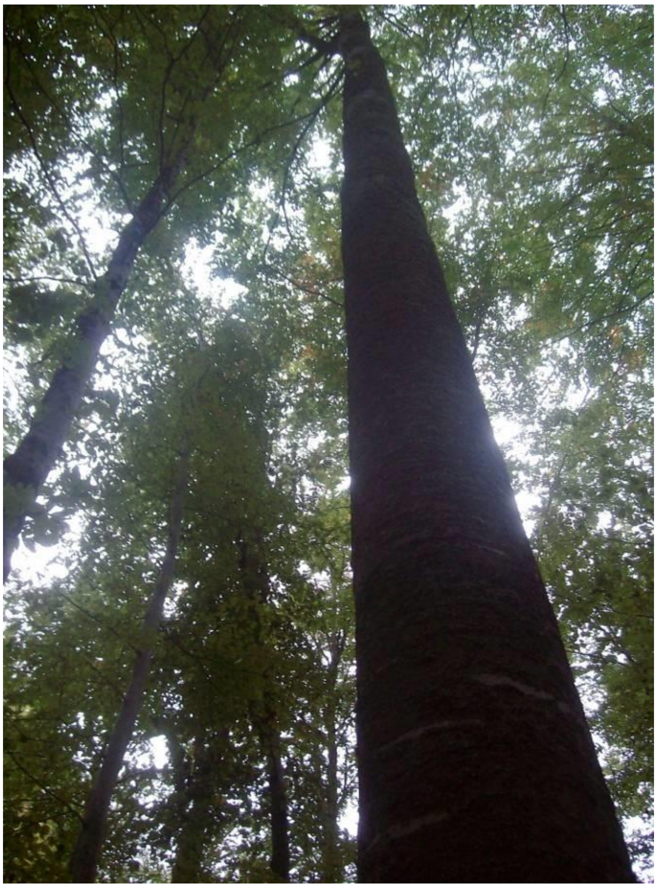


Figure 20. Parental candidate tree for obtaining qualified reproductive material in the registered seed stand of Beech, *Fagus moesiaca*, on the locality Vlatishte Klepalo, FMU "Maleshevski Planini II – Ratevska Reka" – Berovo

Figure 21. Parental candidate tree for obtaining qualified reproductive material in the registered seed stand of Sessile oak, *Quercus petraea*, on the locality Bezgashtevo, FMU "Obeshenik" - Berovo

The individual selection in the region of Malesh started in 1962, by selecting the "plus" trees of Austrian pine as the most important commercial conifer species in the country.

The selected plus trees of Austrian pine with their basic characteristics are presented in Table 30.

Table 30. Selected "plus" trees of Austrian pine with individual selection

No.	**Mountain range**	**Municipality**	**Locality**	**Number of "plus" trees**	**Height (m)**	**Chest diameter (D 1.30 m)**
1	Maleshhevski	Pehchevo	Mal Trebomir	10	31 - 36	39 - 60
2	Maleshhevski	Berovo	Dabovec	14	27 - 40	46 - 67

Figure 22. Generative seed orchard of Austrian pine

In 1987, the first generative seed orchard was established for *ex situ* genetic conservation of genetic resources of Austrian pine in the country, with an area of 1 hectare of the locality Obozna in Berovo.

Along with the Austrian pine in the region of Malesh, an individual selection was performed on Scots pine by selecting the "plus" trees, which are shown in Table 31.

Table 31. Selected "plus" trees of Scots pine with individual selection

No.	Mountain range	Municipality	Locality	Number of "plus" trees	Height (m)	Chest diameter (D 1,30 m)
1.	Maleshhevski	Pehchevo	Ravna Reka	10	31 - 35	40 - 50
2.	Maleshhevski	Pehchevo	Mal Trebomir	5	33 - 46	42 - 60
3.	Maleshhevski	Berovo	Klepalo	11	34 - 39	36 - 58
4.	Maleshhevski	Berovo	Crnovo	14	29 - 39	36 - 48

Figure 23. Vegetative (clonal) seed orchard of Austrian pine

Figure 24. Scots pine selected “plus” tree on the locality “Ramna Reka”

In 1978, on the locality Izgorela Baraka – Djami Tepe, Berovo, and the first generative seed orchard was raised with an area of 5 ha, from the generative offspring of 20 "plus" trees from the Malesh and Mariovo provenance, i.e. genetically most quality and most superior trees of this species in Macedonia.

The same year, the first vegetative seed orchard of Scots pine was raised on the locality Groshec, Berovo, with an area of 2.5 ha, from clones of the same 20 "plus" trees, of which the generative seed orchard was raised.

Currently these seed orchards are in a phase of re-registration under the new Law on reproductive material of forest trees and the Rules on the conditions for the recognition of basic material types.

With their re-registration in the region of Malesh we will have the most important and largest seed orchards area of Scots pine and Austrian pine within the Republic of Macedonia for *ex situ* conservation of forest genetic resources, which should give the best quality material with the best reproductive genetic characteristics and potential for the forestry in the country of the two most important commercial conifer tree species. Therefore, in the future, a very important aspect will be the management of these seed orchards and the subsidiary PE Macedonian Forests in Berovo will be charge for this.

Figure 25. Vegetative (clonal) seed orchard of Scots pine

Figure 26. Grafted tree of Scots pine in the vegetative (clonal) seed orchard

7.5. Description of the old (virgin) forests without significant disruption

Up to now, on the territory of the Region of Malesh there have been no selections of old (virgin) forests or forests with high value. An exception makes only the locality Murite, where according to the Law on Nature Protection, this locality was declared a national monument. There have been more such forests in the past, but they have not received adequate treatment and concern for selection or protection. Therefore, they are subject to regular forest management activities because they are turned into classic management forests. However, in some parts, fragments (scraps) of such forests can still be found and they should receive appropriate treatment. A particular problem is that the Regulation on the content of specific plans for forest management, Special plans for silviculture and protection of forests and Annual Performance Plans (Official Gazette of RM no. 48/98) are not providing selection of such forests because they are not recorded during the preparation of these planning documents. Therefore, it is necessary to conduct field research and to identify certain locations that have remained without a significant human impact, and meet the criteria for virgin forests and select them as such.

Figure 27. Old beech forest at near Trebomir River

7.6. Guidelines for ecosystem-oriented forest management

Ecosystem sustainable forest management (also called naturalistic forest management) is a multipurpose forest management, which aims to ensure that the capacity of forest products and services do not decrease over time (FAO 1993). It involves the application of management practices on forest ecosystems that allow the use of wood, other forest resources to be used, and the sustainable development of the nation and for the benefit of customers who live in the forest or near it. Ecosystem sustainable forest management and conservation of forest genetic resources are interdependent. Many of the selected species are not adequately represented in protected areas, nor involved in reforestation programs. As a result, alignment of goals for conservation and management, as well as practices in commercial forests or multifunctional natural forests is essential for preservation of forest genetic resources of these tree species. These factors further emphasize that the central role in the conservation of forest genetic resources have economically productive forest ecosystems, which are managed. The continuous process of conservation of forest genetic resources, which is also a large-scale, can only be achieved by involving the possible problems of conservation practices in the managed forests.

The main goal of ecosystem sustainable forest management will be to maintain vital populations for breeding commercial tree species and species that provide non-wood forest products for local communities. Ecosystem sustainable forest management must take into account the link with animal pollinators and dispersal of seeds from commercial and non-commercial tree species. Also, a special view needs to be given to the maintenance of biodiversity, including flora and fauna at forest and landscape level.

7.7. Synchronization of loggings with ecosystem oriented forest management and with forest genetic resources

Managing the process of wood production bares the risk of extinction of local endemic species, especially those that are sensitive to physical disturbance of habitats. Logging is currently the only measure in many of our forests. The consequences of logging operations can be reduced by reducing the volume of logging of economically valuable species, especially those with very high value. Zoning of arranged and managed forests, within which different management regimes and measures are adopted, can significantly reduce the impact of logging on biodiversity. One cycle of selective logging does not necessarily reduce species richness among tree populations, even providing the adequate restoration of growth, and no major damage during harvesting or if seed is available for regeneration in the soil or in neighboring areas. The impact of logging on forest genetic resources will depend on several key factors:

- The intensity, frequency, and the time for performance of cuttings,
- The procedures for determining which trees will be cut or saved,
- Levels of planning, including the implementation of specific measures for conservation,
- Implementation of logging,

- Regeneration system,
- Management after logging.

Besides the assessment of the extent of logging, sustainable increment and natural regeneration, inventory of forests should be so planned and designed to provide basic information for continuous monitoring. This will include the establishment of permanent sample plots or continuous inventory of the forests. This information can be used to explore the implications and impact of various tending and harvesting measures.

With regard to the ecosystem oriented forest management in the region of Malesh, we can say that this system is not implemented yet. The approach towards the activities in the forest is a traditional, with application of classic measures for silviculture and reforestation. There is a need to do more in terms of education for the benefits provided by ecosystem oriented forest management, both for the forest ecosystems and the wider community, especially for a man who is connected to the forest.

8. SOCIOECONOMIC INFORMATION

8.1. Population dynamics

The dynamics of the population is an essential element in the demographic structure of the population. Of primary importance are: a sizable movement of population structure by gender, population by age and gender, the natural increase of population, households and structure of households by number of members per population literacy and school readiness, population by occupation, and population by nationality .

8.1.1. Numerical population movement

Numerical population movement displays the total population of a certain area. Of particular importance is the dynamic movement of the population, the conditions and reasons that have an impact on it.

It may be said that the territory in the region of Malesh is not densely populated, which can be seen from the data presented in Table 32.

Table 32. Total number of population in the region of Malesh

Municipalities	Population total number	Households	Apartments and type of dwellings
Berovo	13,941	4,715	6,742
Pehchevo	5,517	2,026	2,877
Total	19,458	6,741	9,619

Source: Statistical Yearbook, 2013 – State Statistical Office of the Republic of Macedonia

The data presented in Table 32 shows that the total population size in the region of Malesh in 2013 was 19,458 living in 6,741 household. The total number of apartments and other dwellings in the region of Malesh accounted for 9,619.

The dynamics of a numerical movement of the population in this region is not equal between the urban and rural population. From the middle of the last century an important increase of the urban population occurs, while the rural population is declining. The move of urban and rural population in Malesh is presented in table 33.

Table 33. Dynamics of a numerical movement of urban and rural population in the region of Malesh for the period (1948-2013)

Year	**Malesh**	
	Urban	**Rural**
1948	5,306	13,711
1953	5,926	14,512
1961	6,116	13,932
1971	6,974	12,987
2013	9,442	10,016

Source: Malesh and Pijanec II (1980) & Statistical Yearbook of the Republic of Macedonia (2013)

The data presented in Table 33 displays that in the region of Malesh there have been continuous reduction of rural population and an increase of urban population.

This movement of population from rural to urban contributed to a significant reduction in the size of the villages.

Most people in the villages of the region of Malesh live in villages of 501 to 1,000 people. Only one rural settlement has over 1,000 residents and that is the village Rusinovo. The general feature of the villages in the region of Malesh is that they are compact.

8.1.2. Population by age and gender

The age structure is an important demographic element because it indicates the vitality of the population, which is reflected in many spheres of the social life and economic development.

According to data from the State Statistical Office for 2013, in the region of Malesh, most of the population is aged 19-60 years and the lowest representations have persons over 60 years of age. According to the percentage, the persons aged 19 to 60 years represents 59%, the persons aged 0 to 19 years have 26%, and those aged over 60 years have 15%.

Besides age structure, the gender structure is an important element in the demographics of the population. It displays the numerical relationship between male and female persons.

According to data from the State Statistical Office for 2013, the regions of Malesh have 49% female population and 51% male population.

Figure 28. Mountain hut on the locality "Klepalo"

Figure 29. Rural mountain tourism at the locality "Ramna reka"

8.2. Natural growth of the population

The natural movement of the population depends on the relationship between the birth rate and mortality in this area, displaying significant differences not only by years, but also by municipalities.

Basic data on the demographic structure of the population, such as newly born, deceased, natural growth, marriages and divorces in the region of Malesh and Pijanec by municipalities for 2010 are presented in Table 34.

Table 34. Dynamics of the natural movement of population by municipality

Municipality	**Berovo**	**Pehchevo**
Newly born	117	40
Dead	164	78
Natural growth	-46	-38
Marriages	60	27
Divorced	9	2

Source: Statistical Yearbook, 2011. State Statistical Office of the Republic of Macedonia

The data presented in Table 34 displays that the two municipalities have a negative natural growth. In Berovo it is -46 and in Pehchevo it is -38.

8.2.1. Population by educational attainment

The academic preparedness of the population is of great importance for the modern development of each area. The educational structure of the population in the region of Malesh is outlined in Table 35.

Table 35. Educational structure of population in the region of Malesh in percentage

	Informal education	Primary education	Secondary education	College	Higher education
Malesh	19.6	32.5	36.2	3.6	5.7

Source: Statistical Yearbook, 2011. State Statistical Office of the Republic of Macedonia

The data presented in Table 35 on the status of the population by educational attainment in the region of Malesh shows that the largest percentage of the population is with secondary and primary education.

8.2.2. Population by ethnicity

In terms of ethnic structure of the population in the region of Malesh there are different nationalities represented.

Their number and share of the total population for the overall region, and by municipality, is separately presented in Table 36.

Table 36. Ethnic structure of the population in the region of Malesh

Municipalities	Berovo		Pehchevo		Total	
	number	%	number	%	number	%
Macedonians	13,335	95.60	4,737	85.90	18,072	92.80
Albanians	--	0	--	0	0	0
Turks	91	0.70	357	6.50	448	2.30
Roma	459	3.30	390	7.10	849	4.40
Vlahs	6	0.04	2	0.04	8	0.06
Serbians	20	0.14	12	0.20	32	0.20
Bosniaks	3	0.02	--	0	3	0.04
Others	27	0.20	19	0.30	46	0.20
Total	13,941	100.00	5,517	100.00	19,458	100.00

Source: Statistical Yearbook 2011. State Statistical Office of the Republic of Macedonia

The data presented in Table 36 shows that most of the total population in Malesh, which is 19,458 inhabitants, are Macedonians 18,072, and they account for 92.8% of the total population, followed by Roma with 849 or 4.4%, and the Turks with 448 or 2.3%. The participation of other ethnic groups is below 1%.

8.3. Migratory population movements

The migratory population movements are an important item that displays the movement of the population in terms of its immigration and emigration.

Migration represents spatial movement and territorial distribution of the population. These processes result from the biological human development and are closely related to living conditions, socio-economic conditions, political and other events that have a major impact in moving the population from one place to another. Migration caused significant changes in the demographic structure of a particular area where they are. What will be the extent of migration of a particular area will depend on whether that space will increase or decrease the number of population. In the migration movements, the essential is the motive for migration and the formation of a potential mass migration, the act of moving the population from one place to another and the adaptation of migrants to the new conditions of life.

Depending on the selection and criteria, migrations can be of different types. They are impacted by the reasons which encourage migration, duration, spatial distance, etc. Therefore, migrations are distinguished as: settler migration or immigration and immigrant migration or emigration.

8.3.1. Immigration

Immigration is a process that, to a different extent and intensity, has long been present in the region of Malesh. In this region, in the middle of the last century, significant internal migration took place, as it happened in the whole country. It is interesting that immigration takes place from rural to urban, while immigration from village to village almost does not exist.

According to data from the Statistical Yearbook of the Republic of Macedonia, we can see what is the total number of people who have moved within the municipality and the number of immigrants from other countries.

Table 37. Total number of immigrants in the region of Malesh in 2012

Municipalities	Total immigrated	Immigrated from the municipalities within the country	Immigrated from other countries
Berovo	66	44	---
Pehchevo	27	22	1
Total in Malesh	93	66	1

Source: Statistical Yearbook, 2013 State Statistical Office of the Republic of Macedonia

The data presented in Table 37 displays that the total number emigrants in the region are 93, and only one is from the other countries.

8.3.1.1. Immigration by gender

The movement of population by gender is an important indicator, in which you can see migration movement of the male and female population. Data on the number of immigrants by gender for 2012 are presented in Table 38.

Data presented in Table 38 displays that most of these persons in all municipalities in the region of Malesh are female.

8.3.1.2. Immigrant population by ethnicity

Immigrant population by ethnicity displays the number of people moved in by ethnic background. This demographic element for a given region can be seen from the Table 39.

Table 38. Immigrants by gender in 2012

Municipalities	Total emigrated by municipalities	male	female
Berovo	44	6	38
Pehchevo	22	-	22
Total in Malesh	66	6	60

Source: Statistical Yearbook, 2013 State Statistical Office of the Republic of Macedonia

Data presented in Table 39 displays that most immigrants are with Macedonian ethnicity. Besides the Macedonian ethnic immigrants, there is also increase of Roma immigrants.

Table 39. Immigrated citizens by ethnicity in 2012

Municipalities	Berovo	Pehchevo	Total
Total	44	22	66
Macedonians	41	19	60
Albanians	--	--	0
Turks	1	--	1
Roma	2	2	2
Vlahs	--	--	0
Serbians	--	--	0
Bosniak	--	--	0
Others	--	--	0
Unknown	--	1	1

Source: Statistical Yearbook, 2013 State Statistical Office of the Republic of Macedonia

8.3.2. Emigration

The depopulation of the population is a negative demographic phenomenon. This condition occurs due to a number of socio-economic factors and has had a major impact in this region.

According to data from the State Statistical Office of the Republic Macedonia for 2012, the total number of emigrated population in the region of Malesh has relatively high values, which can be seen in Table.

Table 40. Total number of emigrated people by municipalities for 2012

Municipalities	Total number of emigrants	Emigrants within the country	Emigrants out of the country
Berovo	117	95	--
Pehchevo	32	28	--
Total	149	123	--

Source: Statistical Yearbook, 2013 State Statistical Office of the Republic of Macedonia

Data presented in Table 40 displays that a total of 149 citizens emigrated from the region of Malesh in 2012.

8.3.2.1. Emigration by gender

Emigration of population by gender is an important indicator, in which you can see the outflow movement of the male and female population. Data on the number of emigrated people by gender for 2012 are presented in Table 41.

Table 41. Emigration by gender in 2012

Municipalities	Total emigrated by municipality	male	female
Berovo	95	23	72
Pehchevo	28	6	22
Total	123	29	94

Source: Statistical Yearbook, 2013 State Statistical Office of the Republic of Macedonia

Data presented in Table 41 displays that most of the emigrations from all municipalities in the region of Malesh are by the female population.

8.3.2.2. Emigration by ethnicity

Emigrated population by ethnicity displays the number of people moved out, according to ethnic background. This demographic element for a given region can be seen in table 42.

Data presented in Table 42 displays that most emigrated citizens belong to the Macedonian ethnic group. Besides the Macedonian immigrants, there is also increase of Roma and Turkish immigrants.

This situation occurs because the region does not offer great socio - economic opportunities for advancement, employment, investment, etc., which could keep the population and offer a better existence.

Table 42. Emigration by ethnicity in 2012

Municipalities	Berovo	Pehchevo	Total
Total	95	28	123
Macedonians	89	26	115
Albanians	--	--	0
Turks	1	1	2
Roma	4	1	5
Vlahs	--	--	0
Serbs	--	--	0
Bosniaks	--	--	0
Other	--	--	0
Unknown	--	--	0

Source: Statistical Yearbook, 2013 State Statistical Office of the Republic of Macedonia

8.3.3. Migration balance

From the migration balance, we can see the total proportion of immigrants and emigrants in a certain region or municipality. Data on migration balance for the region of Malesh, and especially by municipalities, are presented in table 43.

Table 43. Migration balance by municipalities for 2012

Municipalities	Total balance	Migration balance within the country	Migration balance out of the country
Berovo	-51	-51	--
Pehchevo	-5	-6	1
Total	-56	-57	1

Source: Statistical Yearbook, 2013 State Statistical Office of the Republic of Macedonia

Data presented in Table 43 displays that, in both municipalities in the region of Malesh, there is a negative migration balance, which means that more are moving out of the region than moving in.

8.4. Spatial distribution and status of settlements

In the establishing of network of settlements in the region of Malesh, an important role has to be attributed to the natural geographic factors that directly determined the spatial distribution of settlements. Socio-economic factors also had an impact on the kind and type of settlements established. Typical for the region of Malesh is that the settlements were established at relatively higher altitudes. The mean absolute altitude for the region of Malesh is about 800 meters. Data on the density of settlements in terms of altitude for the settlements in the region of Malesh are presented in Table 44.

Table 44. Total number of settlements according to altitude

	settlements up to 750 meters	Settlements from 751-900 meters	Settlements over 901 meters
Malesh	--	10	6

Source: Malesh and Pijanec II, Skopje (1980)

Data presented in Table 44 displays that 10 villages are spread at an altitudes of 751 to 900 meters, and 6 settlements over 901 meter altitude.

Two major transport networks pass through the region including: (i) Kochani - Kamenica - Delchevo - Pehchevo - Berovo - Strumica and (ii) Kochani - Vinica - Berovo. The international road Berovo - Pehchevo - Blagoevgrad is especially important, since it connects the region with Bulgaria. In order to better connect the region with Bulgaria, there are three additional border crossing planned, as follows: Klepalo, Ajduchki Kladenec and Crna Skala, which are in the initial phase of construction.

Unfavorable socio-economic factors in the past, as well as the proximity of the border, lead to the development of urban areas in special functional core zones that grouped people from surrounding villages. This was also influenced by the distance of affected rural areas to the urban areas, and the poor rural infrastructure in the past.

The distance of the regions of Malesh and Pijanec with the nearest metropolis is about 170 km from Skopje, 162 km from Thessaloniki and 165 km from Sofia.

8.5. Local and regional position of settlements

There are two town settlements in the region of Malesh, and they are Berovo and Pehchevo.

Medium size settlements dominate in this region. The result of this relatively low density of settlements is the predominance of mountainous terrains and the adverse socio-economic conditions of the past. The type of the settlements and the density of the network of settlements is primarily a reflection of the relief features in the region, while the spatial organization, size and functional significance are resulting from the possibilities for exploitation of natural resources, which is conditioned from the nature of the socio - economic position in the past. As a result of the overall impacts and potentials, in the region of Malesh there are 16 settlements, out of which 9 in Berovo and 7 in the Pehchevo municipality. Their representation in municipalities and population size are presented in Tables 45 and 46.

Table 45. Settlements in the Berovo municipality

No.	Settlement	Population size
1.	Berovo	7,002
2.	Budinarci	681
3.	Dvorishte	757
4.	Machevo	206
5.	Mitrashinci	729
6.	Ratevo	844
7.	Rusinovo	2,095
8.	Vladimirovo	861
9.	Smojmirovo	765
	Total	**13,941**

Table 46. Settlements in the Pehchevo municipality

No.	Settlement	Population size
1.	Pehchevo	2,440
2.	Negrevo	270
3.	Pancharevo	707
4.	Robovo	580
5.	Umlena	520
6.	Crnik	928
7.	Chiflik	411
	Total	**5,517**

9. INFORMATION ON THE FORESTS OWNERSHIP AND THEIR USE

Forests under the Law on Forests (Official Gazette of RM No. 64/09) are classified under eitherstate orprivate property rights. Significant portion of forests in the region of Malesh are privately owned (approximately 45%). As a special feature of private forests is that they are relatively small lots, which are not allocated in a separate complex, but are mixed with state lots, and lots which cadastre records are maintained as "not defined property" because the owners didn’t legalize or exercised their property rights.

Forest management units are mainly covered by state owned forests, but almost all forest management units have also privately owned land in mosaic structures distributed throughout the area.

In some parts of the forest management unit, where the cadastre records are more advanced, there is solid data on land ownership and they are used and incorporated into the management plans. In some Special plans for forest management, the records were kept for privately owned land, and this data is provided. However, in most plans there is lack of such data, mostly because the privately owned surfaces are not separated and marked on the ground and because they are not distinguished from state land.

Reliable data on the land ownership of can be obtained only from the Department of Survey and Cadastre in Berovo, which is under the direct administration of the State Authority for Geodetic Works in Skopje. However, this data need to be further processed because the Department of Survey and Cadastre classifies data according to cadastre municipalities, and not according to forest management units. Because the boundaries of forest management units do not overlap with the boundaries of municipalities, there is a need of more extensive work for their delimitation and, therefore, the data is missing for the ownership of all plots within the forest management unit.

Up to 2013, harvesting in private forests is carried out in a way that the owner would submit an application to the branches of PE "Macedonian Forests" in Skopje, which was reviewed and approved by the professional staff within the enterprise. From 2013 onwards, wood harvesting in private forests iscarried out through special licensed private companies registered for doing work in the forestry sector. They receive requests from private forest owners, perform marking of trees for logging and issue the necessary documentation.

The question of clarifying forest ownership is a crucial one when determining the future role of forestry in the Region of Malesh. Also, the management of private forests in a wider context of landscape management also merits specific attention in the area.

10. PROPOSALS AND RECOMMENDATIONS FOR FUTURE FOREST MANAGEMENT

Based onanalyzed data and the summary of the Specific plans for forest management, for all nine forest management units in the region of Malesh, the following initial suggestions and recommendations for the future managementof forests in the upper Bregalnica region can be given. They include:

- ✓ The extent and quality of forests and particular forest stands covered by forest management units for the period up to 2014 are determined using ground data and mapsplanimetry. Given the fact that today more modern and accurate method are at disposal, using digital data, satellite images and GIS method, new methods should be introduced and regularly applied in the preparation of Specific plans for forest management. They will deliver more precise and accurate information on the extent and quality of forests overall for conservation and forest management.
- ✓ The current forest management practices should be carefully analyzed from a viewpoint of broader forest management objectives, accuracy and appropriateness for the region of Malesh. The preparation of an experimental regional forest development plan can be envisaged in a way that would be used for introducing new technologies, but also capacity development and participatory planning purposes.
- ✓ In order to have more complete data on timber volume, and increment, it is necessary to determine datafor the forest cultures as well, no matter whether they are at a younger age or not. Also, an area analysis should be done, determining where forests are lost and where forests are regaining terrain through natural growth.
- ✓ In most of the Specific plans for forest managementthe, middle-stem forest stands have not been taken into consideration, even though they exist on the ground. Therefore, some inappropriate management measures are proposed for them up to now. These stands should be also taken into consideration when preparing new management plans and appropriate silviculturaltreatments are needed to be developed at experimental level of their future management. There is, indeed, a good potential to convert some of the low-stem forest stands into functional and biodiversity rich middle-stem forests.
- ✓ High-value forests or virgin forests have not been identified in the region of Malesh as for now. However, small areas of these forests still prevail. They need to be identified and described, registered as conservation area, and their bioecological values should be analyzed for the protection and enhancement of the forest biodiversity.
- ✓ A special problem for forest management in the region of Malesh is the still insufficient and unclear delimitation of private and state property and themixture that still exist in between them in certain areas. To overcome this problem, the cooperation with the Agency for Cadastre of the Republic of Macedonia is urgently needed, and the application of modern GIS techniques can help to speed up the process of clarification.

- ✓ A particular problem in forest conservation is occurrence of illegal logging in certain parts of the forests. Therefore it is necessary to strengthen the capacity of services for the protection of forests and appropriate law enforcement. Underlying causes of illegal activities need to be determined and broadly discussed and measures to suppress them introduced.
- ✓ The health of forests is generally good as for today, but there isappearance of some diseases, including Scots pine stands dieback, which threatened the species extent in the region. Therefore, it is necessary to apply appropriate silvicultural practices in these forests that will stimulate their natural regeneration, and maintain their vitality and health to a higher level.
- ✓ The effects of climate change on the forests of Malesh need particular attention. Climatic data are insufficient and there is a need to develop some observatory on the possible vulnerability of forests and trees to climate change in the Region of Malesh.
- ✓ The traditional and classical silvicultural measures are still applied in the region of Malesh. Principles of ecosystem-oriented management of forests (naturalistic forest management) and management of forest genetic resources are not applied. Therefore in the future, more attention should be given to this approach.
- ✓ Seed stands and seed orchards in the region of Malesh have a great value for thepreservation of autochthonous forest genetic resources. They should be subject to special treatment, management and protection.
- ✓ In terms of the dynamics of population movement, more migration is from rural to urban areas. This happens because of better living conditions in the urban areas, and the possibility of employment of the population. The region of Malesh has a negative migration balance as more people are emigrating than migrating. Options at the level of employment, including ecotourism and carefully planned infrastructural development that include the distribution and development of forests need to be actively sought.

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ANNEXES

- List of common English and Latin names of tree and shrub species occurring in the region of Malesh
- Forest vegetation map
- Forest stands map
- Soil map
- Forest road infrastructure map