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THE CHARACTERISTICS OF FORESTS WICH ARE PROTECTING WATER SUPPLY OF LAKES LOCATED IN THE BANAT MOUNTAINS

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Abstract. Banat Mountains are characterized by chalky rocks, a continental temperate climate with Mediterranean influences, a rich hydrographic network and numerous accumulation lakes. The present paper analyses all state forests that belong to the category of forests from river slopes that supply accumulation lakes and to this area, which comprises 24 forest districts. The data was centralized and interpreted from management forest plans. The analysis of an extremely wide set of data (9774 stand elements) ensures a good representation of the obtained results. These results relate to stand conditions (location, age, structure, consistency, production class, and species) as well as site conditions (exposition, field inclination and altitude, flora, soil and site type). The forests are comprised of common beech and Norway spruce, have relatively uniformly distributed ages (with a preponderance of forests aged 20-40), mainly relative even-aged and relative uneven-aged structures, high consistencies, and average production classes. Furthermore, they are mainly distributed on North-West and South-West expositions, on high and very high slopes, at average altitudes, on dystric cambisols and eutric cambisols. The forests from river slopes located in Banat Mountains that supply accumulation lakes have an extremely important ecologic purpose. Even though they occupy a small surface (8%) in comparison with other forest types from this area, they ensure a regularization of water fluxes, reducing erosion and landslides. In addition, they contribute to soil water infiltration and to the reduction of accumulation lake cogging. All these effects are also translated in the specific management measures destined for them like prohibiting cuttings and ensuring natural regeneration.
Keywords: forests, accumulation lakes, Banat mountains, soil, site.

1. INTRODUCTION

Watershed behaviour is influenced by factors such as its geomorphologic characteristics like slope, exposition, soil, land use and climate conditions (Jabbar and Grote, 2020). In terms of land use, forests are the most important ecosistems wich are helping in protection of water supply. Evaluating the watershed response to these stressors is pivotal for achieving environmental sustainability (Deshmukh and Singh, 2006), considering that worldwide, meaningful changes are projected by the Intergovernmental Panel on Climate Change (IPCC) in rainfall, temperatures and extreme events (IPCC 2014).

In this article there are presented characteristics of forests wich are protecting water supply of lakes from Banat mountains. Banat Region has a diversified relief due to the presence of carst starting from the West towards the East so that the relief forms succeed in levels: low field, high field, hills and mountains. Accumulation lakes are essential for supplying nearby cities.

Banat's hydrographic network is formed on numerous rivers among which the most important ones are: Danube, Timiș, Mureș and Cerna who occupies a large surface in this area (Munteanu and Harabagiu, 2001). The following accumulation lakes are present in Semenic Mountains: Trei Ape Lake, Văliug Lake, Gozna Lake, Buhui Lake, and Secu Lake (Artugyan and Urdea, 2014). Two important lakes are also present in Dognecea Mountains: Lacul Mic (Small Lake), Lacul Mare (Big Lake) (Ogarlaci, 2015).

2. METHODS

2.1 Study area

Banat Mountains are located in South-West Romania (Fig.1). They belong to the Western Carpathians and are bordered by Danube's Ravine in the South and Lugojului Field in the North.

The following mountains are present in this region: Semenic Mountain (1446 m altitude, in East), Dognecea Mountain (617 m altitude, in North-West), Aninei Mountains (1160 m altitude, in the center), Locvei Mountains (727 m altitude) and Almajului Mountains (1224 m altitude, in West) (Timár et al., 2008; Iurkiewicz et al., 2005).

From a geologic point of view, this area belongs to the largest and most compact surface of chalky, carbonate rocks from Romania, Sinclinariul Reşiţa-Moldova Nouă (Artugyan and Urdea, 2014). The soils have the properties necessary for the growth of forest vegetation, while their succession is influenced by parental material, climatic conditions and the relief. The soils from Locvei Mountains are formed on crystalline rocks, while Dognecea Mountains are also on crystalline rocks with granitic intrusions and Semenic Mountains on crystalline and sedimentary rocks (Ianoş, 2002).

The climate from Banat is continental temperate with Mediterranean influences. The average temperatures ranges between 9-11° C, while the thermic regime is moderate with annual average precipitations of 600-1400 mm/year (Aldescu, 2008; Iurkiewicz et al., 2005). Semenic Mountains record an average annual temperature of 3.5 -4.0° C (Grozav and Rogobete, 2010).

The forest vegetation from Aninei and Locvei Mountains is formed of common beech, Turkey oak, holm and hornbeam (Nitzu et al., 2011). Black pine stands can be found in relatively small bodies in Domogled Mountains at altitudes of over 700 m, on Cerna river's left side slopes on a length of approximately 24 km (Crişan, A., 2006).

Timiş river originates from Semenic Mountains from under Piatra Goznei Peak (1135 m altitude) and has a length of 241 km up to the border with Serbia (Bănăduc et al., 2013).

Trei Ape Lake is located in the alpine area of Semenic Plateau and was exploited from 1970. The water's accumulation volume is of 5.34 m^3 while its surface amounts to 52.612 ha (Munteanu and Harabagiu 2001).

Two important lakes from Semenic Mountains were built in 1963 to supply Resita City, Văliug-Gozna Lake and Secu Lake. The first one, Văliug-Gozna Lake is an important reservoir located at 500 m, has a surface of 66.2 ha surface and a water volume of 11.732.000 m^3. The second one, Secu Lake, is located at 350 m altitude, has a surface of 105.67 ha and a water volume of 15.132.000 m^3 (Fetke et al., 2013).

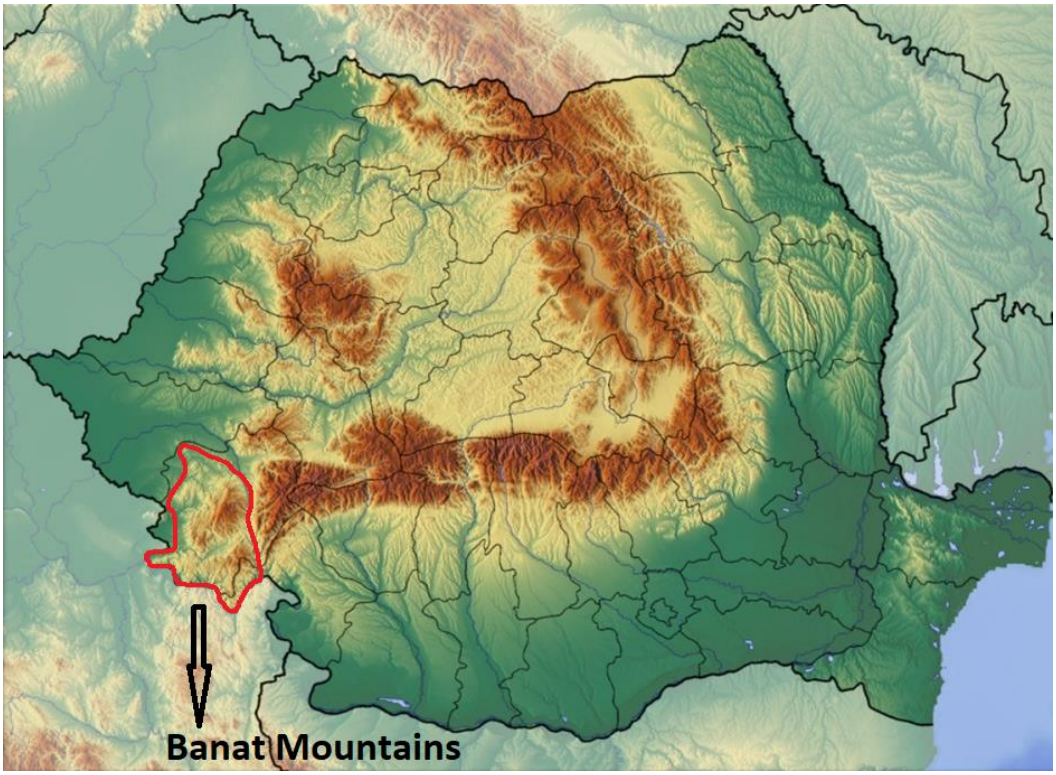

Figure 1. The location of Banat Mountains

2.2 Materials

According to silviculture management plans realized starting with the 50's, Romanian forests are situated in two functional groups: Group 1 – Forests with special protection functions and Group 2 – Forests with production and protection functions. In its turn, Group 1 is divided in five sub-groups from which sub-

group 3 is named 1,1C = Forests from river slopes located in the mountain and hill areas that supply present or future accumulation lakes, situated at distances of 15 up to 30 km upstream from the accumulation limit, based on the lake's volume and surface, alluvial transportation and basin torrentiality.

The present article analyses the state forest situated in the 1,1C functional category from Banatului Mountains. The research is based on forest management plans realized during 1991-2007 for 24 forest districts (*** Amenajamente). As such, 9774 stand elements were extracted and analyzed: the surface occupied by these forests, their location and age, structure, consistency, production class, species, exposition, field slope and altitude, flora, soil and the characteristic type of station.

3. RESULTS AND DISCUSSION

The surface occupied by these forests is of 37.502 ha, namely 8% of the total surface of forests from Banat Mountains.

The majority of forests from river slopes that supply accumulation lakes from Banat Mountains are situated in the following forest districts: Berzeasca (10.735 ha), Caransebeș (6.992 ha), Băile Herculane (5.298 ha), Reșița (3.385 ha), Oțelul Roșu (3.276 ha), Văliug (2.447 ha) and Moldova Nouă (1.159 ha).
The most widespread forest species that can be found in these forests are: common beech (24106 ha), Norway spruce (3242 ha), holm (2328 ha), hornbeam (1428 ha), silver fir (1248 ha), linden (739 ha), pines (347 ha), sycamore (336 ha) and ash (189 ha), (fig. 2). Some of these species are adapted to a soil water excess, specific to these forests functional group, namely ash (Dincă and Constandache, 2019), and alder (Blaga et al., 2019).

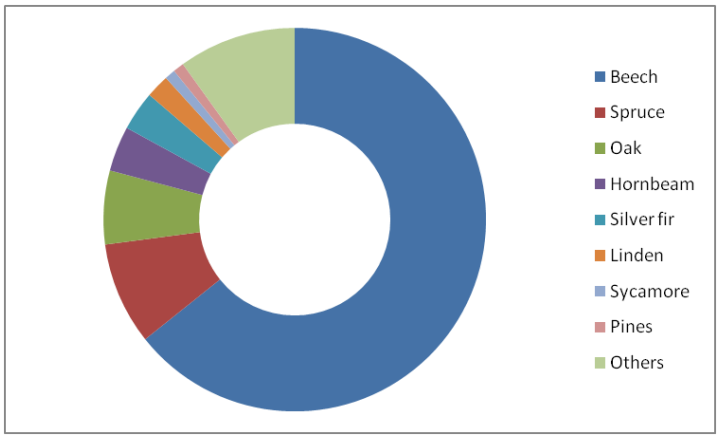

Figure 2. Tree species characteristic to river slopes that supply accumulation lakes from Banat Mountains

The age of the studied stands is relatively evenly distributed, with a predominance of relatively young stands (fig. 3). The oldest stands are a 220 year-old silver fir stand from Oțelul Roșu, a 210 year-old common beech stand from Băile Herculane and two 210 year-old silver fir stands from Oțelul Roșu. The advanced age is a characteristic of smart forests (Dincă et al., 2019a) and is specific to some stands with special protection functions (Cântar et al., 2019; Dincă and Achim, 2019).

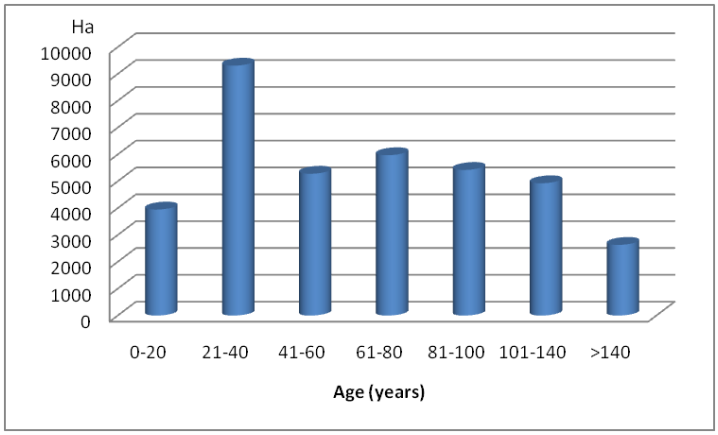

Figure 3. The age of stands from river slopes that supply accumulation lakes from Banat Mountains

From a structural point of view, the analyzed stands are relatively even-aged (25490 ha) and relatively uneven-aged (10543 ha), fig. 4. Uneven-aged stands are located in Caransebeș and Reșița Forest Districts.

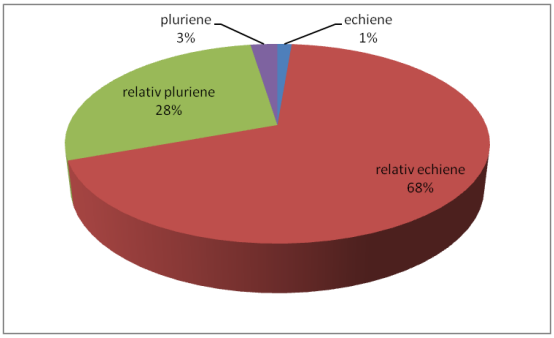

Figure 4. The structure of stands from river slopes that supply accumulation lakes from Banat Mountains

The stands' consistency is mainly high (0.8 = 19103 ha; >0.8 = 9663 ha), fig. 5.

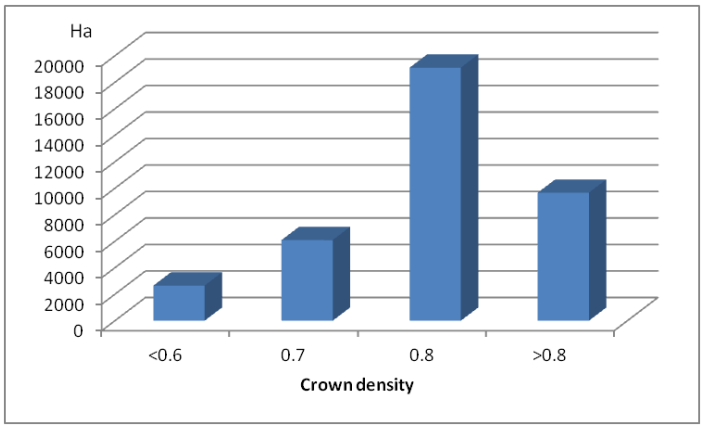

Figure 5. The consistency of stands from river slopes that supply accumulation lakes from Banat Mountains

The most numerous stands are the ones from average production classes (25557 ha), as well as superior production classes (8189 ha) or inferior ones (3688 ha), fig. 6.

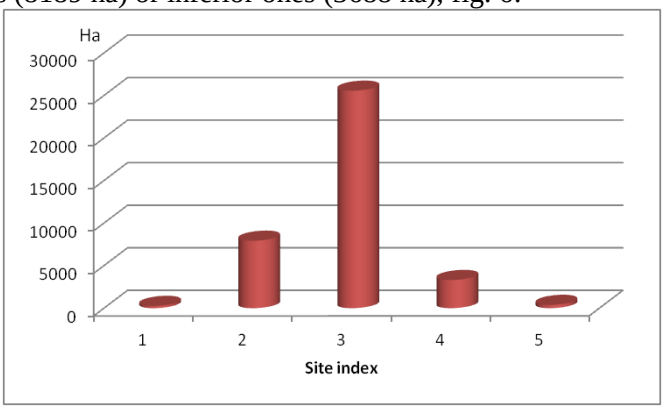

Figure 6. The production class of stands from river slopes that supply accumulation lakes from Banat Mountains

These stand's exposition is relatively uniform, with the exception of East-West direction where there are fewer stands (fig. 7).

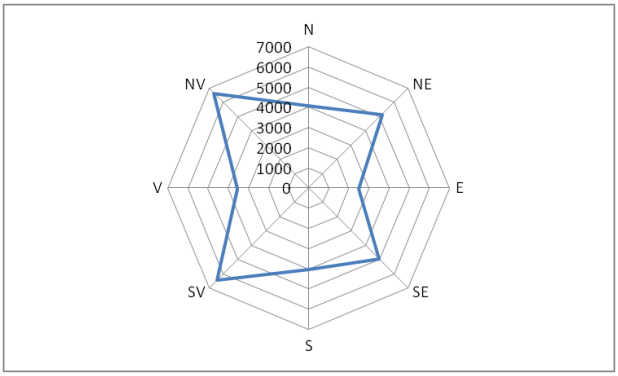

Figure 7. The exposition of stands from river slopes that supply accumulation lakes from Banat Mountains

Field inclination for the studied stands is relatively high (52%) and very high (38%), (fig. 8). This situation is normal, as the stands are located in the mountain area as well as on river slopes that supply accumulation lakes. The highest slopes (38 %) are recorded at Oțelul Roșu.

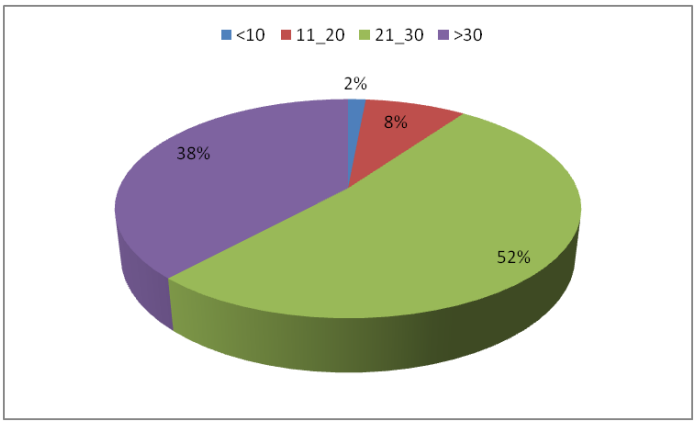

Figure 8. Field inclination of stands from river slopes that supply accumulation lakes from Banat Mountains

The altitude characteristic for these stands is of 600-800 m. However, lower or higher altitudes are also present (fig. 9). As such, the highest altitudes can be found at Oțelul Roșu (1650 m) and Caransebeș (1600 m).

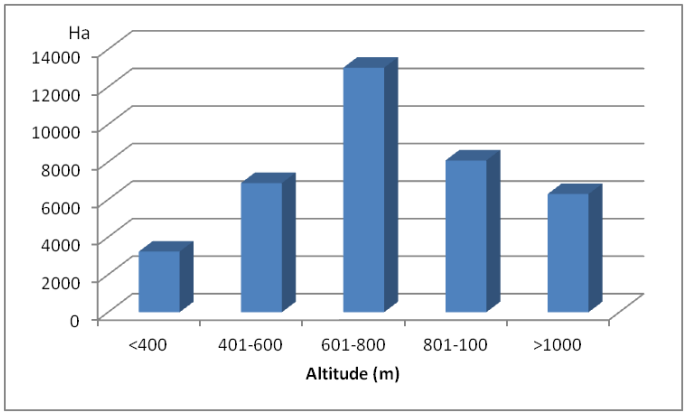

Figure 9. The altitude of stands from river slopes that supply accumulation lakes from Banat Mountains

The flora is represented by *Asperula-Asarum* = 21135 ha; *Asperula-Dentaria* = 9421 ha; *Poa pratensis-Carex caryophyllae* = 790 ha; *Oxalis-Dentaria* = 781 ha; *Festuca altissima* = 663 ha; *Rubus hirtus* = 626 ha; *Asarum-Stellaria* = 528 ha; *Luzula albida* = 501 ha; *Festuca altissima* = 369 ha; *Festuca heterophylla* = 319 ha; *Carex-Poa pratensis* = 112 ha.

The soil types characteristic for these stands are: dystric cambisol = 9919 ha; eutric cambisol = 21118 ha and luvisol = 2804 ha. These soils are well supplied with water (Dincă et al., 2018), are rich in nutritive elements (Chisăliță et al., 2015; Dincă et al., 2019b) and in micro-organisms (Crișan and Dincă, 2017; Oneț et al., 2019).

The most widespread site types for these stands are: Bm common beech mountain-premontane, average edaphic eutric cambisol with Asperula-Dentaria = 6055 ha; Bs mountain-premontane, high edaphic eutric cambisol with Asperula-Dentaria = 4742 ha; Bm common beech mountain-premontane, eutric cambisol with average edaphic mull = 2296 ha; Bm mixtures mountain, average edaphic eutric cambisol with Asperula-Dentaria = 1406 ha; Bm mixtures mountain, high edaphic eutric cambisol with Asperula-Dentaria = 961 ha; Bm Norway spruce mountain, sub average edaphic dystri cambisol with Oxalis-Dentaria +- acidophilus = 691 ha.

The forest types are the following: Hill common beech on coarse soils with mull flora = 8612 ha; Mountain common beech on coarse soils with mull flora = 6429 ha; Normal common beech stand with mull flora = 5241 ha; Coast holm with gramineae and Luzula luzuloides = 1540 ha; Common beech stand with Festuca altissima = 1353 ha; Normal mixture of resinous and common beech with mull flora = 1005 ha; Hill common beech with mull flora = 938 ha; Mixture common beech from the hill area = 931 ha.

4. CONCLUSIONS

The forests from river slopes located in Banat Mountains are mainly comprised of common beech, followed by Norway spruce, oak and other species. Furthermore, they have a relatively uniform distribution on ages (with a preponderance of forests aged 20-40), have mainly relative even-aged and relative uneven-aged structures, high consistencies and average production classes.

From the point of view of site conditions, these forests are mainly distributed on North-West and South-West expositions, on high and very high slopes, at average altitudes specific to Banat Mountains, on dystric cambisols and eutric cambisols, on stations from the common beech mountain-premontane level on superior and average quality, on common beech or mixtures forest types with an Asperula-Asarum flora.
It can be seen that forests from river slopes that supply accumulation lakes from Banat Mountains are forests of a high quality (superior production classes, high consistencies, diversified structures) that use in a superior way local site conditions (soils of average and superior quality).

The forests from river slopes located in Banat Mountains that supply accumulation lakes from these mountains have an extremely important ecologic purpose. Even though they occupy a small surface (8%) in comparison with other forest types from this area, they ensure a regularization of water fluxes, reducing erosion and landslides. In addition, they contribute to soil water infiltration and to the reduction of accumulation lake cogging. All these effects are also translated in the specific management measures destined for them like prohibiting cuttings, with the exception of hygiene ones or ensuring natural regeneration.

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