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FOREST REVIEW

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PREFACE

Dear Colleagues and Readers,

It is a great pleasure to announce the online publication of the first issue of 47th volume of the Forest Review!

Yes, we have doubled the efforts and start to publish two issues a year. We really hope that you will find our authors' dedicated work interesting again, due to the original research articles in it.

Next 2017 is once again a jubilee year. UKiM Faculty of Forestry in Skopje celebrates 70 years of its establishment, but more on this in our next issue. Until then, enjoy in our "firstborn" in 2016!

Special thanks to all authors and members of the Forest Review, as well as to all peer – reviewers for the participation in this volume and issue.

On behalf of the Editorial Board,

Asst. Prof. Bojan Simovski PhD, Editor-in-Chief

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NUMBER AND QUALITY STRUCTURE OF NATURAL BEECH REGENERATION IN ROUND APERTURES ON BISTRA MOUNTAIN

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ABSTRACT: This research is made on the number and quality structure of the natural regeneration of beech in round apertures on Bistra Mountain. It's conducted by direct scientific research activities, by gathering information from the field. This information was later classified and processed by mathematical-static methods, and appropriate analysis were made, which results are shown both tabular and graphically. The study was made in pure beech forests represented in the Bistra Mountain. The natural conditions of the researched area, as essential for the growth and the survival of the forest ecosystems, also take a place in this paper. It was found that they are favorable for the development of forest vegetation. This paper also provides an overview of forest management in the past, as well as an analysis of results of taken silvicultural and regeneration measures, and it was determined that the studied forests have been under anthropogenic and zoogenic impact deep in the past. The development and the regeneration processes in the studied forests stands were being researched in their early development stages. The research was made under natural regeneration in round apertures and including quality structure of the offspring, as an important indicator over the next regeneration processes. From the conducted research is concluded that the beech forests of Bistra Mountain have a strong regeneration potential which is mainly correlated with the size of the round apertures.
Keywords: beech, beech forests, natural regeneration.

1 INTRODUCTION

The beech is one of Macedonia's most valuable tree species that can be found on all of the mountains in the country. The wide area covered by this species, as well as large concentration of wood stock in its forests, makes this specific species very important. According to the data of the publication "Forestry", edited by State Statistical Office of the Republic of Macedonia, the clean beech forests in the Republic of Macedonia cover 232.243 ha, or 23.61% of the full area covered in forest. Beech also participates on a large scale in mixed forests with fir, oak, pine etc., which forests are provided in Macedonia on 270.525 ha or 27.5 % of total forest area.

The great significance of beech and beech forests are reflected not only on its importance as a commercial tree species, but this species is especially important from a bio-ecological aspect, because it builds communities with many different species of trees and plants that are characterized by considerable diversity.

For further survival and development of these forests, the natural regeneration processes are considered extremely important. That is why a large number of researchers have been dealing with the question of the beech forests in Macedonia and the regeneration processes in these forests.

At Bistra Mountain most prevalent are beech forests, then mixed beech – fir and oak forests.

As one of the most important forests in the country, beech forest communities have already been studied by many authors, from different aspects and in different areas.

Thus, the characteristic of crowns in some beech coppice forests is explored by Krstevski, K. (1975). The structure, growth and productivity of pure beech stands with virgin characteristics for Osogovski Mountains and Belasica were researched by Ivanovski C. (1971 and 1978). The form of the beech and oak trunks in Republic of Macedonia was studied by Gogushevski M. and Ivanov D. (1980 and 1981). The bio-structural relations in the beech high forests were analyzed by Mirchevski S. (1978).

Beech forests in terms of their reconstruction and development in pure high forests, depending on the canopy on the massif of the Arbit Mountain are explored by Petrushevski, S. (1982).

The structural elements and the productivity of the beech stands on the Kozhuf Mountain were researched by Ristevski P. (1987). The structure, productivity, bio-ecological characteristics and natural renewal for Maleshevski Mountains are analyzed by Velkovski N. (1999 and 2007).

The mixed beech-fir forests are especially important because of their structure, productivity and other functions. The productivity of beech-fir forests in Forestry Unit "Doshnica" was studied of Gogushevski, M. (1970). Natural regeneration and development of beech and beech – fir forests, depending on management is researched by Mirchevski S. (1983).

The ecological characteristics of the beech-fir forests were researched by Koshanin (1925), Grebeshchnikov, (1938), Dzekov, (1962), Em, H. (1961, 1975), Nikolovski, T. (1968), Vilarov, L. (1970), Hadzigeorgiev, K. (1972) and others, and the wood production ability of oak and beech forests are researched by Ivanov D. (1971).

Previous researches showed that the development of beech forests and their regeneration processes largely depend on the site conditions and the adjustability of the beech to them, according to its bio-ecological and genetic predispositions.

In general, in Macedonia is present Balkan beech *Fagus moesiaca* (Domin, Maly) Czeczott. (*F. silvatica* ssp. *moesizaca* (Maly) Czeczott), which manifest some intermediary differences between the European beech (*Fagus silvatica* L.) and the Eastern beech (*Fagus orientalis* Lipsky) from morphological, biological and ecological characteristics. Optimal soil conditions for proper development of the Balkan beech are fresh, deep, well aerated and humic soils, with a mild acidic reaction and a pH of around 0,6. On such soil, regardless on the

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subsoil, beech forms a thick and branched root system, which effectively uses the nutrients from the soil. As a shade tolerant species, beech builds dense stands and produces large amount of timber. The ratio between total area of upper side of the leaves and the soil area in the mountain beech forests can be 8:1, which means that 1 ha of beech forest covers 8ha of land. Therefore, choosing the method of rejuvenation, concerning the appearance and silvicultural care of the new growth and avoidance of excessive shade are very important.

An important requisite for the appearance and silvicultural care of the young stands is the protection of the parent trees, because in the first years the new growth is very sensitive to extreme temperatures and drought. First, the regrowth's are lifting their cotyledons from the carpel above the ground. Soon after that, the carpel fall off, and the cotyledons remain on the young tree on a height of around 8 mm above the ground. The growth of the beech is slow, especially in the juvenile period, so beech trees at the age of 20 years reach about 3 m in height, but in unfavorable conditions, they grow even less. They tend to grow faster at later age, depending of the available amount of sunlight, and around the age of 100 years they reach maximal height, so at favorable site conditions the beech stands can have a wood mass of 800m³/ha. However, some environmental conditions or inadequate silvicultural practices can have a significant negative impact on the regeneration process of the beech forests, but also to the entire forest ecosystem. Special limitation role has temperature extremes and the availability of water, as a primary factor which limits the production of the natural ecosystems (Whittaker 1975). The drought periods in the last few decades are a key factor for the degradation of the beech and oak forests in Europe (Raftoyannis & Radoglou 2002).

Despite the considerable number of studies which researched the beech forests around the country, one can still say that the area of Bistra Mountain is not sufficiently studied. Therefore, research in this paper aimed at determining the number and quality structure of natural regeneration of beech in round apertures in the forests of Bistra Mountain.

2 METHOD AND RESEARCH OBJECT

The research on the number and quality structure of beech natural regeneration in round apertures is made on the massif of Bistra Mountain, which is situated in the western part of Macedonia, where different climate, soil, topographical and anthropogenic impacts encounter, providing conditions for prevalence of the beech forests.

The research was being pursued through direct measuring on the field and later office data analysis of the collected data. The data was collected through direct measuring on previously placed trial plots, chosen as authentic representative areas of the natural regeneration and its development stadium. Further, by mathematical calculations and methods, the results and values for fixed areal unit of 1ha has been obtained. The juvenile individuals are classified according to their development stadium, but also a valuation of their quality was made, as a basis for further determination of their potential for a proper natural regeneration. By processing and analyzing the data, obtained appropriate results, that are further compared with results from different researches on adequate type of forests and regeneration processes, determined by other authors on other sites and extracted relevant conclusions.

In the process of the natural development, the stands follow different development stages, from the smallest, just sprouted offspring to trunks that, with further differentiation, take over the main part in the structure of the mature plantation. According to Bonushevac (1951), the forest in its development goes through the new growth, young stand, middle aged stand, non-grownup stand and grownup stand.

For examination of the natural regeneration of the forests on the Bistra Mountain, the research has been made on the first two development stadiums: new growth and young stand. These stadiums according to *Šafar* (1958) are:

- Regrowth – Plants at age of one year.
- New growth - From the stadium of regrowth to 1.30m height. Furthermore, the new growth stadium is separated as *non-grownup*, up to 0.30m and *grownup*, from 0.30 to 1.30m high.
- Young stand - over 1.30m in height, to 10cm in diameter at breast height. Further, the young stadium is separated as *non-grownup*, from 1.30m height to 3cm diameter at breast height, and *grownup*, 3-10cm diameter at breast height.

According to this classification, the term of natural regeneration comprises all the individuals at juvenile stands from the age of 1 year, to 10cm in diameter at breast height.

The subsoil at the researched area is mostly silicate and contains mainly shale; also quartzite is found on small areas. The slope of the terrain is mainly moderately steep to steep. The beech forests are mainly represented on acidic brown soils (distric cambisole), where in the upper part of the horizon, to 10 cm depth, high level of humus is notable, reach up to 10 %. The soil reaction is mild acidic. These soils are well provided with nitrogen, medium rich with potassium and almost always poor with phosphorus.

A very important hydrological object from an anthropogenic character - the Mavrovo Lake, is situated not far from the beech forests. The lake dominates the landscape by its coverage area and water reserves. The lake is formed by raising a dam on river Mavrovska Reka, but also many other rivers flow into it.

At the Bistra Mountain is prevailing highland climate, with great influence of the continental climate. According to data of the meteorological station in Mavrovi Anovi for the period 2001-2010 the mean annual air temperature is 7,6°C,the mean annual rainfall amount is 1.150 mm and is very favorable for growth and development of the forest vegetation. The increased air humidity affects the air temperature positively. The increasing of the humidity soothes the temperature variations and the extremes occur rarely. At the area most often are the northeast winds, with frequency of 212 ‰ and an average speed of about 6 m/s.

The undertaken silvicultural measures mainly positively affected the development of juvenile stands. However, on certain locations are notable effects of improperly selected and undertaken silvicultural and managing measures, which left traces that are noticeable even after several decades. Examples include the effects of belt type clear cuts in the eastern parts of the researched area.

The most represented forest communities on the northern slopes of Bistra Mountain are beech forest and mixed forest of beech and fir, which accounted for 84.2% of the researched area. As a result of the favorable ecological conditions on these sites, there are mainly high, productive forests, with high standing timber and high growth. Timber in studied stands ranged from 175 to 370 m³/ha. Occasionally, individually or in groups, can be found mixtures of other species such as maple, alder, willow, oak, rowan etc. On smaller locations, on the peripheral parts of the researched area, mostly in lower altitudes and specific site conditions, encountered forests of Sessile oak and various modifications of the forest of Hop hornbeam, with hints of Manna ash, Pubescent oak, linden, etc., but still, the beech is the dominant tree species of the entire mountain range.

3 RESULTS AND DISCUSSION

The studies of natural regeneration in round apertures, was done in beech forest stands with different sizes of the apertures.

Analysis on the number and structure of natural regeneration of beech in development stages, depending on the aperture size was made.

The number of the natural regeneration, as an important indicator for the regeneration potential of the stand, for area of 1 ha is calculated using the following formula:

$$N = \frac{n \times 10.000}{P}$$

N = number of individuals on area of 1 ha
n = number of individuals on measured area
P = measured area (ha)

Table I: Representation of natural regeneration of beech in different development stages and different sized apertures

Number of individuals/ha in development phases	Aperture area (m²)						Total	
	440	%	1.600	%	2.500	%		
non-grownup new growth	2.500	4,0	1.400	3,5	1.213	4,2	**5.113**	**3,9**
grownup new growth	22.500	36,0	5.480	13,7	2.380	8,3	**30.360**	**23,1**
non-grownup young stand	25.000	40,0	13.080	32,7	7.187	25,0	**45.267**	**34,5**
grownup young stand	12.500	20,0	20.040	50,1	17.970	62,5	**50.510**	**38,5**
Total	**62.500**	**100,0**	**40.000**	**100,0**	**28.750**	**100,0**	**131.250**	**100,0**

The data presented in Table I and Figure 1 shows that in all round apertures are registered individuals from all development stages, which means that regeneration process runs continuously. The largest amount of individuals per 1 ha area is at the round apertures of 440m² (62.500 individuals/ha), and lowest amount at the largest round apertures of 2.500 m² (28.750 individuals/ha).

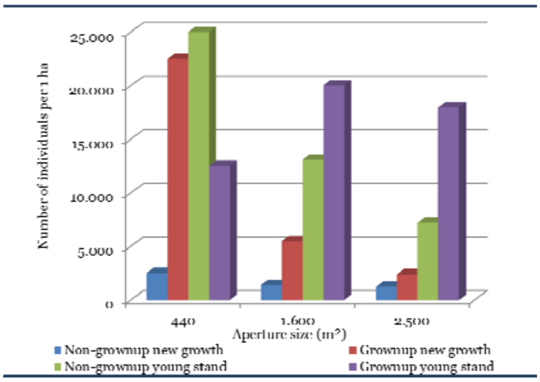

Figure 1: Representation of natural regeneration of beech in different development stages and different sized apertures

Figure 2: Regeneration in round apertures of 440 m²

Figure 3: Regeneration in round apertures of 440 m²

Figure 4: Grass emersion in round apertures of 1.600 m²

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Figure 5: Regeneration in round apertures of 2.500 m²

Figure 6: Weed emersion in apertures larger than 2.500 m^2

It is notable that in the larger apertures (1.600 and 2.500 m²), the participation of individuals from the development phase grownup young stand is higher. It is an outcome of greater free space in these apertures, so the natural regeneration grows faster and convert to the next development stage.

Such dependence between the size of the apertures in the forests and the amount of the natural regeneration was concluded on other localities too. Thus in the Maleshevski Mountains, amount of the natural regeneration individuals of beech in the apertures to 500m², varies between 77.500 individuals/ha on the eastern exposure to 144.500 individuals/ha in the northern exposure; in the apertures from 500 to 1000m² from 46.500 individuals/ha on the eastern exposure to 80.000 individuals/ha in the north and in the apertures from 1000 to 1500m² from 16.500 individuals/ha on the eastern exposure and 25.000 individuals/ha on the northern exposure (Velkovski, 2007).

Certain correlation between the size of the apertures in the forests and the amount of the natural regeneration is found in other species of trees. Thus, in the fir forests in Macedonia it was determined that, on the northern exposures, the amount of the natural regeneration in the apertures of 400 m² is 46.800 individuals/ha, in the apertures from 401 to 800 m² equals 34.500 individuals/ha, in the apertures from 801 to 1200 m² equals to 25.500 individuals/ha and in the apertures from 1.201 to 1.600m² amounted to 21.700 individuals/ha (Mirčevski 1976). In the southern exposures determined the following values: in the apertures up to 400 m² the amount equals 45.400 individuals/ha, in the apertures from 401 to 800 m² equals 26.700 individuals/ha, in the apertures from 801 to 1200 m² amounts to 17.700 individuals/ha, and in the apertures from 1.201 to 1.600 m² equals 13.200 individuals/ha (Mirčevski 1976). In Scots pine forests on the mountain massif Nidže on northern exposures is determined that the abundance of the natural regeneration individuals in the apertures up to 500 m² amounted to 10.000 individuals/ha, in the apertures from 500 to 1.000 m² amounted to 8.700 individuals/ha; while on the western exposure in the apertures up to 500 m² determined to 42.050 individuals/ha, and in the apertures from 500 to 1.000 m² specified 8.700 individuals/ha (Batkoski, 1977).

The greater abundance of the natural regeneration of shade-tolerant tree species, such as beech and fir, compared to Scots pine is expected because they can develop in low amount of light, as according to their bio ecological characteristics are more adaptable of such natural conditions such as are created in round apertures in the forest.

The qualitative structure of the natural regeneration individuals of the stands on the northern slopes of the Bistra Mountain has been studied so that all individuals of the researched plots were evaluated individually, the data are calculated and reduced per 1 ha area and shown in Table II and Figures 7, 8 and 9.

The grouping was done in three quality groups:

- *Individuals of good quality* - a group that includes all those who stand out for their quality and good health,
- *Individuals with medium quality* – a group that includes all individuals who are behind the individuals of good quality, but they are still in a good health condition and good vigor,
- *Individuals with poor quality* - those who left behind in its development, with bad phenotypic and genotypic characteristics, dry branches or tops and incorrectly developed, branched canopy.

Table II: Quality structure of beech renewal in different sizes of circular apertures

Aperture area (m²)	Quality in %			Total
	good	average	bad	
440	52	29	19	100
1.600	23	52	25	100
2.500	15	36	49	100

The data presented in Table II and Figures 7, 8 and 9 shows that by increasing the size of the round apertures in the forest the number of individuals with good quality decreases from 52% at the apertures sized 440 m², 23 % in apertures sized 1.600 m², to 15% apertures sized 2.500 m². At same aperture size, the number of individuals of poor quality increases from 19% at the apertures sized 440 m² to 49% at the apertures sized 2.500m². These data suggest that the best conditions for quality natural regeneration of beech exist in the round apertures of 440 m².

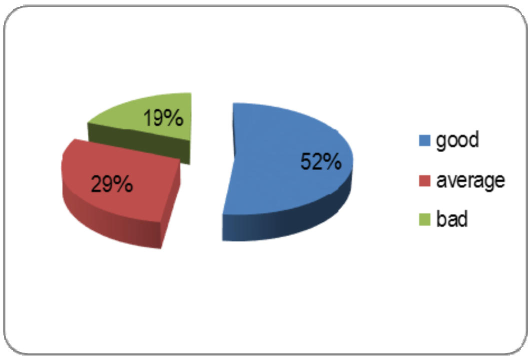

Figure 7: Quality structure of beech regeneration in round apertures of 440 m²

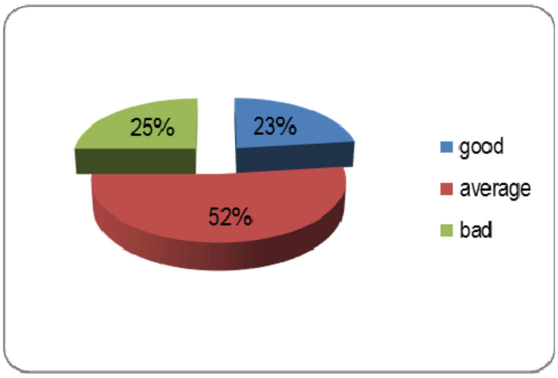

Figure 8: Quality structure of beech regeneration in round apertures of 1.600 m²

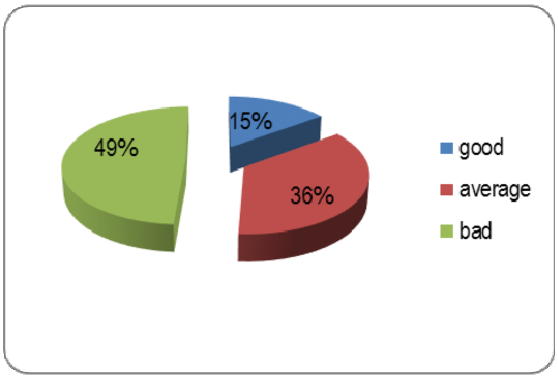

Figure 9: Quality structure of beech regeneration in round apertures of 2.500 m²

Large apertures of 1.600 m², and even more of 2.500 m², are not favorable for quality natural regeneration of the beech. In these large apertures, beside the decreased quality and abundance of beech natural regeneration individuals, are featured processes of grass overgrowing, which further complicates the regeneration process. Therefore, the application of future silvicultural measures in beech forest stands should be aimed to avoid creating large apertures, because apertures about 440 m² are the most suitable for quality natural regeneration.

Little better quality structures on the regeneration of the beech was concluded on Maleshevski Mountains, where in the apertures of 500 m² the number of individuals of good quality was 57 %, and the number of individuals with poor quality of 15 %. In apertures with a size of 500 to 1.000 m², number of individuals of good quality was 41 %, and the individuals of bad quality 21 %. In apertures with a size between 1.000 and 1.500 m² number of individuals of good quality was 20 % and those with poor quality of 47 % (Velkovski, 2007).

Economic activities affected the natural rejuvenating processes on many localities in the investigated area. So, in the past, after the cuttings in beech forest stands, seedlings of spruce or seeds of fir were introduced. This practice continues today too, although in many places, after the 15th year regenerated individuals' dieback due to lack of light. Regarding the rejuvenation of stands, can be concluded that at the stands where silvicultural measures are taken, occurs quality offspring.

In the stands of the researched area, following silvicultural measures were taken: protection of the young stands, filling of the non-regenerated areas, thinning, pruning and seedling.

Protection of the young stands is a measure that is continuously implemented in the investigated area. Moreover, it is aimed primarily at protecting the grazing of domestic animals (sheep and goats), which in some cases can completely destroy the young forest, and prevention of illegal logging. Special measures for protection from wild animals were not been taken, but also not recorded any serious damage, because the wildlife population of this area is not too high.

Filling of the non-regenerated areas after the cuttings is a measure that is often applied. Filling is performed by applying seeds of fir or spruce in square areas or by seedlings of the same species. This measure initially has delivered some results, with the good advancement of fir and spruce, but later absence of silvicultural measures result in dieback after the tenth year. The reason for this is that these conifer species were suppressed by the natural regeneration of beech, which develop intensely and with good quality in the apertures area.

In other parts of stands, mostly used silvicultural measure is thinning. It is performed in coppice and high forests, with intensity between 15 and 20%. This intensity proved to be insufficient. The site conditions of the area are suitable for the development of forest stands with good quality structure, which can provide better, faster and more optimal development, applying thinning with intensity of 25 % and at better site conditions up to 30%.

4 CONCLUSIONS

1) The natural conditions of the Bistra Mountain together with anthropogenic and zoogenic factors contributed for prevalence of pure beech forests at this mountain range.
2) The most used measure in previous management of the stands is thinning. It is performed in coppice and high forests, with intensity between 15 and 20%. This intensity proved to be insufficient, because the natural conditions of the area are suitable for development of forest stands with good quality structure and which can provide better, faster and more optimal development if applied thinning intensity of 25% and in better site conditions even up to 30%.
3) In the researched area, mostly applied regeneration measure is group selective cutting. In small areas, round or belt type, in coppice plantations, clean cutting is applied. As a result of the regeneration measures in the beech forests, in many places is appeared quality natural regeneration of beech.

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4) In certain parts, in order to improve regeneration process and enrich the forests with conifer tree species is performed fir seed dispersal and spruce afforestation. However, due to absence of further silvicultural measures, the offspring of these conifer species is with bad quality, because there is rarely occurrence of it, in the form of small groups, or on many parts dieback. There is particular poor success in spruce seed dispersal and seedlings planting. The reason of this is because for advancement in the beech forests, spruce individuals need properly enforced silvicultural measures, as well as assistance in the competitive struggle with the natural regeneration of beech, which varies in quality and density.
5) Natural regeneration in round apertures of 440m² is most favorable for regeneration of beech forests, because it brings together individuals from all stages of development, with a high percentage of individuals with good quality (52%), meaning that regeneration process runs continuously and with quality.
6) Increase of the apertures over 500m², reduce the number and quality structure of natural regeneration, and over 1.600 m² occur processes of grass overgrowing. Apertures over 2 500 m^2 are least favorable because good quality natural regeneration is estimating as low as 15% and overall regeneration process in these apertures is low. Apertures of this size should be avoided in management of the beech forests.

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FOREST VEGETATION MAPS AND ITS DEVELOPMENT IN TURKEY: A CASE FROM ISTANBUL-BELGRADE FOREST

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ABSTRACT: Forests provide a wide range of direct or indirect benefits to urban life which vary over space and time. Increasing demands from forest resources made planned forest management indispensable for sustainability. At this point, mapping forest stand types has come into prominence from the early stages of planning efforts. Belgrade Forest, which is a cultural and natural heritage of the city, has been influenced by historical processes and also with the development in forest science. In this study, forest maps of Belgrade forest were evaluated since the establishment of the first forestry school in terms of forest stand classification. Also, changes in some forest types were determined from the digitized of historical maps. It was found that first forest map (1888) distinguished oak, hornbeam and chestnut stands in addition to openings and meadows around the forest. Second map (1938) was prepared in planned forest management period and distinguished stand as management type and dominance of oak and chestnut. In both of these maps, beech were not mentioned and more emphasize were given to oak, chestnut and hornbeam. The map prepared in the second forest management plan period (1949-1965) gives more information about stand types. From past to present forest management plans were based on stand classification considering dominant tree species. However, detailed floristic researches carried out in the forest (653 sample plots and 380 species) condense compositional and structural information and expresses all historical, sociological and habitat factors. But these detailed researches have not already been implemented in forest management plans. In fact, conversion of current forest structure to potential forest structure based on historical vegetation maps can provide a basis for close to nature silviculture and thus failings in ecological restoration efforts might be eliminated.
Keywords: oak forests, forest history, forest degradation.

1 INTRODUCTION

Historical events, which influenced forest structure during the history, are good predictor for future conservation approaches. According to Nowak (1993) understanding these events will prepare foresters for present and future events that will influence urban forests for years to come. Human influence on natural ecosystems cause multi-directional changes on vegetation and these may continue for centuries. Due to such continuing anthropogenic effects which cannot be seen easily, less changed or altered vegetation types are even accepted as natural (Erz, 1992, Bergstedt, 1997, Reif and Walentowski, 2008).

It is well known that deforestation and forest degradation are increasing as a result of rapid population growth. When deforestation involves a reduction of the forest area, forest degradation often implies a change in the health and vitality of a forest ecosystem but it can also relate to other factors such as changes in the composition of tree species, a loss of biodiversity, a permanent or long term reduction in the crown cover and changes in timber volumes (Achard, 2009). In general, there are many difficulties to estimate the degree of degradation due to lack of knowledge of initial state of the forests. At this point, forest vegetation maps can be accepted among the main references showing changes in forest structure. However, vegetation maps based on forest species composition provide much more information. Such a detailed knowledge are presented by phytosociological studies which condenses compositional and structural information within a hierarchical system, and expresses all historical, sociological and habitat factors that influence the actual and potential vegetation (Blasi and Burrascano, 2013). Therefore, vegetation maps are important in terms of monitoring changes in forest structure.

Forestry works in Turkey are dated back to forestry school established in 1857 and first comprehensive studies have been accepted to be started since that time. In this context, pioneering researches and applications have been implemented in Belgrade Forest in Istanbul. For this reason, the forest is a good example for comparing historical developments with forest structure due to historical documents and researches. The forest was protected with special regulations due to its water resources and aqueducts built in Byzantium and Ottoman periods supplying water to the city. There are 7 reservoirs within the present boundaries of the forest and joined to the city by a joint aqueduct (Çolak *et al*., 2013). Especially, it was reported that the forest was protected with Sultan's edicts which forbid cutting trees. For this reason, forest area had not changed for longer periods due to these strict edicts. On the other hand, the forests were exposed to damages in some periods of time during history (Çolak *et al*., 2013).

The aims of this study are to (1) evaluate historical developments in forest stand classification derived from historical forest maps, (2) compare forest maps which were drawn in different time periods, (3) assess vegetation maps based on phytosociological studies and current forest management maps and (4) evaluate the place of forest vegetation maps in forest management planning and nature conservation.

2 MATERIAL AND METHODS

2.1 Study area

Belgrade Forest is located in northern part of Istanbul, between 28°53'25'' 29°00'55'' eastern longitudes and 41°09'44'' 41°14'40'' northern latitudes (Fig. 1). Belgrade Forest corresponding to 0.03% of total forested areas in Turkey covers an area of 5.444 ha. The forest is located on a peneplain which reaches maximum an altitude of 200 m. The highest point of the region is Kartal Tepe (230 m) in the north and the lowest point is

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Kuru Dere (40 m) in the south (Çolak *et al.*, 2013). The distance from the Sea varies between 2-10 km.

According to Saatçioğlu (1940), the forest was covering whole peninsula in the past and decreased considerably till current borders due to over exploitation during Byzantium term and thereafter ongoing exploitations and fires. During Ottoman period, the forest was used as a water resource for the city.

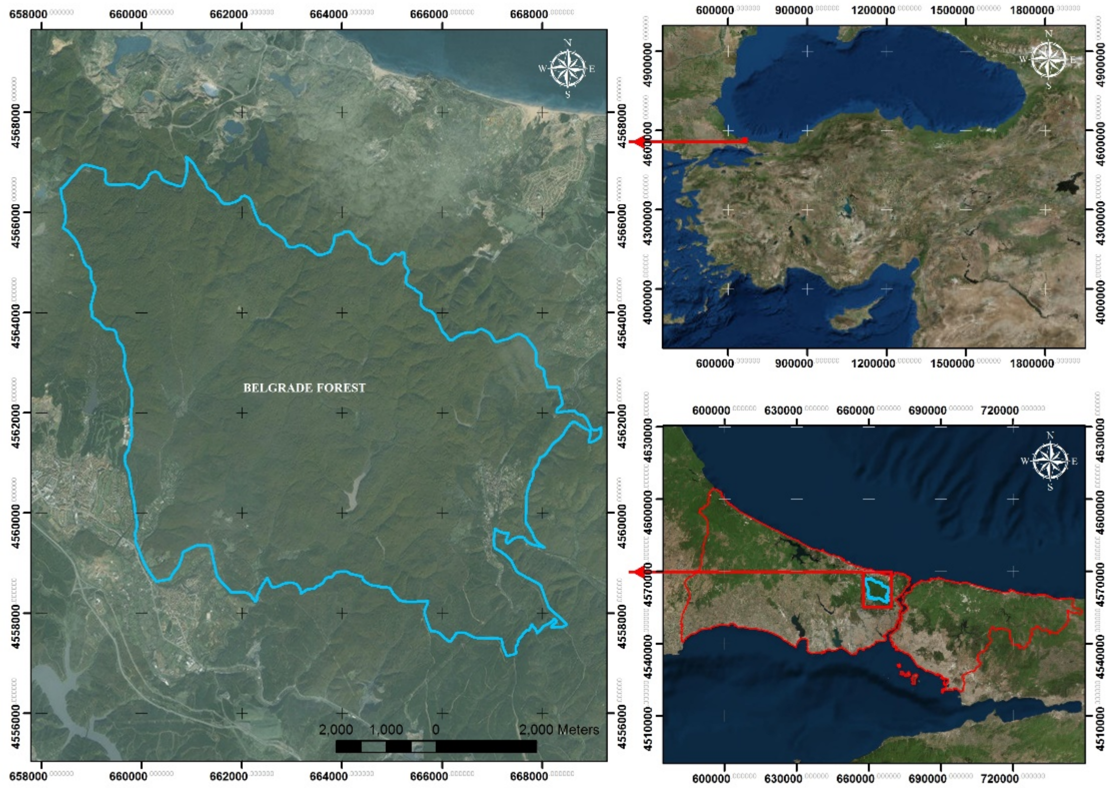

Figure 1: Location of Belgrade Forest

2.2 Climate and soil

According to Kantarcı (1980), Belgrade Forest has a climate type of humid, moderately warm with oceanic influences. Water deficiencies are only seen moderately in summer time and very humid in winter time. Vegetation period is about 7.5 months (230 days).

Large part the region is covered by limeless Neogene sediments (83.4%) which are stream materials. Under these deposits, carboniferous dust stones and greywacke schists occur. These schists cover 16.6% of the region. On carboniferous schists, brown forest soils develop which are shallow or moderately deep. On the other hand, quite deep podzolic brown soils, brown soils and pseudogleys develop on neogene sediments (Kantarcı 1980).

2.3 Vegetation

In terms of Mayr's climate zone classification, the study area falls in the *Castanetum-Fagetum* transition zone. Flora of Belgrade Forest contains Euxine-Colchic, Mediterranean and Central European elements (Yaltırık and Efe, 1989). According to Kayacık (1966), the ratio of Central European and Balkanic elements is 56,1 %, Mediterranean is 22 % and colchic is 18%.

Plant communities of Belgrade forest were firstly studied by Yaltırık (1963) according to Braun-Blanquet method. Yaltırık *et al.* (1983) classified plant communities as *Carpinus betulus-Acer campestre*, *Fagus orientalis-Ilex aquifolia*, *Quercus petraea* subsp. *iberica-Lathyrus niger*, *Erica arborea-Erica verticillata* communities. Second study was carried out by Yönelli (1986) who combined forest subcommunities to a higher unit called *Quercus petraea* subsp. *iberica-Carpinus betulus* which is composed of *Quercus frainetto*, *Fagus orientalis* and typical (*Castanea sativa*) subcommunities. As it was seen from these classifications, forest has an optimum conditions for Oak and Hornbeam trees. In addition, it was determined that 19 tree, 46 shrub and 316 species are found in Belgrade Forest from last flora research. Among herb species, 6 species are endemic and 9 species are rare (Çolak, 2013; Özalp, 2013; Özhatay and Yüzbaşıoğlu, 2013).

2.3 Method

In the context of the study, vegetation or forest maps and sample plot data which was used for forest stand type classification were evaluated. For this purpose, all available historical maps showing forest types of the region were found and classification methods were assessed considering development in forest science.

In the study, all maps were digitized using ArcGIS 10 geographic information system software and the areas of forest types were calculated.

The first map is dated back to 1888 which was prepared in the first years of the first Forestry School of Turkey (Fig. 2a). Second map was prepared after establishment of Turkish Republic in 1938 (Fig. 2b) in the context of first management plan. Third map was prepared in the second forest management period (1949) (Fig. 2c). Fourth map was prepared after a long time in 1986 by Yönelli (1986) who shows forest communities (Fig. 2d). The latest map was taken from Forest

Management Plan (2012) showing current condition of the forest (Fig. 2e).

Phytosociological studies which were carried out in the forest were compiled and a database was constructed by Çoban and Bayraktar (2016) using TURBOVEG (Hennekens and Schaminée, 2001) software. Structural characteristics of this vegetation database and its potential usage for forest management were also assessed.

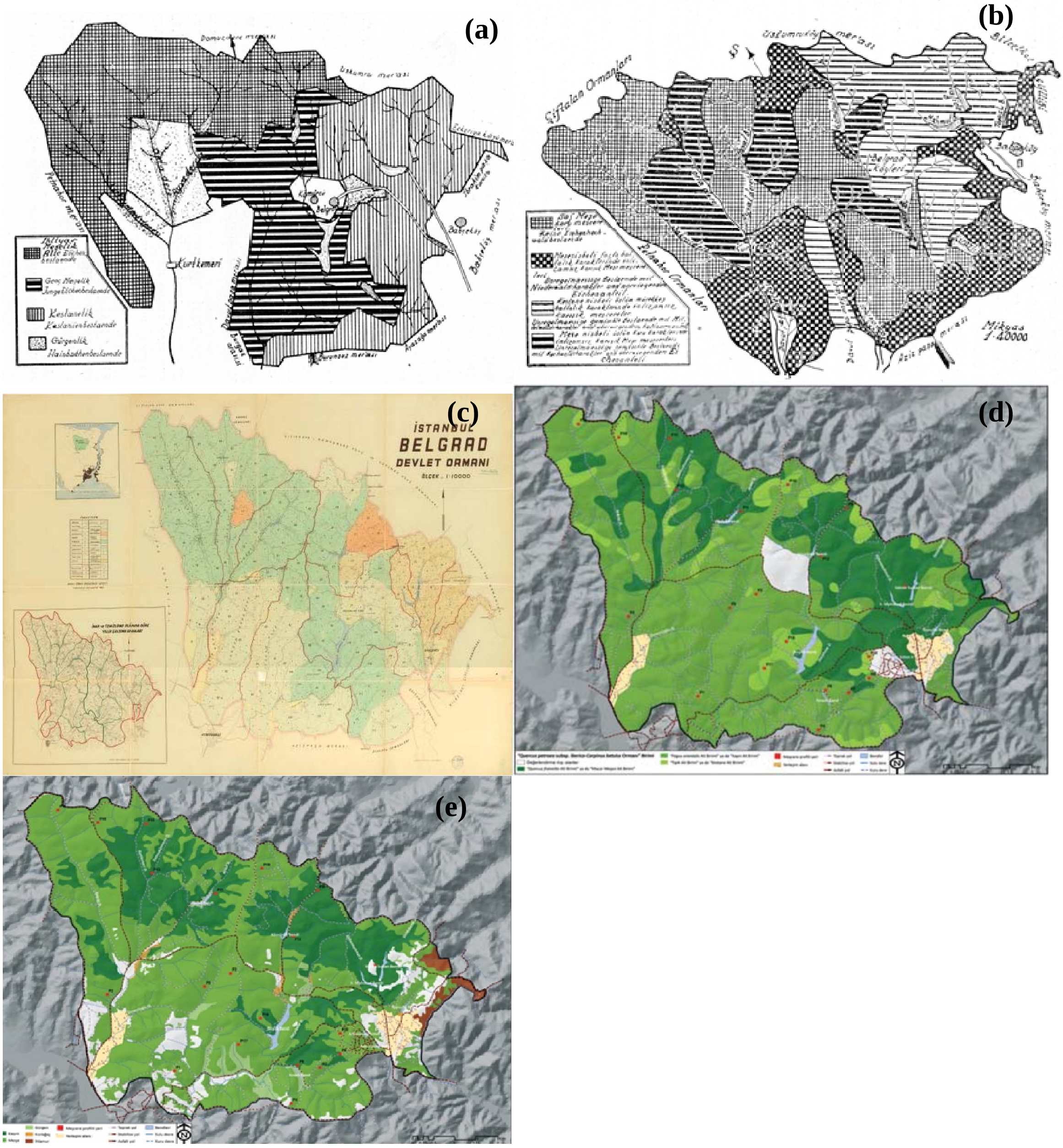

Figure 2: Maps showing forest types of Belgrade Forest from 1888 to 2012 (a: first forest map of 1888, b: first forest management map of 1938, c: forest stand map of 1949, d: forest vegetation map of 1986, e: forest management map of 2012) (Saatçioğlu, 1940, Çolak et al., 2013)

3 RESULTS

3.1 Historical forest vegetation maps

First known forest map dated back to 1888 was prepared by a student of the first forestry school of Turkey (Vural, 1940). In this map, forest types were classified broadly and gives information about general appearance of the forest and surrounding. It distinguishes four types of stands which include old oak, young oak, chestnut and hornbeam forests. In addition, land use types around the forests (i.e. meadows and settlements) were showed. However, beech forests were not mentioned. At that period, oak stands were covering large part of the forest as young or old stand (43%). Although coppice types was not used in the map, classification of

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oak forests as old and young forest might indicate irregular exploitation and undamaged forest types. For this reason, young oak forest may refer to irregular coppice forest which is found around settlement areas. Also, hornbeam forest around the settlements was probably in coppice character used for firewood. The map clearly shows that chestnut stands covered large areas (21%) at that period (Fig. 3).

First forest management plan of the forest was implemented in 1937 and the map of 1938 shows the situation in the beginning of first management period and also in the first decades of Turkish Republic. Furthermore, it is possible to see the terminology for forest stand classification. In this map, management type of the forest (coppice or high forest) were indicated in addition to dominant tree species. Also, pure and mixed stand discrimination were used for stand classification. In the description of the forest type, dominance of main tree species was emphasized (i.e. coppice forest of oak dominated mixed forest). The map distinguishes pure oak high forests, oak-dominated mixed forest with irregular coppice characteristics, chestnut-dominated mixed forest with irregular coppice characteristics and oak dominated mixed high forests. In this classification, hornbeam and beech were not indicated and all included within mixed stand structure. The sized of distinguished stand types were calculated that pure (30% of the area) and mixed oak forest (38 %) were covered most part of the forest. On the other hand, other main tree species like beech and hornbeam stands were not determined as a separate stand and more emphasis were put on oak. From this classification, only pure and mixed stands of oak and chestnut stands were distinguished with their management type (Fig. 3).

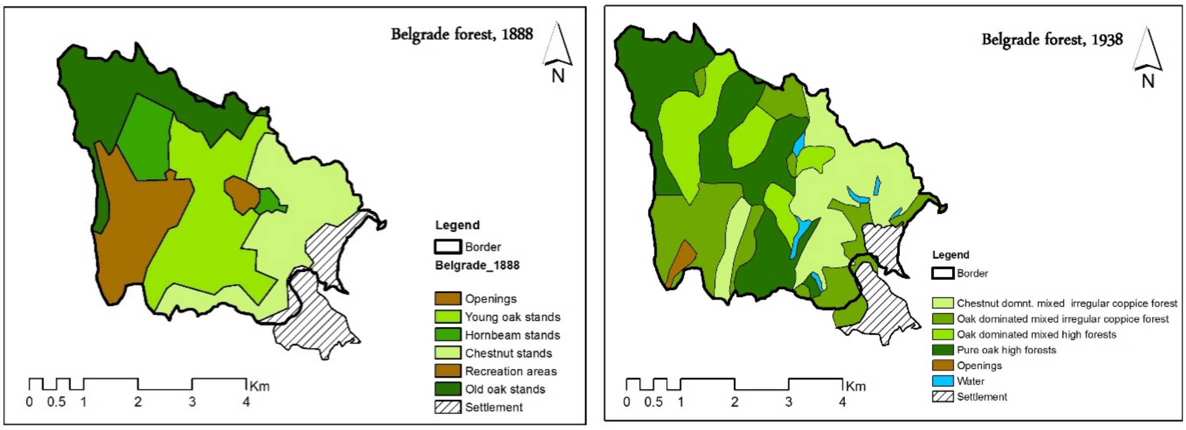

Figure 3: The first forest map prepared in 1888 (on the left) and forest management map of Belgrade Forest in 1938 (on the right) (modified from Çolak *et al*, 2013 and Saatçioğlu, 1940).

The map of 1888 shows that settlements inside and around the forest caused a decrease in the forest area due to farmlands and meadows in addition to irregular coppice stands. On the other hand, old oak forests further from settlements and main roads were not damaged much and the forest was mostly surrounded by meadows which are Ayazağa, Burunsuz and Davupaşa meadows in the south; Bahçeköy and Zekeriyaköy Meadows in the east; Uskumruköy and Domuzdere meadows in the north, Petnahor meadow in the west. From 1888 to 1938 forest openings were decreased and coppice stands were developed. However, chestnut stand were covered same areas and sizes of the stands were not change much (Fig. 3 and Table I).

Table I: Sizes of forest types in the map of 1888 and 1938

1888		**1938**	
Stand type	Area (ha)	Stand type	Area (ha)
Old oak stands	1131.40	Pure oak high forest stands	1771.32
Young Oak stands	1381.14	Oak-dominated mixed coppice stands	1343.21
Chestnut stands	1263.26	Oak-dominated mixed high forests	899.27
Hornbeam stands	413.67	Chestnut-dominated mixed coppice stands	1329.41
Openings	975.21	Openings	58.69
Settlements	676.41	Settlements	424.26
Total	5841.10	Total	5826.16

3.2 Developments in forest management periods

Forest management plans of the Belgrade forest was firstly prepared in 1937 and renewed in 1949, 1970, 1990, and 2012. Figure 3 shows the status of the forest at the second forest management period which based on 758 survey plots. In this map, forest types in this map were given as Beech, Oak coppice, Oak high forest and irregular Chestnut stands. The map differs from previous maps with the beech stand unit which was firstly described.

With the changing management purposes, timber production function of forest were replaced with soil protection, hydrological functions, health and aesthetical functions (Şad and Kızıl, 1996). In the recent forest management plans, wood production function were not considered and coppice forest were subjected to conversion to high forest. Similarly, these plans considered dominance of tree species and also stand structural characteristics in terms of aforementioned functions of the forest (Fig. 4). Currently, stand discrimination is based on tree species, stand development stage, horizontal cover and layers in even-aged forests. In addition, stand consisting of one species with a 90% ≥ volume are accepted as pure stands and any tree species incorporating stand mixture with a value of 10 % ≥ are accepted as mixed stands. Tree species which occur in the stand lower than 10% threshold value are not included in stand type which is a lack of these maps.

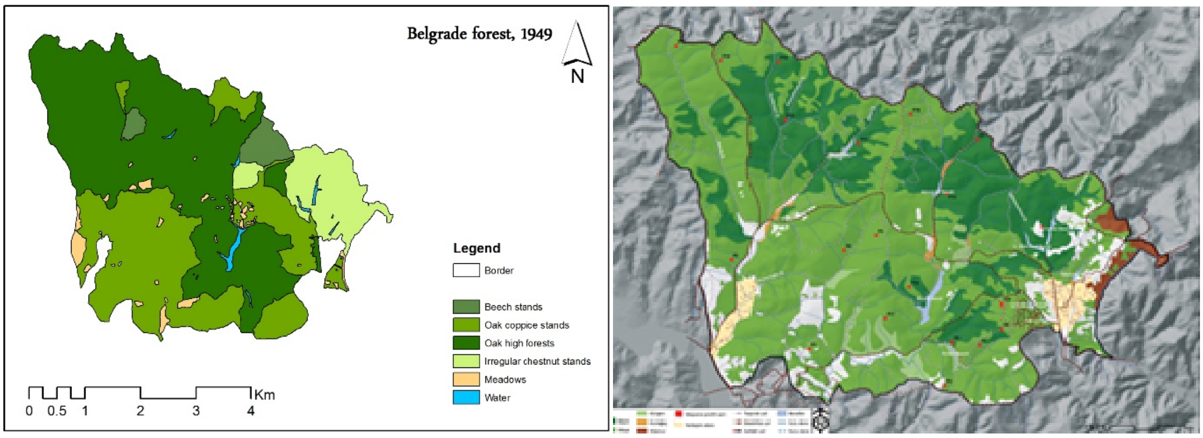

Figure 4: Forest stand maps prepared in 1949 and 2012 (Forest management plans of 1949 and 2012)

When the changes in forest stand types were compared, a gradual decrease in chestnut stands can be clearly seen and also openings were closed and classified as coppice stands of oaks in the map. On the other hand, comparison between other stand types is not possible due to dominance of tree species were considered in forest management plan of 1949. For example, only pure stands of beech were given in the map and their mixture with oak species were not mentioned and accepted as oak stands (Table II).

Table II: Sizes of forest types in the map of 1949 and 1986

1949		1986	
Stand type	Area (ha)	Forest communities	Area (ha)
Chestnut stands	539.26	Castanea sativa sub-community	426.59
Oak high stands	2713.62	Quercus frainetto sub-community	1484.41
Oak coppice stands	1763.57	Fagus orientalis sub-community	3250.67
Beech stands	172.75	Settlement	247.21
Meadows	137.01	Openings	432.22
Total	5326.21	Total	5841.10

3.3 Phytosociological studies and vegetation maps

In parallel with forest management plans, phytosociological studies were also carried out in the forest since 1963. Plant communities of the forest were firstly studied by Yaltırık (1963) who took releves from pre-defined stand types and identified plant communities were described with the characteristic species. The dataset includes 104 relevés and 129 species. Average number of species and Shannon diversity per relevés was calculated as 20.31 and 2.12 respectively. The second study was carried out by Yönelli (1986) who took 549 releves (352 taxa) from natural and plantation areas (*Pinus brutia, Pinus nigra* ssp. *pallasiana, Pinus pinaster, Pinus strobus*) which cover most of the forest. Average species numbers and shannon diversity per relevés were found to be 36.92 and 2.47 respectively. In addition, forest stand profiles, which shows stand structural diversity, were prepared by Yönelli (1986) (Fig. 5 and Table III).

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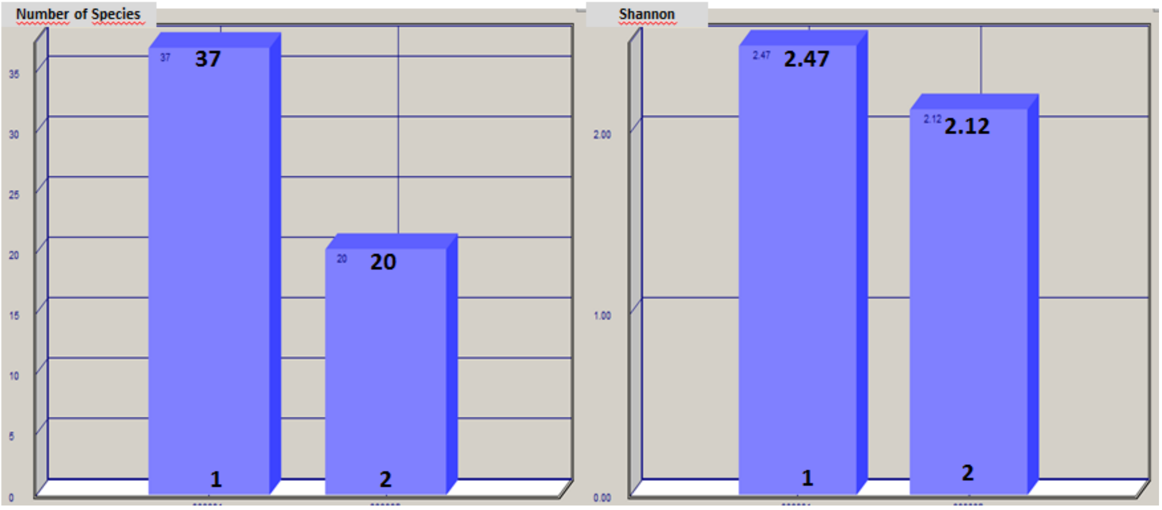

Figure 5: Average species number in phytosociological datasets (1: Yönelli /1986/; 2: Yaltırık /1963/)

Table III: Summary of vegetation datasets (Çoban and Bayraktar, 2016)

Author/s	Nr of releves	Minimum	Maximum	Average	Std_deviation
Yönelli (1986)	549	10	67	36.92	9.14
Yaltırık (1963)	104	6	40	20.31	7.66

Forest vegetation map based on 549 releves distinguished 3 forest sub-communities under *Quercus petraea* subsp. *iberica-Carpinus betulus* community. Each forest community was described with their differential species and stand structural characteristics. *Castanea sativa* forest type which were determined as a typical sub-community covers 426.59 ha. On the other hand, *Fagus orientalis* sub-community cover large part of the forest (3250.67 ha). However, *Quercus petraea* occur in all forest communities. In addition, *Quercus frainetto* sub-community was firstly determined as a seperate unit for the first time with this vegetation map which was not distinguished in forest management maps (Fig. 6).

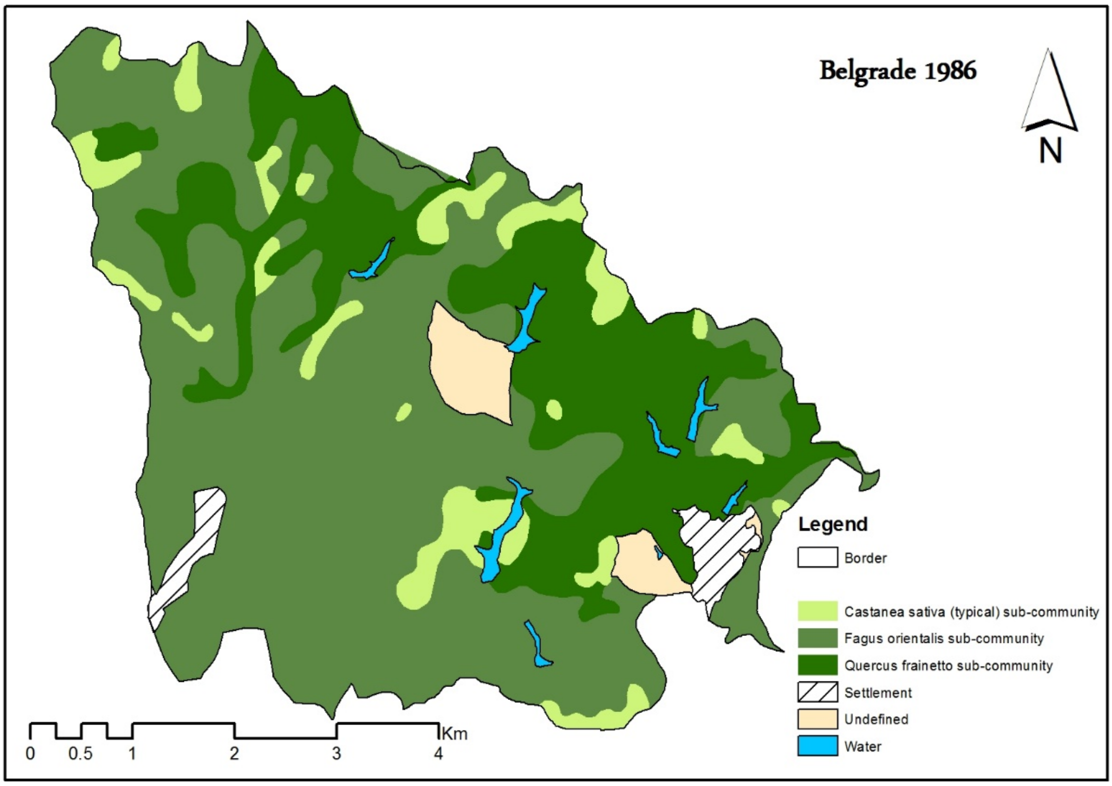

Figure 6: Vegetation map of Belgrade forest (modified from Yönelli 1986)

Vegetation database of the forest consists of environmental data which describes site conditions. However, it is possible to increase environmental variables (soil type, site quality, bedrock type) of each syntaxa from a variety of studies carried out in the forest. Both phytosociological studies complete deficiencies of each other. For instance, Yönelli (1986) have high number of sample plots including plantation areas. However, this study does not include maquis (pseudomaquis) vegetation which occur within the forest openings and surrounding of the forest. On the other hand, Yaltırık (1963), covers all vegetation types including maquis and low-lying damp alder stand which occur in limited areas along streams. The vegetation database includes slope, aspect, altitude and top stand height in addition to species composition data (Table IV).

Table IV: An example of header data of Belgrade Forest vegetation database (Çoban and Bayraktar, 2016)

Relevé number: 16		Relevé number: 655	
Author	: Yönelli (1986)	Author	: Yaltırık (1963)
Nr. relevé in table	:189	Nr. relevé in table	: 3
Cover abundance scale	: Braun/Blanquet (old)	Cover abundance scale	: Braun/Blanquet (old)
Date (year)	: 1963	Date (year)	: 1986
Relevé area (m^2)	: 400.00	Relevé area (m^2)	: 200.00
Altitude (m)	: 90	Altitude (m)	: 89
Aspect (degrees)	: NW	Aspect (degrees)	: NNE
Slope (degrees)	: 20	Slope (degrees)	: 30
Height (highest) trees (m)	: 18	Richness	: 15
Community	:*Quercus frainetto* subcom.	Shannon	: 1.72
Richness	: 29	Evenness	: 0.64
Shannon	: 2.49	Simpson	: 0.71
Evenness	: 0.74		
Simpson	: 0.87		

Phytosociological sample plots consist of all plant species in contrast with forest management survey plots which include only tree species exceeding %10 volume or stem numbers. Other species with an amount of less than 10% are not recorded in the survey plots. However, many tree species which are important in stand composition occur in Belgrade forest. For instance, the forest has optimum conditions for oak species and contain *Quercus petraea, Quercus frainetto, Quercus robur, Quercus cerris, Quercus infectoria and Quercus coccifera.* In addition to these, there occur many deciduous and shrub species co-occurring with main tree species (Table V). In the phytosociological data, it is possible to distinguish all tree species in each stand layer in addition to herb species. On the other hand, seedling or saplings of tree species stored within the herb layer show regeneration status of stands.

Table V: Tree and shrub species in vegetation database of Belgrade Forest

Tree layer	Shrub layer	
Acer campestre	*Arbutus unedo*	*Prunus divaricata*
Acer trautvetteri	*Calluna vulgaris*	*Prunus spinosa*
Alnus glutinosa	*Chamaecytisus pygmaeus*	*Prunus x domestica*
Carpinus betulus	*Cistus creticus*	*Pyracantha coccinea*
Castanea sativa	*Cistus salviifolius*	*Pyrus elaeagnifolia*
Fagus orientalis	*Clematis vitalba*	*Pyrus malus*
Fraxinus angustifolia	*Cornus mas*	*Quercus coccifera*
Pinus nigra s. pallasiana (plantation)	*Cornus sanguinea*	*Rosa canina*
Pinus pinaster (plantation)	*Corylus avellana*	*Salix cinerea*
Pinus sylvestris (plantation)	*Crataegus monogyna*	*Sambucus ebulus*
Pinus brutia (plantation)	*Daphne pontica*	*Smilax excelsa*
Pinus strobus (plantation)	*Erica arborea*	*Sorbus domestica*
Populus tremula	*Erica manipuliflora*	*Spartium junceum*
Quercus cerris	*Euonymus europeaus*	
Quercus frainetto	*Frangula alnus*	
Quercus infectoria	*Genista tinctoria*	
Quercus petraea	*Hedera helix*	
Quercus robur	*Ilex aqifolium*	

Tilia argentea	*Ilex colchica*
Cerasus avium	*Laurocerasus officinalis*
Juniperus oxycedrus	*Laurus nobilis*
Populus tremula	*Ligustrum vulgare*
Populus alba	*Malus sylvestris*
Sorbus domestica	*Mespilus germanica*
Sorbus torminalis	*Osyris alba*
Abies bornmülleriana	*Phillyrea latifolia*

3.4 Historical developments and vegetation change

Belgrade forest is very important in terms of presenting historical development effecting improvement in forest science of Turkey due to pioneering studies carried out there. These studies, which were implemented in this forest, encouraged foresters for further application in all around Turkey. Following the history of Turkish forestry, scientific methods were increasingly continued but this development process was interrupted during WWI and Independence War of Turkey. Therefore, damages were occurred in forest structure due to authority gap. In the subsequent processes, establishment of Turkish Republic and enacted forest laws implemented planned method for managing forests. However, more informative floristic researches and vegetation maps prepared for forest communities were not adopted in forest management plans (Table VI).

Table VI: Development in forest science and vegetation mapping with historical processes in case of Belgrade forest (developed from Eraslan (1963), Şad and Kızıl (1996), Çolak et al. 2013) (intensity of red colour represent the degree of disturbance)

Year	1857 Forestry faculty; 1870 First forest directory; 1888 First forest map; 1894 Removal of villages	1917 1st Management of Rep. of Turkey; 1918 WW I and Independence War; 1923 Establishment of Rep. of Turkey.; 1924 State Forest Enterprise	1937 Forest law (Nr. 3116); 1938 1st Belgade Forest Manag. Plan; 1949 1st Revision plan of the forest	1953 Protection Forest; 1956 Forest Law (nr.6831); 1957 First recreation areas	1963 Pytosociological studies; 1986 Pytosociological studies; 2012...
Event	First attempts to manage forest	Planned management term of Turkey Forest damages during the wars	Conservation policies in the first decades of the Republic of Turkey	Status of forest changed Picnic areas were opened	Floristic and ecological characteristics of the forest were studied.
Description	With the increasing inhabitants, illegal fire wood exploitation caused damages. Belgrade villages were removed due to pollution in water resourses of İstanbul. First forestry school were established and the forest subjected to many researches.	First forest management plan of Turkey were conducted which prometed further plans. Forests were decided to managed as high and coppice forest forms with forest management plans	Rehabilitation and improvement of the forest were given to the forestry faculty First forest management plan of the forest were completed.	Legal status of the forest was defined as 'Protection Forest'.	Forest communities were determined using Braun-Blanquet method.
Stand classification	Forest stands were classified with a dominance type approach				Floristical classifications
	There is not a standart for stand classification.	Coppice and high forest management forms were adopted in management plans.	Coppice and high forest, stand development stage, dominance of trees and canopy cover		
Disturbance type	With the increasing inhabitants, illegal fire wood exploitation caused damages.	Autority gap caused illegal and over exploitation during the war	After the establishment of Republic of Turkey, strict conservation precautions were taken.	Some recreational areas were allowed around dams which increased forest degradation.	
Disturbance intensity					

4 DISCUSSION AND CONCLUSION

First records about the flora of Belgrade forest dated back to 16th century (Belon, 1517-1564). Since that time, many famous botanists had been visited the forest and published plant lists which contributed to phytosociological studies. Establishment of forestry school (1857) accelerated scientific researches which laid the foundations of sustainable forest management (Çolak *et al.*, 2013.). Until 1857, a forestry based on a planned and sustainability principle had not been implemented in Turkey. For this reason, it was accepted that forestry began with the establishment of the first forestry school of Turkey in 1857 (Eraslan, 1963). An important progress were started with the first forest management plan of Turkey which was carried out in Adapazarı-Hendek by a team of Turkish and Austrian foresters in 1917. Following the establishment of Turkish Republic, management of forests with methods concerning sustainability were increasingly adopted with the legal rules (i.e. Forest Law No: 3116) and forest management plan of Belgrade forest was firstly put into practice in 1937. During these developments, available historical forest stand maps show the progress in forest stand classification.

From historical perspective, forest maps were prepared based on main forest tree species and also management type (coppice or high forest). Implementation of aerial photographs and statistical methods enabled discrimination of forest stands up to 1 ha in currently applied forest management plans. In this method, forest stands are determined with tree species, mixture ratio, stand development stage and cover density and these are represented with standardized symbols (Eraslan, 1971). On the other hand, tree species with the lowest mixture ratio (less than 10% cover value) are not included in the stand type. Forest stand maps which use same classification methodology are more applicative in terms of monitoring the success of forest management on nature conservation. Forest maps of Belgrade Forest, which were prepared in different time periods, show the development in forest stand classification from past to present. Beside this progress in forest management, phytosociological studies which integrate information on forest's current and potential composition were completed in the forest. Developments in the digital storage and numerical analysis of vegetation data, which had started in the 1960s, provided many opportunities for further usage of phytosociological datasets (Mucina and van der Maarel 1989). In this context, Belgrade Forest, which has a longer history in terms of scientific researches and many ecosystem based studies, can be accepted as a sample forest for Turkey. For instance, detailed phytosociological studies and vegetation maps can be combined with forest stand maps. Thus, close-to-nature management approach can be achieved and a multifunctional base for sustainable forest management can be obtained. However, floristic composition of the stands were not considered although available phytosociological studies for a long time. According to Pott (2011) plant communities, which are classified with their floristic composition, express all historical, sociological and local influences. Also, the use of plants and of plant communities as indicator for land planning and nature conservation policy is in principle quite accepted in most countries (Loidi, 1994). The use of vegetation maps based on forest types with detailed information on composition instead of maps based on dominant tree species will also contribute to the assessment of the indicator tree species composition (Blasi and Burrascano, 2013). For this reason, plant community maps encompass much more information then forest maps prepared based on main tree species. Because each forest community consists of characteristic species which repeated in the same communities. Also, further analysis of species composition reveals information about site conditions and also disturbance regime with indicator plans. Plant community maps also provide basis for hemeroby and naturalness maps.

Assessment of forest degradation for longer periods are not sufficient from these maps although many existing historical documents. Because, historical forest maps does not present a detailed information due to different classification schemes which they adopted. In addition, some anthropogenic effects cannot be seen easily from stand types determined from dominance of tree species. On the other hand, remarkable changes can be observed in terms of coppice forests and chestnut forest areas. For instance, the effect of the conservation attempts after the establishment of Forestry school and removal of villages can be seen from the maps of 1888 and 1938. Removal of villages inside the forest had caused a decrease in irregular coppice stands and also openings (or meadows) from 1888 to 1938. Also, these protection precautions were interrupted with the World War I and following Independence War of Turkey which caused over exploitation of valuable oak forests due to authority gap (Çolak *et al.,* 2013; Çoban and Akgül, 2014). Due to these damages, strict protection measures were implemented and regular forest management plans were started. Because of the importance of the forest, forest functions were redefined and conservation approaches were adopted. Following these advances considerable changes have been occurred in the forest structure especially in the areas of coppice and high forests. But, stands of chestnut has dramatically decreased due to Ink disease (*Phytophthora cambivora* /Petri/ Buisman) and Chestnut blight (*Cryphonectria parasitica* /Murrill/ Barr) (Çolak *et al.*, 2013.).

Sustainability of forests can be ensured with the ecosystem management referencing reliable documents. For instance, forest biological diversity (tree species composition, naturalness and deadwood) is accepted one of the criteria and indicator for sustainable forest management (Blasi and Burrascano, 2013). Vegetation maps which reflect biological diversity of the forests more or less can be accepted among the main references for monitoring biological diversity. Although vegetation maps based on floristical composition are not widespread in Turkey, some important forest areas were intensively studied in terms of vegetation classification and vegetation mapping (i.e. Aksoy, 1978; Yönelli, 1986). On the other hand, forest stand types are also classified with the aim of forest management for all forests of Turkey for a long time. These two approaches which have a long-standing background must be evaluated as an integrated basic for a sustainable forest management.

The results also indicated that GIS can be used to effectively monitor and analysing of forest pattern changes in long term.

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TREE CROWN STRUCTURE OF DOUGLASS FIR (*PSEUDOTSUGA MENZIESII* [MIRB.] FRANCO) ON THE KARADZICA MOUNTAIN

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ABSTRACT: This paper presents the results of surveys and studies of some of the elements that characterize the crown of the trees of Douglass fir (*Pseudotsuga menziesii* [Mirb.] Franco) on Karadzica Mountain. On this mountain the Douglass fir had been introduced in 1967 in the zone of Sessile oak forest, and in its 50 years of development showed very good adaptability and productivity, which exceeds all other introduced non-native tree species, as well as other native tree species. Considering that the crown of the trees of Douglass fir on the Karadzica Mountain has not been studied yet, in this paper the structural elements were analyzed through mathematical-statistical methods and relevant data was obtained for the main structural elements that characterize the crown. The biological position of all the trees was determined, which are grouped into three groups and for all of them following elements have been identified: the width of the crown, chest diameter, the heights of all trees, the absolute length of the crown, the relative length of the crown, horizontal projection of the crowns, the crown index, the coefficient of space for growth and relative space for growth of the tree, depending on the biological position of the trees. The results indicate that in the 50 years of development in the researched forest stand, the trees clearly differentiated into three biological positions with clear patterns in terms of the development of their crowns. However in order to improve the situation in the forest stand and directing their development in the optimum direction it is necessary to perform thinned cuttings in order to regulate the numbers of trees per unit area and their spatial distribution in the forest stand in order to achieve better use of space for the development of the trees.
Keywords: tree crown, Douglass fir, structural elements, Karadzica Mountain.

1 INTRODUCTION

The Douglass fir (*Pseudotsuga menziesii* [Mirb.] Franco) in the scientific literature is described as large and long-living forest tree that has rapid growth and big production of timber. It can reach heights of up to 100 m, 4 m in diameter and age of about 1200 years. Natural range of distribution of Douglass fir are the Pacific regions of North America from British Columbia to California, north to south, on the altitudes up to 900 m. The first samples of Douglass fir in Europe were planted in UK in 1825 (Dzekov 1988).

Douglass fir is the most important introduced tree species for the Macedonian forestry. It has been first time introduced in the beginning of 1960. It is provenance is originally from Oregon (USA).

In the researched area on Karadzica Mountain the Douglass fir was planted in 1967 on northwestern exposure and at the age of 45 years has an average diameter of mean wood (at 1.30 m) of 30.5 cm and a height of 30.0 m. It features good health, great adaptability to the specific natural conditions of the area and the high productivity of the timber which is 621.77 m³ / ha at the age of 45 (Velkovski et el., 2012).

Green Douglass fir is one of the world's most valuable and most important species for wood production (Larson 2010). It is a species that successfully adapts to different external conditions and to retain high growth and enables high production of good quality wood (Weise et al., 2001; Kenk & Thren 1984). Ecological amplitude of green Douglass fir is great, but when creating plantation it should be taken into account the soil type because certain provenances suffered damages of abiotic origin. Therefore choosing the type of provenance in green Douglass fir is very important (Perić et al., 2011).

By studying the results of introduction of conifer tree species in the country, as well as the elements that characterize the crown of the trees by many authors such as: Andonovski, 1978; Ivanovski 1978; Panić 1966; Ristevski 1984 & 1987; Trajkov 1992; Velkovski 1999 & 2007; Mirchevski & Vasilevski 2000; Velkovski et al. 2012; Delov et al. 2014, it suggests that this species is very adaptable and is characterized by much higher productive capacity than other introduced tree species such as: *Pinus strobus* (L.), *Chamaecyparis lawsoniana* (Parl.), *Larix decidua* (Mill.) and *Larix europaea* (DC.), as well as other indigenous tree species *Fagus moesiaca* (Domin, Maly) Chezzot and *Quercus petraea* (Matt.) Liebl..

Crown of trees as one of the main factors for the development of every tree has been studied by a number of authors from home and abroad: (Ivanovski 1971 & 1978; Krstevski, 1975; Andonovski, 1978; Panić 1966; Ristevski 1984 and 1987; Trajkov 1992; Borrmann 1993; Perermann 2000, Velkovski 1999 and 2007; Takenaka 2000, Mirchevski&Vasilevski 2000, Grote 2003; Purves et all. 2007; Schröter 2012; Velkovski et al., 2012; Delov et al. 2014; Krstić et al., 2013 & 2016 and others.

From previous studies on crowns in different tree species on different sites is understood that the crowns can have different sizes of their parts, and also the relationship between the individual parts may be different. These differences are specific to each different tree species and every different site condition and development. The shape and construction of the crown are influenced by a number of factors such as: age of the tree, its location in the plantation, exposure to wind, the genetic characteristics of the species, the application of tending measures in plantations, and other biotic and abiotic factors.

The location of the tree and its exposure to direct sunlight has a substantial impact on the tree crown development and on the other life processes such as assimilation, transpiration, flowering, pollination and fructification. The amount of light exposure on the crown affects its development so the trees that grow in conditions of more light exposure generally have more

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ramified crowns which are richer in leaf mass. All the trees in the forest stand have the intention to develop larger canopy in order to gain the greater amount of light and larger living space. However due to the limited space in forest stands there is competition between the trees, so more developed trees and those with better biological position develop larger canopy at the expense of other trees that still lag behind in its development. With increasing age of the trees and the increase of their dimensions the competition among the trees is bigger due to insufficient space in the forest stands and dense canopy those trees that lags in development and has not developed its crowns are lagging even more in their growth and in a certain period they will be completely suppressed by the trees that formed a widely ramified crowns.

This situation will contribute to the gradual withering away of suppressed trees in the forest stand, and those with underdeveloped crowns. The construction of the crown is of great importance in silvicultural activities, because it is a very good indicator of the need for performing tending measures in forest stands. By performing various tending measures the crown development can be influenced, and the living space of the tree can be regulated. It is known that the development of the crowns is used as an indicator of when the start with performing with thinned cuttings. The start of intensive withering away of the lower branches of the tree trunks is a sure sign that it is a time to start performing thinned cuttings (Krstić 2007).

2 MATHERIAL AND METHODS

Douglas fir plantations of which are object of the research in this paper are on Karadzica Mountain, in the central part of Republic Macedonia, west of the river Vardar. The researched area belongs to cold continental climate zone, dominated by the forest association *Orno-Quercetum petraea* Em (Sessile oak forest association).

In the researched area prevails cold continental climate with some influence of the mountain climate. The average annual temperature calculated according to vertical gradients of this area is 8.6 to 9.6 ºC, or an average of about 9º C. The absolute maximum was 41.9º C, while the absolute minimum -19.8ºC. The average annual rainfall ranges from 900 to 940 mm. Data are teken from water stations from Solunska Glava and Katlanovo and processed for 10 years. The geological substrate is a silicate which includes eutric brown forest soils, medium deep, with fresh hummus. Overall natural conditions of the researched area proved to be favorable for the development of Douglass fir.

During 2016 in the plantations of Douglass fir measurements were taken on the elements that characterize the tree crowns. Measurements covered trees of Douglass fir in two test areas with size of 500 m² each located on the site named Kitka. Following parameters were measured: tree diameter at breast height of each tree individually, the heights of all trees, the absolute length of the crown, the radii of the crown towards the four corners of the world (east, west, north and south) and the biological position of trees in three classes (classification according Stojanović & Krstić 2008) with I-class includes the dominant tree, II-class co-dominant trees, III-class suppressed trees. The results are grouped in tree diameter size classes and allocated appropriate biological position of trees in three classes. From the collected data and mathematical and statistical calculations and analyzes following parameters were determined: the average diameter of the crown, the horizontal projection of the crown, the relative length of the crown, the crown index, the coefficient of space for growth and relative space for growth of the tree. The results are presented in appropriate tables and graphs, and appropriate conclusions were drawn from the analyzes and calculations.

Figure 1: Trees of *Pseudotsuga menziesii* at the researched area

3 RESULTS AND DISCUSION

A number of factors affect the elements and the development of the tree crowns, such as the type of tree species, the availability of light to the crown, the age of the tree, location, genetic traits, tending and silvicultural measures taken in the plantation, site condition index, biological position of trees in the forest stand and others. It contributes that for a single tree species in the same forest stand to have trees with different crown construction, which in turn further affect the development of the tree as a whole.

The researched forest stands of Douglass fir are located on altitude of 1112 to 1374 m a.s.l. and on moderately strong inclination slope of the ground from 11-20 °. They are aged 50 years and have a canopy cover of 1.0. The number of sampled trees per hectare in the two test areas (TA-1 and TA-2) was 540 and 820, or average 680 trees per hectare. Of the total number of trees 58% are dominant and belong to the I class, 32% co-dominant belong to the II class, and 10% are suppressed and belong to the III class.

Table I: Number of trees distributed in tree diameter size classes

Tree diameter size classes	TA-1		TA-2		Mean	
	N/ha	%	N/ha	%	N/ha	%
17.5	80	14.8	110	13.4	95	14.0
22.5	60	11.1	150	18.2	105	15.5
27.5	60	11.1	90	11.0	75	11.0
32.5	160	29.7	190	23.2	175	25.7
37.5	100	18.5	190	23.2	145	21.3
42.5	80	14.8	90	11.0	85	12.5
Total	540	100	820	100	680	100

In the research of Krstić et al., (2013) in artificially raised plantations of Serbian spruce with age of 51 years 64% of the trees belonged to I-biological position, 32% were in the II-biological position, and 4% were in III-biological position. In the Serbian spruce seed stand from the area of Srebrenica similar results were obtained, according to which 70.9% of the trees belonged in I-biological position, 25.7% were in the II-biological position, and 3.4% were in the III-biological position, Krstić et al., (2016).

The diameter of the crown represents its widest part. It is determined based on the measured radii of the crowns against the four corners of the world. Then with calculations the average diameter is obtained for each tree diameter size class appropriately allocated towards the biological status of the trees in the forest stand.

The results for the average diameter of tree crowns of Douglass fir is distributed in tree diameter size classes and biological positions are shown in Table II and are presented graphically in Fig. 2.

Table II: Tree crown diameters per diameter size classes and biological positions (CBP)

CBP	diameter degrees (cm)						
	17.5	22.5	27.5	32.5	37.5	42.5	Mean
	Mean diameter in meters						
I			4.76	5.80	6.19	6.54	5.82
II		4.16	4.77	5.75	5.82	6.11	5.32
III	2.92	3.86	4.05	5.16	5.76		4.35

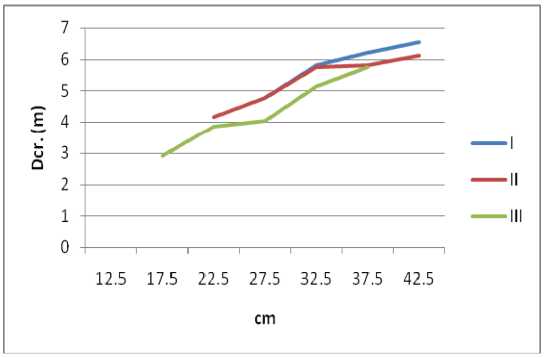

Figure 2: The curves of tree crown diameters per diameter size classes and biological positions

The results for the tree crown diameter presented in Table II and graphically in the Fig.2 show that in all the trees, in whatever biological position there is a trend of increment in the crown diameter with increment of the diameter size class. The biggest i.e. dominant trees have the largest crowns diameters in all diameter size classes. The trees in the III-biological position have the smallest crown diameter, because according to their biological position in the forest stand they are suppressed trees and failed to reach larger diameters and develop their crowns as those co-dominant and dominant trees. The difference in crown diameters between the trees of the I and II-biological position is not very high which indicates more equal development of the crown diameter of these two classes up to the diameter size class of 32.5. Then greater differentiation is observed resulting from the dominant trees in larger diameter size classes that managed to further develop its crowns at the expense of co-dominant and suppressed trees. The biggest mean crown diameter has trees of the I-biological position, which ranges between 4.76 m in the diameter size class of 27.5 and 6.54 m in the diameter size class of 42.5 cm. The mean crown diameter among the trees of the I-biological position is 5.82 m. The mean crown diameter of the trees of the II-biological position varies between 4.16 m in the diameter size class of 22.5 and 6.11 m in the diameter size class of 42.5 cm. The mean diameter among the trees of the II-biological position is 5.32 m. The smallest diameter of the crown have the thinnest trees of III-biological position, found in the diameter size class of 17.5 cm, where the average diameter is 2.92 m and ranges up to 5.76 m in the diameter size class of 37.5 cm. The mean diameter of the crown of the trees from the III-biological position is 4.35 m.

The values of mean crown diameter of Douglass fir are smaller than ever determined values for mean crown diameter of the beech on Maleshevski Mountains ranging between 5.46 m to 8.56 m (Velkovski 2007), the beech on Kozhuv Mountain ranging from 6.00 m to 6.80 m (Ristevski 1984), the beech on the Osogovo Mountains ranging from 5.00 m to 6.90 m (Ivanovski 1978), the beech on Rudnik ranging between 4.40 m and 7.00 m (Panić 1966), mixed forest stands of beech and black pine in the east forest region in Macedonia ranging from 3.40 to 9.00 m (Trajkov 1997), and the mean crown diameters in Giant redwood on Karadzica Mountain ranging from 4.04 m to 6.42 m (Delov et al. 2014). However, they are larger than the crown diameters of Serbian spruce, in the seed stands in the area of Srebrenica, which among the trees of the I-biological position have crown diameters of 1.70 m, among the trees of the II-biological position 1.49 m and in the trees III-biological position the crown diameter was 1.14 m (Krstić et al., 2016). These results are dependent on tree age, canopy, application of tending measures, the density of the forest stands as well as the genetic characteristics of tree species, so some trees form large crowns (beech, etc.), while other naturally form narrow crowns (Serbian. spruce).

Absolute crown length is obtained as the difference of the total height of the tree and the stem length.

Figure 3: Crown length of *Pseudotsuga menziesii*

The results for the absolute crown length of the trees of Douglass fir is distributed in diameter size classes and biological positions of position are presented in Table III and are graphically shown in Fig. 4.

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Table III: Absolute crown length, classes and biological positions (CBP)

CBP	diameter degrees (cm)						
	17.5	22.5	27.5	32.5	37.5	42.5	Mean
	Absolute crown lengthin meters						
I			5.00	6.00	7.50	8.25	6.69
II		3.83	4.40	5.50	6.25	6.50	5.30
III	1.00	3.60	4.00	4.50	4.83		3.59

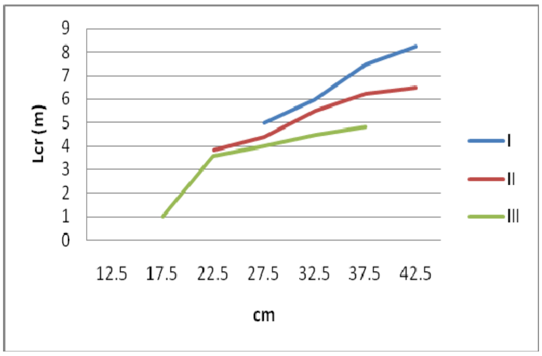

Figure 4: The curves of crown lengths per diameter degrees for different tree social positions

The results on the absolute crown length listed in table III and graphically illustrated in Fig.4 shows that with the increase in their size, the absolute crown length of all trees has also increased, regardless of their biological position. The trees belonging to the I-biological position have the highest absolute crown length ranging from 5.00 m with a diameter degree of 27.5 cm to 8.25 m with a diameter degree of 42.5 cm. The mean absolute crown length of the trees belonging to the first biological position is 6.69 m. The absolute crown length of the trees belonging to the II-biological position ranges from 3.83 m with a diameter degree of 22.5 cm to 6.50 m with a diameter degree of 42.5 cm. The mean absolute crown length of the trees belonging to the second biological position is 5.30 m. The thinnest trees belonging to the III-biological position have the lowest absolute crown length of 1.00 m with a diameter degree of 17.5 cm, and range up to 4.83 m with a diameter degree of 37.5 cm. The absolute crown length of the trees belonging to the III-biological position is 3.59 m. With the growth of the trees and the increase in their diameter degree, there is a distinct trend of higher differentiation in the value of the absolute crown length due to which trees of the I-biological position are increasingly separated from those of the second, whereas trees of the third biological position, due to decreased space and the expansion of trees of the first and second biological position are increasingly lagging behind in terms of the development of their crowns.

The confirmed values of the absolute crown length of the Douglass fir trees are lower in comparison with the so far confirmed values of the absolute crown length and ranged from 9.53 to 15.51 m for the fir on the Maleshevski mountains (Velkovski 2007), 9.20 to 12.00 m for the fir on Kozhuv (Ristevski 1984), 7.00 to 13.80 m for the fir on the Osogovski mountains (Ivanovski 1978), 7.00 to 14.80 m for the mixed plantations of fir and black pine in the Eastern forest region of Macedonia (Trajkov 1997), and 12.68 to 20.88 m for the sequoia trees on Karadjica mountain (Delov et al.) 2014). The measured values of the absolute crown length of the Douglass trees are higher in comparison with those of the Serbian spruce in the seed plantation of the region of Srebrenica, measuring 5.00 m for the trees of the I-biological position, 4.20 m for the trees of the II-biological position and 3.15 m for the trees of the III-biological position. (Krstić et al., 2016).

The relative crown length is obtained as the ratio between the absolute crown length of the tree and its total height. It shows how much of the total height of the tree is assumed by the crown of the tree, i.e. how much of the total height of the tree spreads out into branches.

Table IV: Relative crown length, classes and biological positions (CBP)

CBP	diameter degrees (cm)						
	17.5	22.5	27.5	32.5	37.5	42.5	Mean
	Relative crown lengthin percentage						
I			26.32	28.13	35.71	36.26	31.61
II		21.97	24.18	26.83	28.90	32.10	26.80
III	12.24	17.91	22.01	23.08	24.17		19.88

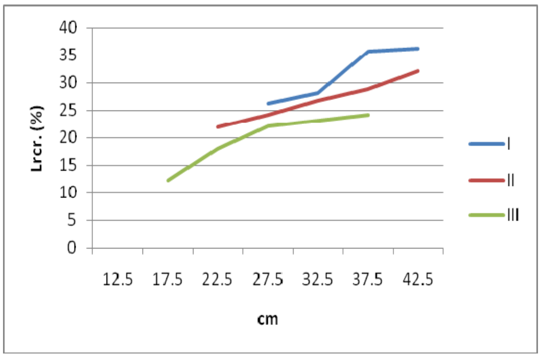

Figure 5: Relative crown length

The results on the relative crown length listed in table IV and graphically illustrated in Fig.5 shows that with the increase in their size, the relative crown length of all trees has also increased, regardless of their biological position. The trees of the I-biological position have the highest relative crown length, which ranges from 26.32% with a diameter degree of 27.5 cm and 36.26% with a diameter degree of 42.5 cm. The average relative crown length of the trees of the first biological position is 31.61%. The relative crown length of the trees of the second biological position ranges from 21.97% with a diameter degree of 22.5 cm to 32.10% with a diameter degree of 42.5 cm. The mean relative crown length of the trees of the second biological position is 26.80%. The thinnest trees of the III-biological position have the lowest relative crown length of 12.24% with a diameter degree of 17.5 cm ranging up to 24.17% with a diameter degree of 37.5 cm. The relative crown length of the trees of the III-biological position is 19.88%.

The confirmed average values of the relative crown length of the Douglass trees are lower in comparison with the so far confirmed values of the relative crown length and range from 36.46 to 63.36% for the fir on the Maleshevski mountains (Velkovski 2007), 27.70 to 42.00% for the fir on Kozhuv (Ivanovski 1978), 9.00 to 57.00% for the combined fir and black pine plantations in the Eastern forest region of Macedonia (Trajkov 1997) and 57.38 to 70.97% for the sequoia on Karadjica mountain (Delov et al. 2014). Krstić et al. (2016)

established that the relative crown length of the Serbian spruce seed plantations ranged from 19 to 64% or an average of 36.5% for the trees of the I-biological position, 23 to 57% or an average of 35.7% for the trees of the II-biological position, and 24 to 46% or an average of 33.0% for the trees of the III-biological position.

The horizontal crown projection has been measured mathematically and is in direct correlation with the size of the average crown diameter. It is the surface covered by the tree crown.

Table V: Horizontal crown projection, classes and biological positions (CBP)

CBP	diameter degrees (cm)						
	17.5	22.5	27.5	32.5	37.5	42.5	Mean
	Horizontal crown projection in m²						
I			17.79	26.41	30.08	33.57	26.96
II		13.59	17.86	25.95	26.59	29.30	22.66
III	6.70	11.70	12.87	20.90	26.05		15.64

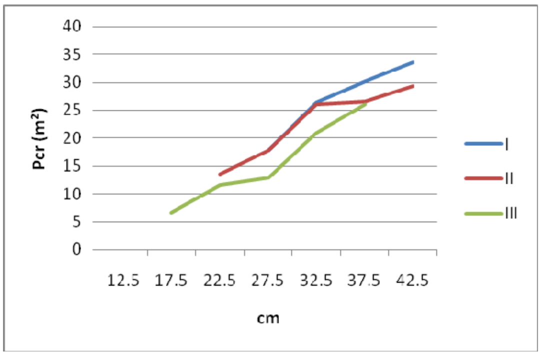

Figure 6: Horizontal crown projection

The results on the horizontal crown projection stated in table V and graphically illustrated in Fig.6 shows that all trees, regardless of their biological position, mark a trend of increase in the size of their horizontal projection by increasing their diameter degree. The largest i.e. the dominant trees have the largest horizontal crown projections. The trees of the III-biological position have the smallest horizontal crown projection, because due to their biological position in the plantation they are suppressed trees and haven't succeeded in growing larger diameters and developing their crowns, in comparison with the co-dominant and more dominant trees. The trees of the I-biological position have the largest horizontal crown projection of 33.57 m² with a diameter degree of 42.5 cm, where as the thinnest trees of the III-biological position have the smallest horizontal projection of 6.70 m² and are of diameter 1. The average mean value of the horizontal crown projection measures 26.96 m² for the trees of the I-biological position, 22.66 m² for the trees of the II-biological position, and 15.64 m² for the trees of the III-biological position.

The mean values of the horizontal crown projection of the Douglass fir trees are within the limits of the so far confirmed values of the horizontal projections of the trees. The horizontal projection ranged from 23.77 to 54.95 m² for the fir on the Maleshevski mountains (Velkovski 2007), 25.00 to 35.00 m² for the fir on Kozhuv (Ristevski 1984), 10.70 to 33.80 m² for the fir on the Osogovski mountains (Ivanovski 1978), 15.50 to 38.20 m² for the fir on Rudnik (Panikj 1966), 9.00 to 64.00 m² for the mixed plantations of fir and black pine in the Eastern forest region of Macedonia (Trajkov 1997), and 13.06 to 33.81 m2 for the sequoia on Karadzica mountain (Delov et al. 2014***)***.

The crown diameter index is obtained as the ratio between the length of the tree crown and the length of the crown.

Table VI: Crown index, classes and biological positions (CBP)

CBP	diameter degrees (cm)						
	17.5	22.5	27.5	32.5	37.5	42.5	Mean
	Crown index						
I			1.05	1.03	1.21	1.26	1.14
II		0.92	0.92	0.96	1.07	1.06	0.99
III	0.34	0.93	0.99	0.87	0.84		0.79

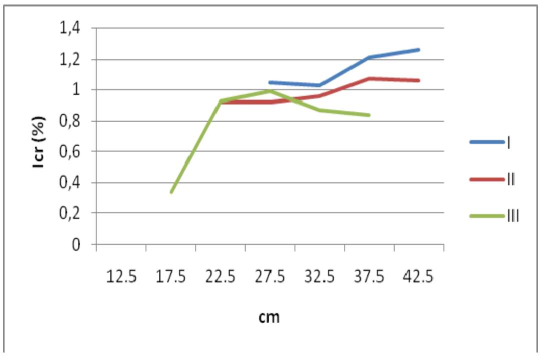

Figure 7: Crown Index

The data stated in table VI and Fig.7 shows that the trees of the I-biological position which are dominant on the plantation have the highest values of the crown index. The average value of the crown index is 1.14 for the trees of the III-biological position, 0.99 for the trees of the II-biological position and 0.79 for the trees of the I-biological position. This state results from the dominant trees of the I-biological position having increased their height and still not having had their crown cleared of branches, due to which they are characterized by quite long crowns, the diameter of which they couldn't expand due to the density of trees on the plantation.

The mean values of the crown index of the Douglass fir trees are lower in comparison with the so far confirmed values of their crown index and ranged from 1.28 to 2.55 for the fir on the Maleshevski mountains (Velkovski 2007), 2.10 to 2.30 for the fir on Kozhuv (Ristevski 1984), 1.28 to 2.72 for the fir on the Osogovski mountains (Ivanovski 1978), 1.50 to 2.24 for the fir on Rudnik (Panić 1966) and 3.07 to 3.51 for the sequoia on Karadzica mountain (Delov et al. 2014).

The lower values of the crown index for the Douglass trees are due to the increased number of trees per unit area, as well as due to not implementing tending techniques which results in the trees not having enough space for further development of their crowns.

The coefficient of space for growth is obtained as the ratio between the crown diameter and the front diameter of trees measured from breast height.

The results on the ratio between the crown diameter and the front diameter of the trees stated in table VII and graphically illustrated in Fig. 8 shows that the trees of the I-biological position have the highest coefficient of space for growth in the plantation.

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Table VII: Growing space coefficient, classes and biological positions (CBP)

CBP	diameter degrees (cm)						
	17.5	22.5	27.5	32.5	37.5	42.5	Mean
	Growing space coefficient						
I			17.31	17.85	16.51	15.39	16.77
II		18.49	17.45	17.69	15.52	14.38	16.71
III	16.69	17.16	14.73	15.88	15.36		15.96

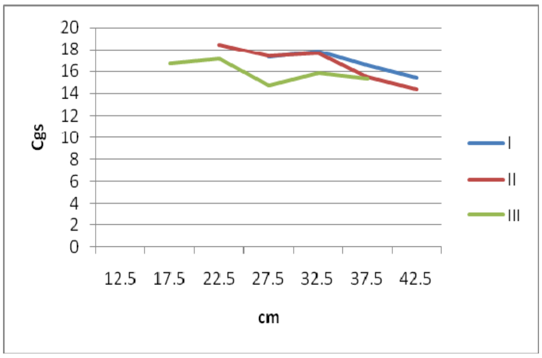

Figure 8: Growing space coefficient (quotient of crown expansion)

The average mean value for the coefficient of space for growth is 16.77 for the trees of the I-biological position, 16.71 for the trees of the II-biological position, and 15.96 for the trees of the III-biological position. These values, as well as the trend of decrease in the values of the coefficient of space for growth indicate that the trees in the plantation already used up the maximum space for growth which they had at their disposal, although the diameter of the front height of the trees is on the increase. The coefficient of space for growth has a huge impact on the increase in the diameter and can be regulated by thinned cuttings of appropriate intensity (Krstić 2003). The average values of the coefficient of space for crown growth ranged from 17.89 to 28.02 for the fir trees on the Maleshevski mountains (Velkovski 2007), 15.76 to 20.93 for the fir on Kozhuv (Ristevski 1984), 11.50 to 17.40 for the fir on the Osogovski mountains (Ivanovski 1978), 12.00 to 15.00 for the fir on Rudnik (Panić 1966), 8.39 to 9.17 for the sequoia on Karadjica mountain (Delov et al. 2014), 28.50 to 38.50 for the low trunk fir plantations on Mavrovo (Krstevski 1975). The crown expansion coefficient for the Serbian spruce trees in the seed plantations of the region of Srebrenica ranged from 5.83 to 16.3 or an average of 10.07 for the trees of the I-biological position. It ranged from 6.56 to 13.2 or an average of 10.13 for the trees of the II-biological position, where as it ranged between 9.0 and 11.8 or an average of 10.20 for the trees of the III-biological position (Krstić at al. 2016).

The relative space for tree growth is obtained as the ratio between the diameter (width) of the crown and the total height of the tree.

The data stated in table VIII and Fig. 9 shows that the relative space for growth of the trees of the I-biological position ranges from 0.25 to 0.29 or an average of 0.28. This value ranges from 0.24 to 0.30 or an average of 0.27 for the trees of the second biological position, and 0.19 to 0.36 or an average of 0.26 for the tress of the third biological position.

Table VIII: Relative space for tree growth, classes and biological positions (CBP)

CBP	diameter degrees (cm)						
	17.5	22.5	27.5	32.5	37.5	42.5	Mean
	Relative space for tree growth						
I			0.25	0.27	0.29	0.29	0.28
II		0.24	0.26	0.28	0.27	0.30	0.27
III	0.36	0.19	0.22	0.26	0.29		0.26

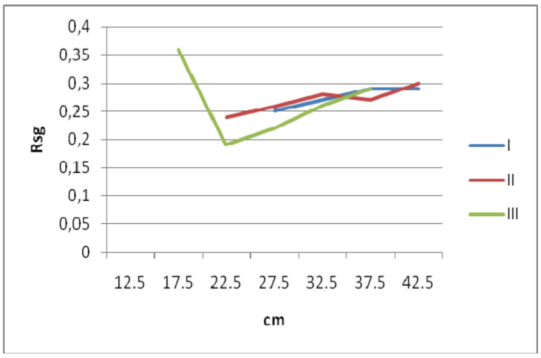

Figure 9: Relative space for tree growth per diameter degrees

The confirmed average values for the relative space for crown growth of the Douglass fir trees are within the limits of the so far confirmed values. The average values for the relative space for growth ranged from 0.23 to 0.36 for the fir on the Maleshevski mountains (Velkovski 2007), 0.19 to 0.28 for the fir on Kozhuv (Ristevski 1984), 0.14 to 0.22 for the fir on the Osogovski mountains (Ivanovski 1978), 0.19 to 0.22 for the sequoia on Karadzica mountain (Delov et al. 2014), and an average of 0.33 for the fir forests on Rudnik (Panić 1966). The relative space for growth for the Serbian spruce trees in the seed plantations of the region of Srebrenica for the trees of the I-biological position ranged from 0.17 to 0.64 or an average of 0.35. This figure ranged from 0.21 to 0.63 or an average of 0.37 for the trees of the II-biological position, and 0.3 to 0.41 or an average of 0.37 for the trees of the III-biological position (Krstić at al. 2016).

4 CONCLUSIONS

On the basis of the results from the research and study of certain elements characterizing the crowns of the Douglass fir (*Pseudotsuga menziesii* (Mirb.) Franco) trees on Karadzica mountain, the following may be concluded:

1. The dominant trees of the I-biological position in the plantation succeeded in developing the largest crowns in comparison with the trees of other positions. The average mean crown diameter measures 5.82 m for the trees of the I-biological position, 5.32 m for the trees of the II-biological position, and 4.35 m for the trees of the III-biological position.

2. With the increase in their size, the absolute crown length of all trees has also increased, regardless of their biological position, which is most noticeable in the dominant trees and least in the suppressed trees. The trend of the trees of the III-biological position lagging behind in the development of their crowns is present due to the dominant and co-dominant trees already

suppressing the trees of the III-biological position in the plantations. The average mean value for the absolute crown length measures 6.69 m for the trees of the I-biological position, 5.30 m for the trees of the II-biological position, and 3.59 m for the trees of the III-biological position.

3. The relative crown length of the dominant trees stands at 32 % of their total height, 27 % for the co-dominant trees, and 20 % for the suppressed trees.

4. The trees of the I-biological position with a diameter degree of 42.5 cm have the largest horizontal crown projection of 42.5 m², whereas the thinnest trees of the III-biological position with a diameter degree of 17.5 cm have the lowest relative crown length of 6.70 m². The average mean horizontal crown projection measures 26.96 m² for the trees of the I-biological position, 22.66 m² for the trees of the II-biological position, and 15.64 m² for the trees of the III-biological position.

5. The average mean value of the crown index is 1.14 for the trees of the I-biological position, 0.99 for the trees of the II-biological position and 0.79 for the trees of the III-biological position. This is a result of the dominant trees of the I-biological position having increased their height and still not having had their crown cleared of branches, due to which they are characterized by quite long crowns, whereas because of the existing density of trees in the plantation they still haven't achieved larger dimensions of the crown diameter. The high values of the crown index for the Douglass fir clearly indicate greater predisposition for larger development of the crown in length instead of in width.

6. The average mean values of the coefficient of space for growth is 16.77 for the trees of the I-biological position, 16.71 for the trees of the II-biological position, and 15.96 for the trees of the III-biological position. These values, as well as the trend of decrease in the values of the coefficient of space for tree growth indicate that the trees have already used up the maximum space for growth which they had at their disposal, although the front height diameter of the trees is on the increase.

7. The average mean value of the relative space for growth is 0.28 for the trees of the I-biological position, 0.27 for trees of II-biological position, and 0.26 for trees of III-biological position.

8. For the purpose of improving the condition of the plantations and directing their development in an optimal direction, execution of thinned cuttings is needed in order to regulate the number of trees per unit area, as well as their spatial distribution in the plantation with the purpose of achieving better use of the space for the development of trees in the plantation.

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VEGETATION AND HABITAT DIVERSITY IN ORELYAK RESERVE (SOUTH-WEST BULGARIA)

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ABSTRACT: The Orelyak reserve is situated in the central part of Pirin Mts. It occupies an area of 759 ha and was declared to protect the well preserved beech forests. Five habitats according to the Habitat Directive were found - 9130, 9150, 5130, 4060, 6520. The most widespread vegetation type belongs to *Carpino-Fagetea* class, represented by alliances *Fagion sylvaticae* and *Cephalanthero-Fagion*, two associations (*Asperulo odoratae-Fagetum sylvaticae*, *Galio pseudoaristati-Fagetum sylvaticae*) and *Abies alba-Fagus sylvatica* community. The rest of the forest vegetation was classified to alliance *Carpinion orientalis* of *Quercetea pubescentis* class and includes *Ostrya carpinifolia* community, which is found locally in the reserve at lower altitudes. Shrub vegetation has limited distribution and was classified to alliances *Pruno tenellae-Syringion* and *Juniperion nanae*. It is presented by *Juniperus communis* and *Juniperus sibirica-Chamaecytisus absinthoides* communities. Grasslands cover only 2 % of the reserve's territory. They were classified into three classes: *Trifolio-Geranietea sanguinei*, *Molionio-Arrhenatheratea* and *Galio-Urticetea*.
Keywords: classification, conservation, endemics, habitats, NATURA 2000, Pirin Mts, vegetation.

1 INTRODUCTION

Orelyak reserve was declared as a protected area in 1985 to preserve a sample of primary, characteristic of southern Pirin beech forests, formed on humus-carbonate soils, having specific flora and limited distribution in the country. Its initial territory (850 ha) was twice reduced (1995 and 2013) and now covers 757.1 ha. More than 90% of the reserve territory is covered by forests.

General information about the flora and vegetation of the Pirin Mountain can be found at: [4, 14, 16, 26].

There was no complete study of the reserve's vegetation until now. The only known specific source of data from its territory is a report, ordered by the Committee on Environmental Protection at Council of Ministers in 1988 [35]. Unfortunately the report is not available anymore and only its title is still known.

This study aims at revealing the syntaxonomic and habitat diversity of Orelyak reserve and at assessing their current condition.

2 MATERIAL AND METHODS

2.1 Study area

The study was conducted in Orelyak reserve, located in the central part of Pirin Mts. The altitude ranges from 990 m to 1870 m a.s.l. (Fig. 1). This determines the clear altitudinal zonation of climatic elements and the occurrence of typical mountain climate. The average annual temperature decreases from 9,0 ºC at the lowest points of the reserve to 4,3 ºC at altitude of 1800 meters. July and August are the warmest months in the year. The average July temperatures are 18,4 ºC at 1000 m a.s.l. and 13,0 ºC at 1800 m a.s.l. The coldest month is January with average temperatures between -1.2 ºC and -4.2 ºC. Absolute maximum temperature is mostly seen in August (27-35 ºC). Absolute minima are recorded in the winter months - December, January and February (-20 ºC – -25 ºC) [19]. Annual precipitation rate is between 850 and 1000 mm. The maximum rainfall occurs in November or December (100-150 mm), which coincides with the maximum frequency of Mediterranean cyclones. The minimum rainfall occurs in August, which coincides with both the minimum in the distribution of these cyclones and the negligible influence of cold fronts of the Atlantic cyclones. The snow cover lasts about 50-100 days a year in low and middle mountain belt. At 1800 m a.s.l. its duration is increased to 150 days [19]. The bedrock type is predominantly silicate. Carbonate terrains are only present at the southernmost part of the reserve as well as in the northeastern corner [6]. The prevailing part of the area, which is characterized by good afforestation and slopes up to 25-30°, is covered by cambisols. On the slopes with inclination above 30-35° (about ¼ of the territory) soils are mainly leptosols. On silicate terrains – rankers, whereas on carbonate – rendzinas. In the lowest parts of the slopes and bottoms of the valleys fluvisols are distributed [8].

The potential natural vegetation is presented by Rhodopean beech and spruce-fir-beech forests (*Fagus sylvatica*, *Abies alba*, *Picea abies*) with *Telekia speciosa*, *Peucedanum aegopodioides* (Mapping unit F153) [32].

The territory of the reserve is a Site of Community Importance (NATURA 2000 site BG0001028 Sreden Pirin-Ali Botush).

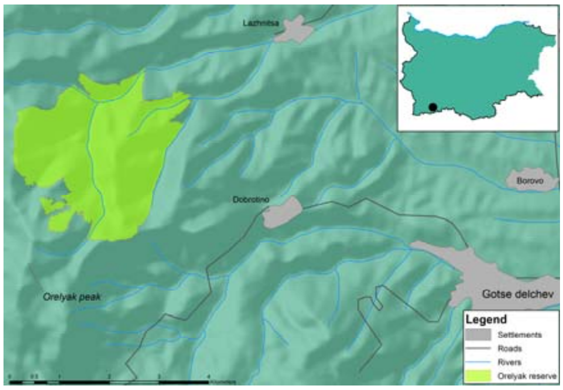

Figure 1: Map of the study area

2.2 Vegetation sampling

The field sampling was carried out in the period July – August 2014 following the Braun-Blanquet approach [18, 36]. We covered the whole range of different vegetation types on the territory of the reserve. We used 16 m^2, 24 m^2 and 100 m^2 square-shaped plots (n = 20), respectively for grassland, shrubland and woodland vegetation. All relevés were stored in TURBOVEG database [30] and in the Balkan Vegetation Database [21].

Species nomenclature pursued Key to the Plants of Bulgaria [5].

2.3 Data analysis of relevés

Numerical classification was performed by PC-ORD [2] incorporated in JUICE 7.0 software package [24]. Relative Sørensen was used as distance measure and species similarity was calculated using flexible beta clustering (-0.25). The species values were square-root transformed and 3 cut leves (0, 5, 25) were used.

Species composition is represented in phytosociological tables with the cover/abundance estimates. The proposed syntaxonomical scheme is based on dendrogram separation so that syntaxa have ecological and phytogeographical interpretation.

2.5. Habitat classification and mapping

Habitat types were determined according to the Interpretation Manual of European Union Habitats [17, 33]. Assignment of each vegetation unit at association level to a certain Habitat Directive Code (HDC) was given in the text. Mapping was done using ArcGIS 10.0 software [9]. Spatial data was collected in the field using GPS devise Juno BS by Trimble and was later overlaid over the most recent orthophoto images available. Outlining the polygons was done manually by using features collected in the field as well as the orthophoto images. Mapping was done in scale 1:5000.

3 RESULTS

3.1 Vegetation types

Classification of the relevés showed 8 different communities on the territory of Orelyak reserve. The list of established syntaxa consisted of 6 classes, 6 orders, 7 alliances, 3 associations and 6 plant communities (Fig. 2). Beech forests were the most widespread vegetation type and covered more than 89.7% of the reserve's territory.

3.1.1 Ass. *Asperulo odoratae-Fagetum sylvaticae* (HDC: 9130; 637.1 ha, Annex III)

This was the most widespread association on the territory of the reserve. Its communities occured between 1200 and 1870 m a.s.l. on moderately steep slopes (10°-35°) with varying aspects. Soils were moderately deep cambisols.

This association included neutrophilous and species-poor beech forests. The dominant species was *Fagus sylvatica*. The shrub layer was usually missing but the herb layer had cover between 0% and 50%, mainly by *Euphorbia amygdaloides*, *Geranium robertianum*, *Lapsana communis*.

3.2.2 *Abies alba-Fagus sylvatica* community (HDC: 9130; 2.3 ha, Annex III)

This vegetation type was found at 1400-1635 m a.s.l. on north and northeastern facing slopes with inclination of 20°-45°. *Abies alba* was the dominant species and subdominant was *Fagus sylvatica*. Shrub layer was presented by young trees of above mentioned species as well as *Evonymus verrucosus* and *Rubus caesius*. The herb layer was species-poor but species with higher cover and abundance were *Geranim macrrorhizum, Dryopteris filix-mas, D. dilatata*.

3.2.3 Ass. *Galio pseudoaristati-Fagetum sylvaticae* (HDC: 9150; 40.4 ha, Annex III)

Alliance *Cephalanthero-Fagion* and association were distributed only in northern part of the reserve, where calcareous bedrock was found. They were distributed between 1000-1200 m a.s.l. on north slopes with inclination of 25°-35°. Soils were moderately deep leptosols. *Fagus sylvatica* dominated the tree layer (75%-95%). Shrub layer was presented by young trees of *Fagus sylvatica*, *Abies alba*, *Acer campestre* and had cover up to 35%. Herb layer was poor-species with total cover up to 30-35%. Species with higher cover and abundance were *Physospermum cornubiense* and *Brachypodium sylvaticum*.

3.2.4 *Ostrya carpinifolia* community (HDC: 91W0; 4.5 ha; Annex III)

Ostrya carpinifolia forests were locally distributed from 1000-1200 m a.s.l. on the territory of the reserve. They covered areas between 750 and 800 m a.s.l. on slopes with varying aspects with inclination between 25°-40°. Soils were moderately deep leptosols.

Ostrya carpinifolia dominated the tree layer (50%-70%). Shrub layer had cover between 10-20% and was formed by young trees of *Ostrya carpinifolia*, *Fraxinus ornus* and *Acer campestre*. The herb layer had total cover between 50-70% and was consisted mainly by *Geranium macrorrhizum* and *Poa nemoralis*. Bryophyte layer was well developed (total cover 20-30%) and species with higher cover and abundance were *Brachytheciastrum velutinum* and *Homalothecium lutescens*.

Shrubland vegetation had limited distribution in the reserve, e.g. 7.2% of its territory. It was represented by *Chamaecytisus absinthoides*, *Juniperus sibirica* and *J. communis* communities.

3.2.5 *Juniperus sibirica-Chamaecytisus absinthoides* community (HDC: 4060; 33.4 ha, Annex II)

The communities of *Juniperus sibirica* and *Chamaecytisus absinthoides* covered areas between 1500 and 1750 m a.s.l. on slopes with varying aspects and inclination between 5°-25°. Soils were shallow to moderately deep cambisols. The cover of shrub layer was between 55-100%. The herb layer was well developed and dominats were *Agrostis capillaris*, *Festuca panciciana*, *F. hirtovaginata*, *Trifolium repens*, *Calamagrostis arundainacea*, *Thymus jankae*. These communities were used as pastures.

3.2.6 *Juniperus communis* community (HDC: 5130; 20.1 ha)

This vegetation was distributed at 1000-1200 m a.s.l. on slopes with varying aspects and inclination of 25°-45°. Soils were moderately deep and dry litosols. The dominant species was *Juniperis communis* with cover 40-70%. Subdominant species were *Festuca valesiaca*, *Thymus* spp. This community was not sampled in the field and there is no relevés in the annexes.

Grassland vegetation had limited distribution in the reserve and covered only 2 % of its territory. It was presented by subalpine pastures and ruderal vegetation.

3.2.7 Ass. *Pteridietum aquilini* (HDC: not present; 10 ha, Annex I)

This association was distributed in beech forest belt on slightly slopes with varying exposition. The vegetation was developed mainly on abandoned pastures or around farmland buildings. The plant communities were dominanted by *Pteridium aquilinum* with cover 90-100%. The rest species were accompanying and their cover was up to 5-7%.

3.2.8 *Agrostis capillaris* community (HDC: 6520; 5.2 ha, Annex I)

This vegetation was locally distributed on higher altitudes between 1400-1600 m a.s.l. Soils were shallow to moderately deep. Tussock-grasses like *Agrostis capillaris*, *Lolium perenne*, *Dactylis glomerata*, *Festuca rubra*, *Lolium perenne* and *Trifolium repens* were subdominants in the communities. The vegetation was used as pastures.

3.2.9 *Urtica dioica* community (HDC: not present ; 0.1 ha)

This community had very limited distribution and covered an area of about 25 m^2. It was found on flat terrain, close to a stream and in the horizontal structure *Urtica dioica* was the dominant species.

SYNTAXONOMICAL SYNOPSIS:

Cl. *Carpino-Fagetea* Jakucs ex Passarge 1968
Ord. *Fagetalia sylvaticae* Pawł. et al. 1928
All. *Fagion sylvaticae* Luquet 1926
Ass. *Asperulo odoratae-Fagetum sylvaticae* Sougnez et Thill 1959
Abies alba-Fagus sylvatica community
All. *Cephalanthero-Fagion sylvaticae* Tüxen 1955
Ass. *Galio pseudoaristati-Fagetum sylvaticae* Tzonev et al. 2006
Cl. *Quercetea pubescentis* (Oberd. 1948) Doing Kraft 1955
Ord. *Quercetalia pubescenti-petraeae* Klika 1933
All. *Fraxinoorni- Ostryion* Tomažić 1940
Ostrya carpinifolia community
Ord. *Fraxino orni-Cotinetalia* Jakucs 1961
All. *Pruno tenellae-Syringion* (Jovanović 1979) Čarni et al. 2009
Juniperus communis community
Cl. *Loiseleurio-Vaccinietea* Eggl. 1952 ex Schub. 1960
Ord. *Rhododendro-Vaccinietalia* Braun-Blanq. in Braun-Blanq. et Jenny 1926
All. *Juniperion nanae* Br.-Bl. et al. 1939
Juniperus sibirica-Chamaecytisus absinthoides community
Cl. *Trifolio-Geranietea sanguinei* T. Müller 1962
Ord. *Melampyro pratensis-Holcetalia mollis* Passarge 1979 in Theurillat et al. 1995
Ass. *Pteridietum aquilini* Jouanne & Chouard 1929
Cl. *Molinio-Arrhenatheretea* Tüxen 1937
Ord. *Arrhenatheretalia* Tüxen 1931
All. *Cynosurion cristati* Tüxen 1947
Agrostis capillaris community
Cl. *Galio-Urticetea* Passarge ex Kopecky 1969
Ord. *Lamio albi-Chenopodietalia boni-henrici* Kopeckỳ 1969
All. *Geo-Alliarion* Lohm et Oberd. in Görs et Müler 1969
Urtica dioica community

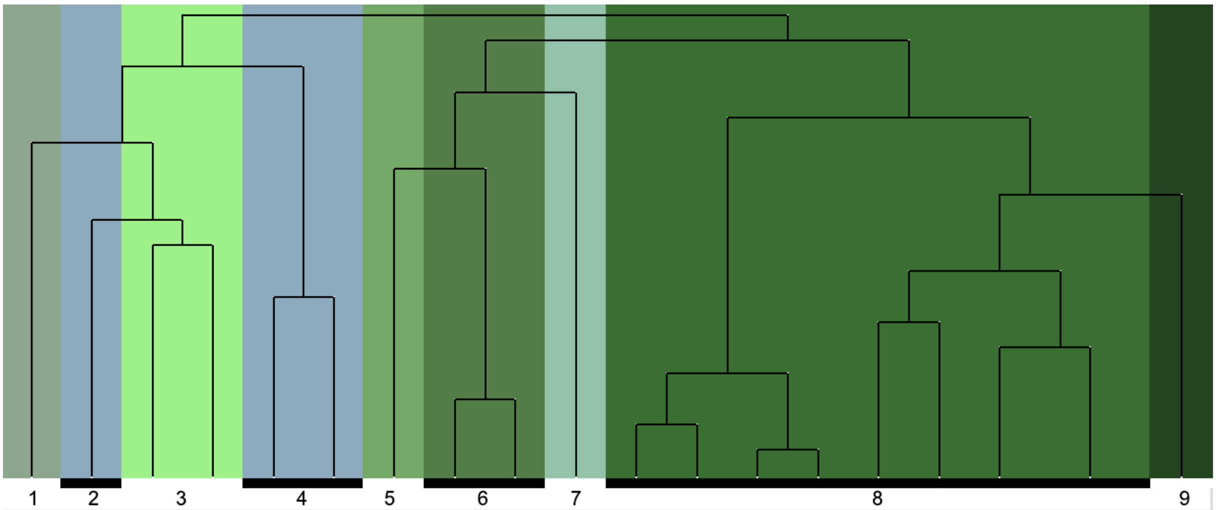

Figure 2: Dendrogram of phytosociological relevés (Relative Sørensen distance measure and flexible beta clustering (-0.25) were used). Legend: *Pteridietum aquilini* (clusters 1), *Juniperus sibirica-Chamaecytisus absinthoides* community (clusters 2 and 4), *Agrostis capillaris* community (cluster 3), *Ostrya carpinifolia* community (cluster 5), *Galio pseudoaristati-Fagetum sylvaticae* (cluster 6), *Urtica dioica* community (cluster 7), *Asperulo odoratae-Fagetum sylvaticae* (cluster 8), *Abies alba-Fagus sylvatica* community (cluster 9).

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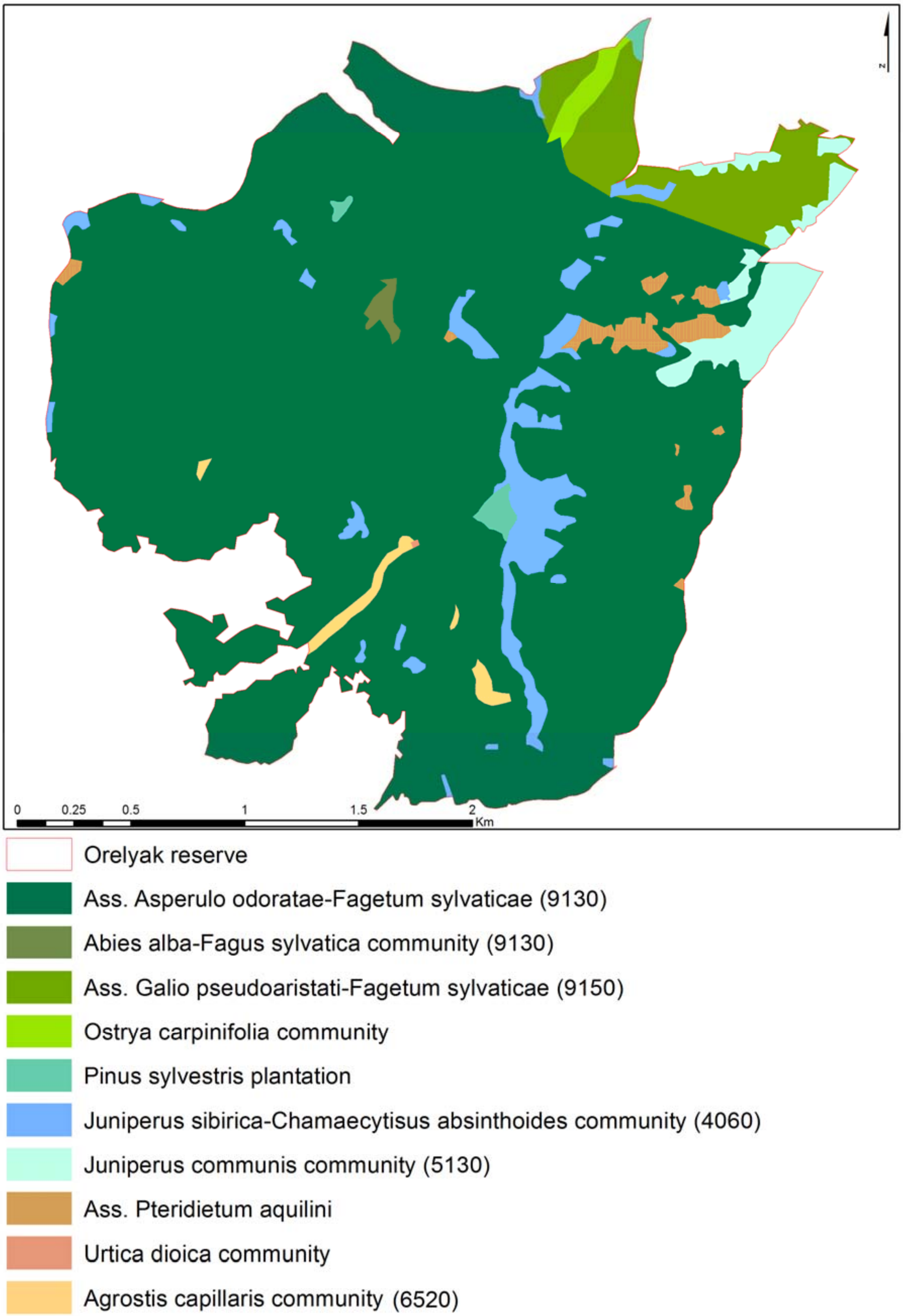

Figure 3: Map of vegetation units of Orelyak reserve. Numbers given in brackets represent the codes of habitats according to the Habitat directive: 9130 – *Asperulo-Fagetum* beech forests, 9150 – Medio-European limestone beech forests of the *Cephalanthero-Fagion*, 4060 – Alpine and Boreal heaths, 5130 – *Juniperus communis* formations on heaths or calcareous grasslands, 6520 – Mountain hay meadows.

4 DISCUSSION

4.1 Vegetation

The territory of the reserve protects well-preserved beech forests. Their separation is a result of different bedrock types – silicate and limestone, which is a reason for distribution of two alliances - *Fagion sylvaticae* and *Cephalanthero-Fagion sylvaticae.* The species composition of the established associations is similar to their characteristic described by Tzonev et al. [29]. The association *Asperulo odoratae-Fagetum sylvaticae*, which has poor-species composition is the most widly distributed syntaxon in the reserve. The *Abies alba-Fagus sylvatica* community, which is mainly found in southern part of the country is distributed in the upper part of the reserve at higher altitudes. In fact, it represents a successional stage between beech and *Abies* woodlands. Alliance *Cephalanthero-Fagion sylvaticae* is found at lower altitudes and its association *Galio pseudoaristati-Fagetum sylvaticae* has similar species composition and ecological characteristics as described by [29].

Ostrya carpinifolia woodlands are locally found at lower altitudes along the mountain streams. This vegetation is poorly studied in the country [10, 11, 12, 25]. Future analysis is needed to reveal the syntaxonomical diversity of this vegetation in Bulgaria.

Shrub and grassland vegetation in the reserve cover limited areas. Grassland vegetation includes subalpine pastures, which has been extensively distributed before declaration of the reserve. Their composition is transitional between alliances *Cynosurion cristati* and *Poion alpinae*. According to [31, 34] *Poion alpinae* is found in Rhodope Mts and mentioned localities are far from the reserve territory. Due to higher altitudes (1400-1600 m a.s.l.) of these grasslands some typical species for the latter alliance are found (*Phleum alpinum*, *Festuca nigrescens*, *Cerastium alpinum*). Finally, these communities are closer to *Cynosurion cristati* alliance because of the prevalence of its diagnostic species in the relevés. *Cynosurion cristati* alliance is studied by [13, 21, 28, 27, 31] from other parts of the country. On the territory of the reserve this vegetation is intensively grazed and trampled. This favors the distribution of gap colonizer species with rhizomes or stolons (e.g. *Trifolium repens*, *Lolium perenne*).

The rest grassland vegetation types are represented by ruderal and fringe vegetation. *Pteridium aquilinum* communities has similar structure, species composition and ecology like other bracken phytocoenoses known from Belasitsa Mt [11], Malashevska Mt, Pirin Mts, Forebalkan, Rhodope Mts, Ograzhden Mt (Balkan Vegetation Database, unpublished data). They are monodominant communities with poor-species composition, which are found on areas, which has been used as intensive pastures in the past but nowadays are abandoned.

Urtica dioica community represents ruderal vegetation dominated by nitrophilous species. Class *Galio-Urticetea* is poorly studied in the country [20, 23]. There is a lack of diagnostic species for previously described associations *Urtico dioicae-Parietarietum officinalis* and *Urtico-Cruciatetum laevipedis* [7, 15, 22]. Further research of syntaxnomy of Bulgarian *Urtica dioica* communities are needed. Shrubland vegetation is dominated by *Chamaecytisus absinthoides* and *Juniperus sibirica*. *Chamaecytisus absinthoides* is a Balkan endemic [1] and only association *Festuco-Chamaecytisetum absinthoides* is known for Bulgaria so far [34]. It is distributed on higher altitudes and is rich of subalpine species like *Festuca valida*, *Potentilla ternata*, etc. *Chamaecytisus absinthoides* communities in *Fagus* and *Quercus* belts are still not studied. This species has wider ecological niche and is also subdominant of some grassland communities. Its communities have wide distribution in mountains of south Bulgaria (Malashevska Mt, Ograzhden Mt, Pirin Mts, Rhodope Mts, Rila Mts). In *Juniperus sibirica-Chamaecytisus absinthoides* community of the reserve some diagnostic species of *Molinio-Arrhenatheretea* (e.g. *Agrostis capillaris*, *Poa pratensis*, *Lolium perenne*, etc.) and *Festuco-Brometea* (*Centaurea rhenana*, *Teucrium chamaedrys*, *Galium verum*, etc.) are also found.

Frequently, shrubland and grassland communities form transitional (mosaic) vegetation types, which represent different successional stages of vegetation. In 1985, when the reserve was declared, the cover of pastures was 11.5 ha whereas nowadays they cover only 5.2 ha. The double reduction of open communities is mainly because of reducing of grazing, which leads to increasing of forest and shrubland territories.

4.2 Conservation importance

From conservational point of view, among all 8 communities, there are 5 habitat types (Fig. 3) protected by Annex 1 of the Bulgarian Biological Diversity Act (2007) [3] and Habitat Directive 92/43/EEC. All of them (9130, 9150, 5130, 4060, 6520) are widespread on the territory of the country.

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Annex I: Synoptic table of grassland vegetation syntaxa of Orelyak Reserve

Table number	1	2	3	4
Plot size (m^2)	16	16	16	16
Altitude (m)	1825	1915	1537	1480
Aspect (°)	135	270	90	90
Slope (°)	5	8	15	45
Total cover (%)	100	90	95	95
Cover shrub layer (%)	5	-	-	-
Cover herb layer (%)	100	90	95	95
Cover moss layer (%)	20	5	2	6
latitude	41,60004	41,58454	41,58958	41,58971
longitude	23,61088	23,63335	23,62923	23,62933
Diagnostic species of ass. *Pteridietum aquilini*				
Pteridium aquilinum	5	.	.	.
Diagnostic species of *Agrostis capillaris* community				
Agrostis capillaris	2	3	3	.
Diagnostic species of *Urtica dioica* community				
Urtica dioica	+	.	.	5
Diagnostic species of Cl. *Trifolio-Geranietea sanguinei* & Ord. *Melampyro pratensis-Holcetalia mollis*				
Clinopodium vulgare	+	.	.	.
Hypericum perforatum	+	.	+	.
Geranium sanguineum	.	.	1	.
Trifolium alpestre	.	.	+	.
Diagnostic species of Cl. *Molionio-Arrhenatheretea,* Ord. *Arrhenatheretalia* & All. *Cynosurion cristati*				
Leontodon autumnalis	.	1	2	.
Plantago media	.	+	+	.
Trifolium repens	.	3	+	.
Prunella vulgaris	.	1	+	.
Dactylis glomerata	+	.	2	.
Festuca rubra	.	.	2	.
Lolium perenne	.	2	.	.
Lathyrus pratensis	.	.	2	.
Poa pratensis	.	+	.	.
Poa annua	.	2	.	.
Diagnostic species of Cl. *Galio-Urticetea* , Ord. *Lamio albi-Chenopodietalia boni-henrici* & All. *Geo-Alliarion*				
Galium aparine	.	.	.	2
Impatiens noli-tangere	.	.	.	+
Geranium robertianum	.	.	.	1
Lapsana communis	.	.	.	+
Festuca gigantea	.	.	.	+
Other species				
Cardamine resedifolia	.	+	.	.
Arenaria serpyllifolia	.	+	.	.
Scleranthus perennis	.	+	.	.
Trifolium pratense	.	.	+	.
Bryum caespiticium	.	1	.	.
Thymus sibthorpii	.	.	+	.
Geum molle	.	.	+	.
Verbascum longifolium	.	2	.	.
Lamiastrum galeobdolon	+	.	.	.
Cruciata glabra	.	.	+	.
Brachypodium pinnatum	.	.	+	.
Sherardia arvensis	.	+	.	.
Cruciata laevipes	.	.	+	.

continued

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continuation of Annex I

Eurhynchium angustirete	.	.	.	+
Arabis glabra	.	.	+	.
Rubus caesius	+	.	.	.
Viola gracilis	+	.	.	.
Geranium pyrenaicum	.	+	.	.
Dryopteris filix-mas	.	.	.	2
Ranunculus polyanthemos	.	.	+	.
Hordelymus europaeus	.	.	.	+
Polygonum aviculare	.	+	.	.
Bilderdykia convolvulus	.	2	.	.
Lysimachia nummularia	.	+	.	.
Cynosurus echinatus	.	.	2	.
Galeopsis tetrachit	.	.	.	1
Rumex acetosa	.	+	.	.
Colchicum autumnale	.	.	+	.
Scabiosa ochroleuca	.	.	+	.
Tortella tortuosa	.	.	.	+
Leontodon crispus	.	.	+	.
Dianthus gracilis	.	.	+	.
Poa trivialis	.	2	.	.
Pottia sp.	.	+	.	.
Capsella bursa-pastoris	.	+	.	.
Rumex acetosella	.	1	+	.
Veronica chamaedrys	.	+	+	.
Carex muricata	.	+	+	.
Alchemilla sp.	.	+	2	.
Veronica acinifolia	.	+	+	.
Stellaria holostea	.	.	.	+
Plagiomnium rostratum	.	.	.	+
Primula veris	.	.	+	.
Poa nemoralis	1	.	.	.
Galium verum	.	.	+	.
Stellaria graminea	.	.	1	.
Taraxacum sp.	.	+	.	.
Phleum alpinum	.	1	+	.
Veronica officinalis	.	2	+	.
Potentilla inclinata	.	+	+	.
Cerastium decalvans	.	+	.	.
Mentha spicata	+	.	+	.
Myosotis arvensis	+	.	.	+
Brachytheciastrum velutinur	.	.	.	+
Tanacetum corymbosum	.	.	+	.
Stachys germanica	.	.	+	.
Rumex sanguineus	+	.	.	+
Sagina apetala	.	+	.	.
Brachythecium rutabulum	.	.	.	+
Chamaecytisus absinthioides	2	.	.	.
Homalothecium lutescens	.	.	.	+
Stachys sylvatica	.	.	.	+
Poa angustifolia	.	.	+	.
Cerastium alpinum	.	+	.	.
Arabis sagittata	.	+	.	+
Hypericum maculatum	.	.	2	.

Annex II: Synoptic table of shrubland vegetation syntaxa of Orelyak Reserve

Table number	1	2	3
Plot size (m²)	64	64	64
Altitude (m)	1513	1758	1589
Aspect (°)	45	90	90
Slope (°)	5	25	25
Total cover (%)	90	85	95
Cover shrub layer (%)	70	60	75
Cover herb layer (%)	75	55	55
Cover moss layer (%)	2	20	
latitude	41,59791	41,6029	41,59001
longitude	23,63659	23,61496	23,62561
Diagnostic species of *Juniperus sibirica-Chamaecytisus absinthoides* community			
Juniperus sibirica*	2	4	4
Chamaecytisus absinthioides	4	1	2
Diagnostic species of cl. *Loiseleurio-Vaccinietea* , Ord. *Rhododendro-Vaccinietalia* & All. *Juniperion nanae*			
Arctostaphylos uva-ursi	.	.	+
Diagnostic species of cl. *Molionio-Arrhenatheratea*			
Poa pratensis	2	.	+
Achillea millefolium	+	.	.
Trifolium repens	2	.	.
Agrostis capillaris	2	.	.
Dactylis glomerata	.	+	.
Achillea millefolium agg.	.	.	+
Coronilla varia	.	+	1
Diagnostic species of cl. *Festuco-Brometea*			
Centaurea rhenana	.	+	+
Teucrium chamaedrys	.	2	1
Galium verum	2	.	.
Melica ciliata	.	.	+
Sanguisorba minor	.	+	.
Armeria rumelica	+	.	.
Viola tricolor	+	.	.
Other species			
Stellaria graminea	+	.	.
Taraxacum sp.	+	.	.
Clinopodium vulgare	+	.	+
Thymus glabrescens	2	2	.
Geum urbanum	+	.	.
Veronica acinifolia	+	.	.
Carex muricata	.	.	+
Rumex acetosella	+	.	.
Veronica chamaedrys	1	.	.
Erysimum diffusum	.	+	+
Daphne oleoides	.	2	+
Ajuga laxmannii	.	+	+
Fragaria viridis	.	+	+
Potentilla pilosa	.	+	1
Hieracium pannosum	.	+	+
Trifolium alpestre	+	1	+
Brachypodium sylvaticum	.	.	2
Campanula rapunculoides	+	+	.
Primula veris	.	+	.
Festuca hirtovaginata	.	.	2

continued

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Hieracium pilosella	+	.	.
Arabis sagittata	+	+	.
Origanum vulgare	.	.	1
Dianthus cruentus	.	+	.
Bromus barcensis	.	.	2
Thymus jankae	.	.	2
Mentha spicata	+	.	+
Digitalis viridiflora	+	.	.
Acinos alpinus	.	+	.
Monotropa hypopitys	.	.	+
Euphorbia amygdaloides	.	.	+
Hypericum perforatum	.	.	+
Lamium maculatum	.	.	+
Helianthemum nummularium	.	1	.
Crataegus monogyna	.	.	1
Astragalus depressus	.	+	.
Calamagrostis arundinacea	.	.	2
Cruciata laevipes	+	.	.
Geranium pyrenaicum	+	.	.
Leontodon hispidus	+	.	.
Trifolium pratense	+	.	.
Bryum caespiticium	.	2	.
Scleranthus perennis	1	.	.
Cirsium vulgare	+	.	.
Arenaria serpyllifolia	+	+	.
Geum molle	+	.	.
Verbascum longifolium	2	+	.
Carex kitaibeliana	.	1	.
Festuca panciciana	.	3	.
Draba athoa	+	+	.
Centaurea sp.	+	.	.
Galium album	.	+	.
Prunus spinosa	+	.	.
Tortella tortuosa	.	2	.
Poa badensis	.	+	.
Acer pseudoplatanus	.	.	1
Plantago lanceolata	1	.	.
Rosa myriacantha	.	.	2
Euphrasia minima	.	+	.
Hypericum linarioides	.	.	+
Berteroa incana	+	.	.
Linaria genistifolia	.	.	+
Cynoglossum hungaricum	+	.	.
Chondrilla juncea	+	.	.
Knautia dinarica	+	.	.
Trifolium campestre	+	.	.
Cerastium brachypetalum	+	.	.
Syntrichia ruralis	+	.	.
Scabiosa triniifolia	.	+	.
Draba muralis	.	.	+
Silene italica	.	+	.
Potentilla argentea	2	.	.
Hieracium murrorum	.	+	.
Achillea clypeolata	.	+	.

* Diagnostic species of *Juniperus sibirica -Chamaecytisus absinthoides* community, cl. *Loiseleurio-Vaccinietea* , Ord. *Rhododendro-Vaccinietalia* & All. *Juniperion nanae.*

Annex III: Synoptic table of woodland vegetation syntaxa of Orelyak Reserve

Table number	1	2	3	4	5	6	7	8	9	10	11	12	13
RelevA area (m2)	100	100	100	100	100	100	100	100	100	100	100	100	100
Altitude (m)	1044	1241	1308	1610	1535	1762	1665	1332	1416	1617	1599	1625	1645
Aspect (degrees)	180	315	315	90	45	45	360	360	90	90	315	45	315
Slope (degrees)	45	15	10	20	10	20	10	60	45	20	45	20	25
Cover total (%)	100	90	85	90	90	85	85	95	100	85	95	90	80
Cover tree layer (%)	70	80	80	90	90	80	80	85	90	70	90	75	80
Cover shrub layer (%)	20	30	35	10	1	-	-	25	10	50	3	5	-
Cover herb layer (%)	60	35	20	2	-	10	3	15	45	20	80	50	1
Cover moss layer (%)	30	2	2	1	-	5	4	5	-	3	1	1	-
latitude	41,60841	41,60667	41,60489	41,58777	41,59706	41,58559	41,58545	41,60435	41,5981	41,59676	41,59487	41,58963	41,59231
longitude	23,63848	23,63994	23,63941	23,62558	23,63577	23,61797	23,62123	23,62963	23,62813	23,61582	23,61757	23,62476	23,6204
Diagnostic species of *Ostrya carpinifolia* community													
Ostrya carpinifolia (tr)	4	2	.	.	.	.	.	.	.	.	.	.	.
Diagnostic species of ass. *Galio pseudoaristati-Fagetum sylvaticae*													
Euphorbia amygdaloides	+	+	.	.	.	.	.	.	.	.	+	1	.
Fagus sylvatica (tr)[1]	.	4	5	5	5	5	5	5	4	4	5	5	2
Fagus sylvatica (sh)[1]	.	2	2	2	+	.	.	2	+	3	1	2	.
Fagus sylvatica (juv)[1]	.	.	+	+	.	.	.	.	.	.	+	.	.
Diagnostic species of ass. *Asperulo odoratae-Fagetum sylvaticae*													
Cardamine bulbifera[3]	.	.	.	.	.	2	+	.	+	+	1	1	.
Galium odoratum	.	.	.	.	.	.	.	.	1	2	2	3	.
Diagnostic species of *Abies alba-Fagus sylvatica* community													
Abies alba (tr)[2]	.	.	.	.	.	.	.	.	3	.	.	.	4
Diagnostic species of *cl. Quercetea pubescentis, ord. Quercetalia pubescenti-petreae & all. Carpinion orientalis*													
Fraxinus ornus (sh)	2	2	.	.	.	.	.	+	.	.	.	.	.
Fraxinus ornus (tr)	1	.	.	.	.	.	.	.	.	.	.	.	.
Veronica chamaedrys	+	.	.	.	.	.	.	.	.	.	.	.	.
Scutellaria columnae	+	.	.	.	.	.	.	.	.	.	.	.	.
Physospermum cornubiense	+	2	+	.	.	.	.	.	.	.	.	.	.
Cruciata laevipes	+	.	.	.	.	.	.	.	.	.	.	.	.
Melittis melissophylum	+	.	.	.	.	.	.	.	.	+	.	.	.

continued

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Diagnostic species of all. *Cephalanthero-Fagion sylvaticae*													
Cephalanthera damasonium	.	+	+	+	.	.	.	.	.	.	.	.	.
Cephalanthera rubra	.	.	+	.	.	.	.	.	.	.	.	.	.
Diagnostic species of *cl. Carpino-Fagetea , ord. Fagetalia sylvaticae & all. Fagion sylvaticae*													
Dryopteris filix-mas	.	.	.	.	.	+	+	1	2	.	+	.	.
Abies alba (sh)	.	.	2	.	.	.	.	3	.	.	.	.	.
Hordelymus europaeus	.	.	.	.	.	.	.	.	.	+	.	.	.
Mercurialis perennis	+	.	.	.	.	.	.	+	.	.	.	.	.
Mycelis muralis	.	.	.	.	.	.	.	.	.	.	.	+	.
Oxalis acetosella	.	.	.	.	.	.	.	+	1	1	.	.	+
Sanicula europaea	.	.	.	.	.	.	.	.	+	+	.	.	.
Viola reichenbachiana	+	+	+	.	.	.	.	+	.	.	.	.	.
Neottia nidus-avis	.	.	.	.	.	.	.	.	.	+	.	.	.
Other species													
Achillea millefolium	.	+	.	.	.	.	.	.	.	.	.	.	.
Geum urbanum	+	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium alpestre	.	+	.	.	.	.	.	.	.	.	.	.	.
Melica uniflora	+	.	.	.	.	.	.	.	.	.	.	.	.
Polygonatum multiflorum	+	.	.	.	.	.	.	.	.	.	.	.	.
Ceterach officinarum	+	.	.	.	.	.	.	.	.	.	.	.	.
Evernia prunastri	+	.	.	.	.	.	.	.	.	.	.	.	.
Euonymus europaeus	+	.	.	.	.	.	.	.	.	.	.	.	.
Anomodon viticulosus	+	.	.	.	.	.	.	.	.	.	.	.	.
Asplenium trichomanes	+	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia foliacea	+	.	.	.	.	.	.	.	.	.	.	.	.
Acer campestre (tr)	2	.	.	.	.	.	.	.	.	.	.	.	.
Polypodium vulgare	+	.	.	.	.	.	.	.	.	.	.	.	.
Moehringia pendula	+	.	.	.	.	.	.	.	.	.	.	.	.
Tilia cordata (sh)	+	.	.	.	.	.	.	.	.	.	.	.	.
Lathyrus aureus	.	+	+	.	.	.	.	+	.	.	.	.	.
Luzula sylvatica	.	1	2	.	.	.	.	+	.	.	.	.	.
Aremonia agrimonoides	.	1	+	+	.	.	.	.	.	+	.	.	.
Brachypodium sylvaticum	.	+	1	.	.	.	.	.	.	.	.	.	.
Campanula rapunculoides	.	+	+	.	.	.	.	.	.	.	.	.	.
Primula veris	.	+	+	.	.	.	.	.	.	.	.	.	.
Rosa sp.	1	2	+	.	.	.	.	.	.	.	.	.	.
Acer campestre (sh)	+	2	2	.	.	.	.	+	.	.	.	+	.
Poa nemoralis	2	1	+	.	.	.	.	.	.	.	.	.	.

continued

continuation of Annex III

Geranium macrorrhizum	3	.	.	.	.	+	.	+	2	2	4	2	.
Festuca heterophylla	.	+	.	.	.	.	.	.	.	.	.	.	.
Plagiochila porelloides	.	.	.	.	.	.	.	+	.	.	.	.	.
Dactylis glomerata	.	+	.	.	.	.	.	.	.	.	.	.	.
Homalothecium lutescens	2	.	+	+	.	.	.	+	.	.	.	.	.
Glechoma hederacea	.	.	.	.	.	.	.	+	.	+	.	.	.
Saxifraga rotundifolia	.	.	.	.	.	.	.	+	.	.	.	.	.
Potentilla rupestris	.	2	.	.	.	.	.	.	.	.	.	.	.
Galium sp.	.	+	.	.	.	.	.	+	.	.	.	.	.
Cardamine impatiens	.	.	.	.	.	.	.	.	+	.	.	.	.
Pseudevernia furfuracea	.	.	.	.	.	+	+	.	.	.	+	.	.
Evonymus verrucosus	+	2	.	.	.	.	.	+	2	.	.	.	.
Arabis sagittata	+	.	.	.	.	.	.	+	.	.	.	.	.
Lamium purpureum	.	.	.	.	.	.	.	1	1	.	.	.	.
Isothecium alopecuroides	.	.	.	.	.	.	.	.	.	+	.	+	.
Brassica rapa	.	.	.	.	.	.	.	.	+	.	.	.	.
Corylus avellana	+	1	.	.	.	.	.	.	.	.	.	.	.
Vaccinium myrtillus (sh)	.	.	+	.	.	.	.	.	.	.	.	.	.
Stachys sylvatica	.	.	.	.	.	.	+	+	.	+	+	.	.
Mnium stellare	.	.	.	.	.	.	.	+	.	.	.	.	.
Orthotrichum anomalum	.	.	.	.	.	.	+	.	.	.	.	+	.
Brachytheciastrum velutinum	2	.	+	+	.	+	.	.	.	+	.	.	.
Circaea luteciana	.	.	.	.	.	.	.	.	+	.	.	.	.
Rubus idaeus	.	+	.	.	.	.	.	.	.	.	.	.	.
Mentha spicata	+	.	.	.	.	.	.	.	.	.	.	.	.
Lapsana communis	+	.	+	.	.	.	.	+	.	.	+	.	.
Paris quadrifolia	.	.	.	.	.	.	.	+	+	.	.	.	.
Cystopteris fragilis	.	.	.	.	.	.	.	.	+	.	.	.	.
Urtica dioica	+	.	.	.	.	.	.	.	.	.	+	.	.
Rumex sanguineus	.	.	.	.	.	.	.	.	+	.	.	.	.
Monotropa hypopitys	.	.	+	.	.	.	.	+	.	.	.	.	.
Cotoneaster nebrodensis (sh)	.	+	.	.	.	.	.	.	.	.	.	.	.
Asarum europaeum	.	.	.	.	.	.	.	+	+	.	.	.	.
Polystichum setiferum	+	.	.	.	.	.	.	.	+	.	.	.	.
Lamium maculatum	.	.	.	.	.	.	.	.	1	.	.	.	.
Daphne laureola (sh)	.	.	.	.	.	.	.	.	.	+	.	.	.
Veronica montana	.	.	.	.	.	.	.	.	.	.	+	.	.
Crataegus monogyna	+	.	.	.	.	.	.	.	.	.	.	.	.

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Polystichum aculeatum	.	.	.	.	.	.	.	1	.	.	.	.	.
Galium aparine	+	.	.	.	.	.	.	.	.	.	.	.	.
Epipactis helleborine	.	.	.	.	.	.	.	+	.	.	.	.	.
Lepraria incana	.	.	.	.	.	.	+	.	.	.	.	.	.
Eurhynchium angustirete	.	.	.	.	.	.	.	+	.	.	.	.	.
Impatiens noli-tangere	.	.	.	.	.	.	.	.	.	.	+	.	.
Rubus caesius (sh)	.	.	+	.	.	.	.	.	.	+	+	.	.
Ballota nigra	.	.	.	.	.	.	.	.	.	.	.	+	.
Luzula luzuloides	.	.	.	.	.	.	.	+	.	.	.	.	.
Ostrya carpinifolia (juv)	.	+	.	.	.	.	.	.	.	.	.	.	.
Pterigynandrum filiforme	.	.	.	.	.	.	.	.	.	.	+	.	.
Cruciata glabra	.	+	.	.	.	.	.	.	.	.	.	.	.
Lamiastrum galeobdolon	+	.	.	.	.	.	.	.	.	.	.	.	.
Geranium robertianum	+	.	.	.	.	.	+	+	.	+	2	2	.
Dicranum scoparium	.	+	.	.	.	.	.	.	.	.	.	.	.
Pseudoleskea incurvata	.	.	.	+	.	+	.	.	.	.	.	.	.
Epipactis sp.	.	.	.	.	.	+	+	.	.	.	.	.	.
Dryopteris dilatata	.	.	.	.	.	.	.	.	2	+	+	.	.
Tortella tortuosa	.	+	.	+	.	+	.	.	.	.	.	.	.
Fragaria vesca	+	.	.	.	.	.	.	.	.	.	.	.	.
Lonicera xylosteum	.	+	.	.	.	.	.	.	.	.	.	.	.
Hepatica nobilis	.	.	.	.	.	.	.	+	.	.	.	.	.
Cardamine pectinata	.	.	.	.	.	.	.	+	.	.	.	.	.
Acer pseudoplatanus	.	.	.	.	.	.	.	.	.	2	.	.	.
Lilium martagon	.	+	.	.	.	.	.	.	.	.	.	.	.
Symphytum tuberosum	.	.	.	.	.	.	.	.	.	.	+	+	.
Allium ursinum	.	.	.	.	.	.	.	.	.	2	.	.	.
Bryum moravicum	.	.	+	.	.	.	.	.	.	.	.	.	.
Syntrichia ruralis	+	.	.	.	.	.	.	.	.	.	.	.	.
Schistidium apocarpum	2	.	.	.	.	.	.	.	.	.	.	+	.
Galeopsis tetrahit	.	.	.	.	.	.	.	.	+	.	.	.	.
Pseudoleskeella nervosa	+	.	.	.	.	.	+	.	.	+	.	.	.
Stellaria nemorum	.	.	.	.	.	.	.	.	.	.	.	+	.

[1] Diagnostic species of cl. *Querco-Fagetea* , ord. *Fagetalia sylvaticae* , all. *Fagion sylvaticae* & *Cephalanthero-Fagion* ; [2] Diagnostic species of *Abies alba-Fagus sylvatica* community & all. *Fagion sylvaticae* ; [3] Diagnostic species of ass. *Asperulo odoratae-Fagetum sylvaticae* & all. *Fagion sylvaticae.* About woody species were used following abbreviations: tr - for tree layer, sh - for shrub layer and juv - for juvenile species.

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Review article

REVIEW OF DESERTIFICATION AND FOREST DEGRADATION ISSUE IN KAZAKHSTAN

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ABSTRACT: Natural and anthropogenic factors are the causes of desertification and forest degradation in Kazakhstan. The key natural factor contributing to desertification processes in Kazakhstan is the intra-continental state of the country, determining continental and arid climate, the scarcity and irregularity of the water resources' distribution, causing wide spreads (up to 30 million ha) and saline lands (127 million ha). These natural features of Kazakhstan cause poor resistance of the environment to human impact. It is estimated that about 75% of the country is subject to high environmental risks. Anthropogenic factors that lead to the emergence and enhancement of desertification processes in Kazakhstan are mainly associated with such economic activities as: grazing, agriculture, intensive usage of mineral resources, construction and operation of industrial, military and civilian facilities, irrigation and linear structures. Desertification is also the result of illegal logging, uprooting shrubs and dwarf shrubs for fodder and fuel, forest and grassland fires, haphazard recreation organization dumps around settlements, pollution of soil and groundwater with toxic substances. In addition, in Kazakhstan, each type of forest has its own set of factors causing forest degradation. The forests of forest steppe zone such as birch stands mixed with aspen and willow suffer from reduction in area because of extensive agricultural cultivation of steppe land around woodland. Briefly, it can be said: The main threats to the forest ecosystems of Kazakhstan include conversion of tugai forest into agricultural land, increased cutting for fuel wood, illegal logging and forest fires.
Keywords: Central Asia, climate change, desertification, deforestation, anthropogenic factor, steppe forest.

1 INTRODUCTION

The Central Asian Region grow out of both vast lowland plains mainly in the north bordering Russia as well as mountain ranges of various altitudes located in the south and southeast such as the Altai, Jungarian Ala Tau and the Tian Shan mountains at the border of Western China. The largest lowland plains are located in Kazakhstan, particularly in the north and western parts of the country. The climate in Central Asia is highly continental with quite hot summers and cold winters. Usually, annual precipitation in the lowlands and foothills ranges from 80 to 500 mm while the mountainous areas receive more rainfall at a level of about 1,000 mm/year. Except for the mountains, in the lowlands the annual rainfall is several times less than what could be evaporated, resulting in a considerable moisture deficit. Dry climate ensures the conditions for the hegemony of desert and semi-desert landscapes. The countries of Central Asia are home to diverse ecological features caused by varying topographical and climatic characteristics (Kleine ***et. al.***, 2009).

This study focused on forest types and climate change and its effects, forest, and land degradation in Kazakhstan; and finally, suggests some measurements to take and priorities to set for forest rehabilitation and restoration practices in Kazakhstan.

1.1 Vegetation and climate characteristics

As represented by FAO's ecological zoning maps, Central Asian countries mainly belong to the moderate steppe and moderate desert zones (Kleine et. *al.*, 2009). Similarly, Kazakhstan lies down mainly in a temperate climate zone, with subtropical deserts in the south lowland plains with steppes, semi deserts, and deserts form 60 % of the surface area, while arid foothills represent 30 % and mountains 10 %. Kazakhstan includes many lakes and rivers, the largest of which are the Lake Balkhash and the Irtysh River. Its location between the Siberian taiga and Central Asian deserts and between the Caspian Sea and the high mountains of the Tien-Shan means the country possesses a great variety of natural landscapes and ecosystems (Anonymous, 2001). Kazakhstan is a forest-poor country (Anonymous, 2007); forest cover percent in the Republic is only 4.57 % (Yesserkepova, 2010; Mambetov *et. al.*, 2013**)**. That's why only 3.1 million ha belongs to high forests. The forest cover percent determined by European standards amount to 1.1 %, not 4.5 % as stated by Mambetov *et al.* (2013). 97 % of the forests have been classified primarily as protection forests, two-thirds of which is entirely excluded from commercial timber harvesting (Kushlin et. al., 2004). Forests mainly occupy the northern part of the country and the high mountain slope valleys and riparian areas (Anonymous, 2001).

Although this region is characterized by severe winters and relatively hot summers in the north and continental climate under hot conditions in the southern parts, it has a unique vegetation character determined by various topographic and climatic features. The climatic features of these zones are shown in Table I (Anonymous, 2001).

The forests in Kazakhstan belong to different phyto-geographical zones. The more humid north refers to forest steppe zone, and with an increase of dryness towards the south follow steppe, semi-desert and finally the desert zone as shown in the zoning map in Figure 1.

The coldest month is January and the warmest one is July. There is little precipitation, especially in the southern regions. Annual precipitation in the south is 100 mm in the south, while it is 300-500 mm in the north. In Kazakhstan (except for its mountainous parts) the annual rainfall is several times less than what could be evaporated, resulting in a considerable moisture deficit. The average temperature in January varies from -5 °C in the extreme south to -20 °C in the north. In the plains of Kazakhstan the average July temperature varies from +18°C in the north to +29 °C in the south (Meshkov ***et. al.***, 2009).

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Table I: Basic climatic indexes of natural zones of Kazakhstan (Arkhipov *et. al.*, 2000)

Climate Indices	Highland	Forest-Steppe	Steppe	Semi-Desert	Desert
Air temperature - annual average (°C)	+ 0.3... +1.0	+ 0.3... +1.0	+1.1...+3.1	+4.4... +6.4	+7... +12
Average temperature in July (°C)	+5... +17	+18... +19	+18... +22	+23... +25	+25... +30
Average temperature in January (°C)	-25	-19	-16... - 19	-12... -20	-5... -15
Annual precipitation (mm)	500... 1200	350... 400	200... 400	150... 280	100... 200
Summer precipitation (% of total annual precipitation)	30... 60	60	70	40	35
Duration of vegetation period (days)	0... 150	160... 170	170... 180	170... 200	200... 240
Duration of the snow period (days)	200... 365	150... 170	140... 160	120... 140	30... 120
Area (percentage of land cover)	1.0	10.3	19.7	22	47

Figure 1: Natural vegetation zones in Kazakhstan (Meshkov *et. al.*, 2009)

1.2 Status of forest and its degradation

Kazakhstan, like whole Central Asia, belongs to the least forested areas in the world. In all five states of the region - Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan – forests cover less than 10% of the territory (FAO, 2007; 2010). The more recent statistics by FAO related to forestry sector is shown in Table II and Table III for Kazakhstan and the other countries of Central Asia Region (Anonymous, 2014). In Central Asia countries, national changes in forest areas over the past 25 years (1990-2015) showed positive trend for Kazakhstan and Kyrgyzstan and negative trends for Uzbekistan. However, the average forest growing stock volume (19 m^3/ha) has decreased in Kazakhstan since 1990 (Sakıcı and Ayan, 2016).

In Kazakhstan, the largest country in the Central Asia Region, forests cover about 12.3 million ha. representing 44 % of the State Forest Fund area of 27.8 million ha or 10.2 % of the total territory (Figure 2) (Kleine *et. al.*, 2009; Meshkov *et. al.*, 2009). The major ecosystems with some form of tree cover include forest steppe, steppe, semi-deserts and deserts, foothill plains, the mountain zone, and lowland forests (Kleine *et. al.*, 2009).

The area and standing wood stock of main woodland type in Kazakhstan is given in Table II (Mátyás, 2010). The main forest-forming species are conifers – *Pinus silvestris* L., *Picea schrenkiana* Fisch. & C.A. Mey., *Picea obovata* Ledeb., *Abies sibirica* Ledeb, *Larix sibirica* Ledeb, *Pinus sibirica* Du Tour; softwood broadleaved – *Betula pubescens* Ehrh. *Betula verrucosa* Ehrh, *Populus tremula* L.; hardwood broadleaved - *Quercus robur* L., *Ulmus laevis* Pall, *Ulmus pinnato-ramosa* Dieck ex Koehne, *Elaeagnus angustifolia* L.; *Haloxylon aphyllum* (Minkw.) Iljin, *Haloxylon persicum* Bunge ex Boiss. & Buhse (Figure 3). In the northern part of the country which represents a continuation of the West Siberian Lowlands, birch forests extend over a huge territory, generally scattered among croplands. To the south is the pine woods seen as the ribbon-like pine forests on the right banks of the Irtysh River. The Kazakhstan Altai covers the eastern part of the Altai range including the right sub-basins of the Irtysh River. This mountainous area is covered by forests consisting of spruce, larch, pine, birch and aspen, while *Pinus sibirica* occupies the top part of the mountain slopes (Meshkov *et. al.*, 2009).

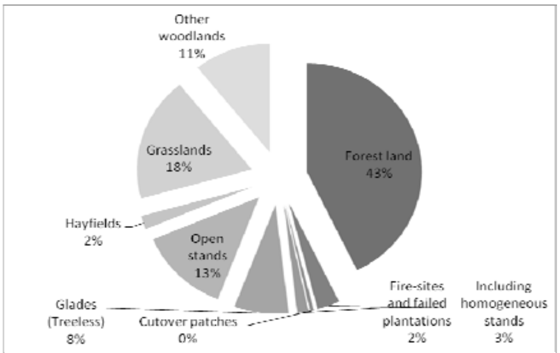

Figure 2: Forestry fund lands according to current stocking conditions (Meshkov *et. al.*, 2009)

With more than 6 million ha, saxaul take up the major part of the forest area followed by coniferous forests and birch forests (Figure 3) (Kleine *et. al.*, 2009). All forests in the Republic of Kazakhstan are protective forests. This issue becomes topical in forest-poor areas, to which Republic of Kazakhstan belongs (Mambetov *et. al.*, 2013). It is seen that some parameters such as employment and gross value added, and also some indicators such as food security, energy, shelter related to Kazakhstan forest sector are comparable with other Central Asia Countries (Table III, IV) (Anonymous, 2014).

The forests in Kazakhstan are unevenly distributed, with about 80 % of the wood stock in the northern and northeastern areas. The percentage of wooded land in Kazakhstan, including *Haloxylon* spp. and bushes, is 4.5%, while forests are only 1.2 %. Nevertheless, despite their small size, the forests play an important role in soil protection, climate and water regulation, water protection and recreation (Yesserkepova, 2010).

1.3 Climate change vulnerability assessment for forest

Yesserkepova (2010) has stated the possible effects of the climate change on the forests of Kazakhstan. In terms of percentage of forest land, Kazakhstan stands low in the global list, although area per person in Kazakhstan,

Table II: The area (1000 ha) and standing wood stock (million m³) of the main woodland classes in the Republic of Kazakhstan (Mátyás, 2010, *Data source: Kazakh Forest Management Enterprise*)

Year	Woodland class											
	Coniferous		Deciduous softwood		Deciduous hardwood		Saxaul spp.		Other wood		Bushes	
	area	stock	area	stock	area	stock	area	stock	area	stock	area	stock
1988	1737.5	221.1	1303.3	115.6	86.5	2.3	481.2	9.7	43.9	1.0	1410.0	6.5
1993	1800.2	240.4	1406.1	123.3	95.3	2.8	5091.4	10.7	80.8	1.4	2068.8	7.0
1998	1719.0	236.6	1430.5	126.0	98.1	2.9	5421.4	10.2	82.5	1.5	2675.6	9.3
2003	1650.8	228.6	1415.6	131.1	100.0	3.1	6252.8	15.2	137.0	2.6	3094.5	11.0
2008	1606.0	235.4	1378.0	127.2	98.9	3.2	6088.0	14.9	140.1	2.7	2963.2	10.9

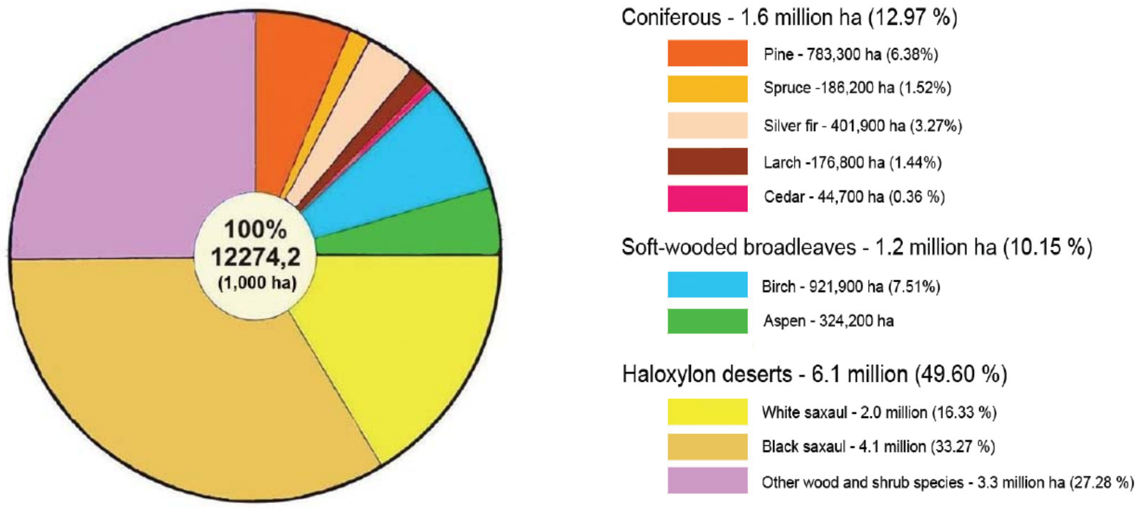

Figure 3: Distribution of dominant species on state forestry fund lands (Meshkov *et. al.*, 2009)

at 0.77 ha, is the same as the United States of America and Malaysia, and more than that in several East European countries. With a possible move to the south in mountain regions, the resistance of forest ecosystems implies eco-climatic zone boundary disturbances. The temperature and humidity changes may cause unsuitable conditions for pine, fir, larch and cedar, and thus leading to changes in species compositions, with an increase in less valuable deciduous trees and shrubs. In mountainous regions, the lower limit of spruce moving upward by 100–120 m will give way to deciduous softwood species and fruit trees. Fir plantings may disappear from the territory of Zhetisu Alatay, and they will remain only in a small area of East Kazakhstan**.**

The main species, such as pine, fir, cedar and juniper, are at the southernmost border of their area, and are very sensitive to temperature and humidity regimes, which explains how highly the forests are vulnerable to climate change (Table V) (Yesserkepova, 2010).

The observed annual temperature trends for the last 50 years in Kazakhstan have been positive, increasing by 1.5 °C. on the grounds that the greater part of the territory of Kazakhstan is occupied by deserts and semi-deserts, their ecosystems and many economic sectors, especially agriculture and water resources, are very vulnerable to climate change. According to climate change scenarios based on global climate modeling, further temperature increases with no significant gain in atmospheric precipitation may lead to a drier climate (Yesserkepova, 2010). On the possible impacts of climate change, the report by the National Human Development (2008) states that: "*Forestry's climate and weather adaptive measures need to focus on overcoming their negative effects and gaining the maximum from those changes, as well as the development of national parks and specially protected areas*" (Anonymous, 2008). Goryunova (2009) has summarized the impacts of climate change in Kazakhstan (Table VI).

2 DESERTIFICATION AND DEGRADATION

2.1 Desertification as a major environmental problem

Desertification is a expressed global environmental and socio-economic matter. With the rise in the population of the Earth, almost full development of good agricultural lands and unprecedented increase of anthropogenic impact on the environment, desertification can become a major threat to the successful socio-economic development for many countries in the XXI century (UNEP, 1994; Saigal, 2003; Glazovsky, 2015). According to the definition of the United Nations Convention to Combat Desertification, desertification is "*land degradation in arid, semi-arid and dry sub-humid areas in result of various factors including climatic variations and human activities*". Both natural and anthropogenic factors are the causes of desertification in Kazakhstan.

As much as two-thirds of Kazakhstan's land is predicted to be prone to desertification, particularly the central and southern parts of the Aral Sea Basin (ADB, 2004). The rank of desertification in the regions ranges from moderate to high, due mainly to unsustainable agri -

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Table III: Contribution of the formal forest sector to employment and GDP, 2011 (Anonymous, 2014)

Counntry/ Area	Employment					Gross value added				
	Roundwood production	Wood processing	Pulp & paper	Total for the forest sector		Roundwood production	Wood processing	Pulp & paper	Total for the forest sector	
	(1000)			(1000)	(% of total labour force)	(US$ million)			(US$ million)	(% contribution to GDP)
Armenia	3	1	1	5	0.3	8	2	8	17	0.2
Azerbaijan	2	2	1	5	0.1	1	5	10	16	0.0
Georgia	8	3	1	12	0.5	49	7	6	61	0.5
Kazakhstan	7	1	3	11	0.1	86	40	48	173	0.1
Kyrgyzstan	3	1	0	4	0.2	3	2	3	9	0.2
Tajikistan	2	0	0	2	0.1	2	4	0	5	0.1
Turkmenistan	9	0	-	9	0.4	1	0	-	1	0.0
Uzbekistan	7	0	0	7	0.1	5	2	6	14	0.0
Total Central Asia	**41**	**8**	**6**	**55**	**0.1**	**155**	**62**	**81**	**297**	**0.1**

GDP: Gross domestic product

Table IV: Indicators of the socio-economic benefits from forests, 2011 (Anonymous, 2014)

Country / area	Employment		Gross value added		Food security		Energy		Shelter	
	Total for the formal and informal sector		Total for the formal and informal sector		Number of people using woodfuel to cock		Primary energy supply from wood		People in homes made partly from forest products	
	(1000)	(% of total labour force)	(US$ million)	(% of total GDP)	(1000)	(% of total population)	(MTOE)	(% of TPES)	(1000)	(% of total population)
Armenia	84	5.8	95	1.0	1348	43,3	1	25.1	2647	85.4
Azerbaijan	4	0.1	106	0.2	799	8,6	0	0.0	8310	89.3
Georgia	17	0.7	95	0.8	1735	40.1	1	14.9	-	-
Kazakhstan	13	0.2	186	0.1	605	3.7	0	0.1	856	5.3
Kyrgyzstan	5	0.2	22	0.4	1790	33.2	0	0.3	-	-
Tajikistan	2	0.1	17	0.3	1844	26.4	0	1.0	-	-
Turkmenistan	11	0.5	23	0.1	987	19.3	0	0.0	4145	81.2
Uzbekistan	7	0.1	14	0.0	4069	14.7	0	0.0	-	-
Total Central Asia	**143**	**0.4**	**558**	**0.2**	**13177**	**16.9**	**1**	**0.8**	**15959**	**20.4**

GDP: Gross domestic product; TPES: Total primary energy supply; MTOE: Million tons of oil equivalent

Table V: Change in average annual air temperature and annual total precipitation as to different scenarios of GHG concentrations (Mátyás, 2010)

Scenario	Climate characteristics	2030	2050	2070
Medium	Change in average annual air temperature	1,4 °C	2.7 °C	4.6 °C
	Change in total annual precipitation	+2%	+4%	+5%
Extremely high	Change in average annual air temperature	1,2-1,9 °C (1,3 °C)	2,5 - 4,0 °C (3,0 °C)	5,7-8,0 °C (6,2 °C)
	Change in total annual precipitation	-2 - +8% (2,2%)	-4 - +15% (3,7%)	8- 28% (6,5%)
Extremely low	Change in average annual air temperature	1,5-2,2 °C (1,7 °C)	1,6-2,6 °C (2,0 °C)	3,1-3,4 °C (3,3°C)
	Change in total annual precipitation	0-8% (3,0%)	-3 - +9% (1,7%)	-2 - +13% (4,1%)

Table VI: Impacts of climate change in Kazakhstan

Change of climate elements and sea level rise	Vulnerable area	Paramount change	Impact	
			Primary	Secondary
> 3 °C (> +20 % precipitation)	Water resources	- Flow change	- Intensification of winter floods - Decrease of summer flows	-Risk to life and property - Stress on water resources in summer time - Negative effects on riparian forest - Negative effects of poplar plantation growth

cultural and forestry applications such as poor irrigation and drainage management systems, intensive livestock grazing, excessive timber cutting, and forest fires (Anonymous, 2007).

The key natural factor contributing to desertification processes in Kazakhstan is the intra-continental state of the country, determining continental and arid climate, the scarcity and irregularity of water resources' distribution, causing wide spread sand (up to 30 million ha) and saline lands (127 million ha). There are conditions for the enhancement of land degradation processes and for the violation of the seasonal features of soil formation under the influence of drought. These natural characters of Kazakhstan conduce poor resistance of the environment to human impact. It is estimated that about 75 % of the country is expose to high environmental risks (Bekturova, 1999).

Anthropogenic factors that lead to the urgent and uptrend of desertification processes in Kazakhstan are mainly associated with such economic activities as grazing, agriculture, development of mineral resources, construction and operation of industrial, military and civilian facilities, irrigation and linear structures. Desertification is also the result of illegal logging, uprooting shrubs and dwarf shrubs for fodder and fuel, forest and grassland fires, haphazard recreation organization dumps around settlements, pollution of soil and groundwater with toxic substances as well as the impact of transport.

2.2 Degradation of vegetation

Degradation of vegetation, water and wind erosion, salinization and dehumidification of soils, chemical pollution of soil, groundwater and surface water, anthropogenic land disturbance and hydrological regime are the main types of desertification in Kazakhstan determined in accordance with the criteria adopted by the Convention to Combat Desertification. Degradation of vegetation is one of the most popular and visually defined desertification processes, manifested in the form of degradation of forests, rangeland sand hayfields. Though little, the forests Central Asia has are highly significant but in a state of continual decline. Forest loss and degradation is estimated to have been on the 75% of the forest area since the 1960s (Loo, 2013).

The degradation of forest is most argument in the forests of Rudnyy and Southern Altai, where over the past 40 years productivity of coniferous forests has decreased by 7 %, and the area of *Abies* spp. forests has diminished by 13 %. Forests degrade very severely in the floodplains of the desert rivers. Undesirable changes in type take place due to a decrease in soil moisture as a result of the regulation of the river flow in these forests (Mambetov *et. al.*, 2013).

In Kyzylorda region, one of reasons of sharp worsening of plantation is the change of forest growth conditions originating from ecological disaster in Aral Sea region. In addition, it becomes unfeasible to grow for the black saxaul, the main species of saxaul forests in Kazakhstan, with drying of Aral Sea and lowering of ground waters in larger parts of Kyzyl-Kum desert. Currently, area of exposed bottom of Aral Sea is more than 5 million ha. These dead areas, covered with salty sand, have steadily been expanding. Saline and active sands soils, which are formed here, serve as arena for leaching salt, dust and sand to adjacent lands of Aral Sea region, doing harm to the economy of the entire region (Mambetov *et. al.*, 2013).

Despite works undertaken in the field of protection, maintenance, rehabilitation and rational use of forests, and preservation of the biological diversity, there is an observed tendency of degradation of forest ecosystem in the country. Destruction of forests and reduction of their areas cause considerable changes in biological diversity. According to the existing terminology, degradation of forests is a slow process of loss of productivity and dying-off of growing stock under influence of anthropogenic or natural factors resulting in the deterioration of the forest environment (Meshkov *et. al.*, 2009).

2.3 Causes of forest degradation

In Kazakhstan, each type of forest has its own set of factors causing forest degradation. The forests of forest steppe zone (birch stands mixed with aspen and willow) suffer from reduction in area due to extensive agricultural cultivation of steppe land around woodland. In most cases plowing was carried out up to the very forest edge, and woodlots with small areas were completely uprooted and destroyed (UNDP 2004; UNCCD 2006a; 2006b). This resulted in a change of the hydrological regime and soil formations on which these forests were formed. In addition, clear cuttings in birch forests over many decades followed by natural re-growth without systematic tending operations resulted in the formation of low-quality stands.

For the last 10 years the forested lands of *Pinus* spp. forests of the Irtysh region in the East-Kazakhstan and Pavlodar regions have been reduced to 162,400 ha with timber stocks decreasing to 16.8 million m^3. Large-scale illegal cutting also became more frequent. Steppe pine forests have been over-logged suffering from large forest

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fires in the past. According to up-to-date satellite image interpretation ribbon-like relict pine forests of the Irtysh region are devastated by forest fires and damaged by depredators practically on half of the area, comprising over 300.000 ha. Furthermore, they were constantly affected by radio nuclides as a result of nuclear tests at the Semipalatinsk nuclear test base in earlier times. However, this influence on forests has not been well studied yet.

For two centuries, large areas of pine woods have been destroyed entirely in the Tugai region as well as in a number of the regions of the Central Kazakhstan. Mountain forests were under pressure by excessive cattle grazing, which lead to degradation of ground cover and destruction of natural regeneration. Unregulated cuttings in mountain forests, particularly in East-Kazakhstan and forest fires resulted in a reduction of tree species diversity and substitution of coniferous species by the less valuable broad-leaved and shrub species.

During the last 100 years the lower boundary of *Picea* spp. forests location in the Zailiysk Alatau Mountains of the Northern Tien Shan have risen by 100-150 m up the hill slopes, therefore the range of spruce forests distribution shortened. The same happened in the mountains of Jungarian Alatau, where the range of Silver fir shortened almost by three times. From 1966 to 1993, the productive capacity of conifer forests decreased by 7% (161 to 150 m^3/ha), the area of Silver fir stands representing a specific worth due to its location at the edge of the natural area was reduced by 16 % (from 459 to 384 ha).

3 CONCLUSIONS

By taking the current situation, degradation and desertification processes into account, priority areas for forestry in Kazakhstan can be underlined as follows. The precedence should be given to strengthening forestry institutions in Kazakhstan, to enhance national and local capacity of fire prevention & control, afforestation & reforestation units and of the units combating desertification. Improving governance especially with regard to private afforestation should also be another priority for Kazakhstan, and some stimulation policies at the national level must be developed. To this end, effective forest governance monitoring practices should be adopted. It is of great significance for Kazakhstan to take necessary steps to reverse the effects of past degradation through physical investment projects addressing water use efficiency and salinity reduction by means of modernizing irrigation and drainage systems for agricultural lands and plantations, depleted and degraded agricultural lands including rangelands by revegetation. Replacement of lost forests by appropriate and reliable reforestation and afforestation practices should also have a priority on the agenda. Opportunities for carbon sequestration in agriculture, rangelands, and forests should further be assessed.

Climate data monitoring should be improved and network development should be ensured. This is to increase information reliability on climate system status and provide the user with information on climate change.

Reforestation should be one of the priorities subject for developing forestry sector. In "Kazakhstan Strategy – 2030" and in the address to the people of Kazakhstan, the President marks out this direction as being one of the priorities that stimulate ecological improvement of the state territory. It is oriented on the use of natural and artificial methods of reforestation (Mambetov *et. al.*, 2013; Norbert, 2010).

On Kazakhstan forestry and forests (Kleine *et. al.*, 2009), *it is briefly stated that:*

- The implementation of strategies for rehabilitation of degraded forests, watershed management and conservation of forest biodiversity must be supported.
- Under the current conditions, the expansion of forest area and rehabilitation and restoration of degraded forests must be financed primarily by the State.
- Several technical matters need to be addressed for enhancing the efficiency of forest rehabilitation work, including improvement of forest seed production and seed sources as well as the expansion of production of planting stocks particularly containerized seedling through enhanced nursery techniques.
- Priority will also be given to the rehabilitation of burnt forest areas, clear-cut stands, and shelterbelts to protect agricultural lands.
- Special attention will be paid to renewed efforts in combating desertification through expansion of saxaul plantations.
- The coniferous forests of the country will be predominantly regenerated by natural means and also expanded through block-strip planting which are more resistant to fire and attacks by pests and diseases.

The new forest policy of the State is directed towards progressive development of the forest sector in all directions, particularly convenient protection of forests, expansion of the forest area, and site-specific management and operations in order to increase the overall forest productivity (Meshkov *et. al.*, 2009).

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Scientific and professional meetings report

FINANCIAL MECHANISM OF THE EUROPEAN ECONOMIC AREA 2009-2014
Programme BG03 Biodiversity and Ecosystem Services
East and South European Network for Invasive Alien Species –
A tool to support the management of alien species in Bulgaria
ESENIAS-TOOLS, Д-33-51/30.06.2015

ESENIAS-TOOLS WG4 MEETING REPORT: DATA COLLECTION, ANALYSIS, STANDARDISATION AND HARMONISATION ON ALIEN PLANT AND FUNGI SPECIES (3-4 March 2016, Novi Sad, Serbia)

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Invasive alien species (IAS) threaten biodiversity and ecosystem services, and have adverse socio-economic impact. Their introductions and spread have increased due to human activities and global change. As a response to this threat, a new EU Regulation 1143/2014 on IAS was adopted and in force from 1st January 2015. The European Alien Species Information Network (EASIN) was developed to facilitate the exploration of existing IAS information. Networking on IAS in different scales is needed to collect data, prevent new introductions and manage already widely spread invasive alien species.

INTRODUCTION TO ESENIAS AND ESENIAS-TOOLS

Starting from 2010 group of experts (scientist and expert employed at the governmental institutions) dealing with invasive alien species, in the region of the West Balkan at the beginning, and later in territory of South-East Europe, started annual meetings. From the beginning, it was stressed that creating of certain non-official network in necessary. Therefore, already next year, in 2011, in Sofia, ESENIAS (East and South European Network for Invasive Alien Species) was established, with the full support from European Environmental Agency. Specialists from IUCN-ISSG are active supporters and part of the ESENIAS from the very beginning.

ESENIAS countries are: Albania, Bulgaria, Bosnia and Herzegovina, Croatia, Greece, Italy, Kosovo (UN Resolution № 1244), Macedonia, Montenegro, Romania, Serbia, and Turkey; Invited countries are Slovenia and Hungary.

Why ESENIAS as a network is necessary? By that time, several pan-European projects dealing with IAS have been realized, and several were ongoing. In the same time, Convention on Biologic Diversity (CBD) strategic plan for the period 2011-2020 was published, and within it Target 9: "By 2020, IAS and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment". This was followed by numerous actions with aim of reaching this target. This finalized with EU Regulation 1143/2014 on Invasive Alien Species. Even this Regulation is not applicable in all ESENIAS countries- recommendation is to apply if it is possible, and to use its guidelines. One of the objectives of ESENIAS is to spread the information dealing with new regulations and IAS programs and projects.

What have ESENIAS done by now? Since 2010, every year at least one workshop for the participants from ESENIAS countries was organized (Zagreb 2010, Sofia 2011, Belgrade 2012, Çanakkale 2013, and Antalya 2014). Internet platform with main information is created www.esenias.org with all available information. Several projects dealing with IAS in the region are already finished, and they can all be seen on the webpage. In 2015, first multi lateral project was started: East and South European Network for Invasive Alien Species – A tool to support the management of alien species in Bulgaria (ESENIAS-TOOLS).

The project is funded by the Financial Mechanism of the European Economic Area 2009-2014, under the Programme BG03 Biodiversity and Ecosystem Services, and aims at networking and development of IAS tools within the framework of ESENIAS to support the management of alien species in Bulgaria and in the overall region. The project promoter is the Institute of Biodiversity and Ecosystem Research of the Bulgarian Academy of Sciences and the Project coordinator is Dr. Teodora Trichkova. Project partners are 10 state and research institutions from Bulgaria, Greece, Croatia, Serbia, Romania, Turkey, Iceland and Macedonia.

One of the project aims is to collect and harmonize data on alien species from ESENIAS countries and prepare outputs. *Why?* Because, even today many online sources, followed by published scientific articles and official state IAS lists, usually they are not comparable, methodologies are different, etc.

Within the ESENIAS-TOOLS project, ten working groups have been organised, among which is the working-group WG4: Data collection, analysis, standardisation and harmonisation on alien plant and fungi species. Project Coordinator for this group is Milica Rat MSc from the University of Novi Sad, Faculty of Sciences. The working group involves expert(s) representatives of each country.

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Faculty of Forestry in Skopje

ESENIAS-TOOLS WG4 MEETING: DATA COLLECTION, ANALYSIS, STANDARDISATION AND HARMONISATION ON ALIEN PLANT AND FUNGI SPECIES, 3-4 March 2016, Novi Sad, Serbia

This meeting was organised by the University of Novi Sad Faculty of Sciences, Department of Biology and Ecology, with the support of the Office of the Rector at the University of Novi Sad, the Institute of Biodiversity and Ecosystem Research of the Bulgarian Academy of Sciences (IBER-BAS) and the East and South European Network for Invasive Alien Species (ESENIAS). The meeting was funded by the Financial Mechanism of the European Economic Area 2009-2014, Programme "BG03 Biodiversity and Ecosystem Services" under the Project "East and South European Network for Invasive Alien Species – A tool to support the management of alien species in Bulgaria" (ESENIAS-TOOLS), and co-funded by the Provincial Secretariat for Higher Education and Scientific Research Activity. The programme of the meeting was additionally supported by the Provincial Secretariat for Urban Planning and Environmental Protection, because of the high importance of the topics related to improvement of the Serbian national legislation of invasive alien species.

Active participation took 37 participants from 12 countries (Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Hungary, Macedonia, Montenegro, Romania, Serbia, Slovenia, Turkey and the United Kingdom). The participants represented project partner institutions, as well as research institutions, universities, environmental protection agencies related to invasive alien plants from other ESENIAS countries.

After the registration, welcoming notes and introduction of the participants, the following topics were presented and discussed in details:

3rd March 2016

- Presentation of ESENIAS Network - history, aims, structure and participants (Milica Rat)
- Presentation of ESENIAS-TOOLS project: Working plan, expected results, issues and challenges (Vladimir Vladimirov)
- State of art on alien plants and fungi in the ESENIAS region
- Country reports - check list, trends and pathways: Bulgaria, Croatia, Greece, Macedonia, Romania, Turkey, Montenegro, Hungary, Slovenia, Serbia
- Alien Freshwater Vascular Plants in SE Europe: Preparation of list of alien species - ESENIAS list (Richard Lansdown)
- Alien Terrestrial Plants in SE Europe: Preparation of list of alien species - ESENIAS list (Milica Rat)
- Discussion
- ESENIAS Book: plants, fungi; fact sheets (Ahmet Uludag, Vladimir Vladimirov)

4th March 2016

- Standardisation and harmonisation of methods, discussion
- Prioritisation of alien species, discussion (Vladimir Vladimirov), open discussion
- Validation of data per countries, publishing of new national lists
- Preparation of fact sheets
- Time-table of future activities, reporting, dissemination of results, technical issues

Finally, the ESENIAS-TOOLS WG4 meeting was successfully closed by making the following activities done:

1) ESENIAS-TOOLS WG4 (alien plants and fungi species) working plan, tasks, activities and expected results;
2) Existing lists of alien plant species per country;
3) Existing review lists of alien plant species for the ESENIAS region;
4) Future activities to compile data for the 2nd ESENIAS book, as one of the Project outcomes; Preparation of fact sheets;
5) Standardisation and harmonisation of methods on alien plant species;
6) Prioritisation of alien plant species for the ESENIAS region;
7) Data validation per country and possible publishing of new national lists.

Figure 1: ESENIAS-TOOLS WG4 meeting in Novi Sad, Serbia, 3-4 March 2016 (Photo: www.esenias.org)

INSTRUCTIONS TO AUTHORS

Author(s)
University(ies) / Institute(s)
Address(es)

ABSTRACT: These notes provide important information on how to prepare and submit your article. Read the notes carefully and follow them as precisely as possible. **Any inaccuracy will cause delay at the Technical Editors and in the publication of the Forest Review**. Your article must be **written in English (UK)** and the layout should be exactly the same as this master document. **In order to prepare your layout, save this document with a new name and use it as a guide. Replace the text of this document with the text of your article without changing the layout, font type and size, line spacing, page margins and structure of this template** (see section 3). **Do not insert page numbers or page headers/footers**. If you have any question, please do not hesitate to contact us (see section 7.3).
Keywords: select 3 to 6 keywords.

1 DELIVERY

Articles will be published in the Forest Review only if correctly submitted.

The electronic version of your article must be submitted to the Technical Editor/s by e-mail according to the technical guidelines (see sections below), by one of the authors, together with **two suggested reviewers** (see section 11).

Your original manuscript must be delivered in the following formats:

- **Microsoft Word** (97/2003, .docx), and **Adobe Acrobat PDF** by e-mail.

Please make sure that the article you submit is the **final version** with all **numberings in the correct order. Do not submit the article more than once.**

2 PREPARING THE MANUSCRIPT

2.1 Volume and length of the article

Please consider that the complete article in pdf format, including illustrations, may not exceed **10 A4 pages**. This is a very good proven capacity for final articles.

2.2 Organisation of the article

The **title** of the article should be informative and concise. It must be followed by the author(s) name(s) – listing the principal author first, organisation, complete address, telephone, fax and e-mail address.

No logos may appear in the title.

The **abstract** preceding the body of your article should give a brief account of the most relevant aspects of your article, in 200/250 words. Please avoid using symbols, graphics and text formatting (bold, italic, underline) in this part of the document.

Next, in order of importance, select three to six of the most relevant **keywords** and include them in your article. The keywords should be separated with commas.

The **body** of the text must be in **two columns**. Number each heading using decimal numbering. Follow the layout specifications in section 3 below.

3 LAYOUT SPECIFICATIONS

The layout of your article should have exactly the same format as this master document.

Before you start working on your article, if you use Adobe Acrobat, select the printer option "Acrobat Distiller" (version 5.0) or Adobe pdf (version 6.0), in order to avoid accidental misplacement of layout elements afterwards when converting the Word file into PDF format.

3.1 Font type and size

Font type: **Times New Roman**. Font size: **9pt**. Line spacing: **single**. Text alignment: **justified left and right**. Captions should have the same font and size as the typeface used for the text. Make sure that illustrations are clear and easy to read. Please do not use any other font than Times New Roman.

3.2 Page size

Page size must be **A4** (210 mm x 297 mm). Margins: top: 32 mm; bottom: 19 mm; left and right: 25 mm.

The **body of the text must be in two equal columns** of 73.6 mm each. All written parts and images must fit **inside** these margins (for further details see subsection 4.1 about figures and subsection 4.2 about tables).

3.3 Typing the text

Begin at the top of the first page with the **title** of the article in bold capital letters and centered.

Leave one blank line between the title and the name of the author(s).

List the surname preceded by the initial of the first name; when several authors prepare an article, the name of the main one should appear first. On the following lines, give the name of the company or institute, wherever applicable, with the full address; the name of each organisation should be easy to depict. This paragraph must be centered and without any blank space.

Next, leave two blank lines and then type an **abstract** of no more than 250 words (keep the indent of this block on both sides, as shown on this document). At the end of the abstract give your 3/6 **keywords** on the last line.

Leave two blank lines between the abstract and the body of the text of your article, which must be in two columns.

3.4 Headings

Leave one blank line before each section and one blank line before the heading of each sub-section. Headings and sub-headings should be numbered (e.g. 3, 3.1, 3.2). Separate the numbers from the text of the heading with two spaces.

There should be no blank line after the title of the sub-sections but only an indentation to indicate the beginning of a paragraph. Section headings should be in capital letters. Sub-section headings should be in upper and lower case. Headings should be normal text – not underlined or in bold.

4 ADDITIONAL COMPONENTS

4.1 Illustrations

Illustrations (photographs, drawings, graphs, charts, etc.) should not exceed 50% of the whole article and should be placed as near as possible their citation. Illustrations must not be taken from previously-printed materials.

Illustrations should have a resolution of **300 dpi** using simple colors (Standard+RGB) and be placed at **100% scale** (i.e. if an illustration covers the full column width, it should be of approx. 860 pixel).

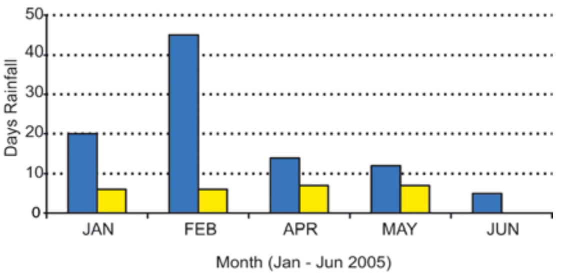
Illustrations should have the layout in line with the text (right click on the object – Format object – Layout – in line with the text, which should be the left-most option in the layout dialogue window).

All illustrations must be numbered progressively in bold decimals (e.g. **Figure 1**:) and have a reference in the text (e.g. Fig. 1). Captions should be as clear as possible, to allow comprehension of the illustration without reference to the text.

Graphs and charts must not be imported from Excel, but should be inserted as a picture (.jpg, .bmp or .gif). Please, use simple contrasting colors and effects instead of fill patterns. See Fig. 1 for good/bad example.

Illustrations must be clear also when printed in black and white.

Good example with contrasting colors:



Bad example with fill patterns:

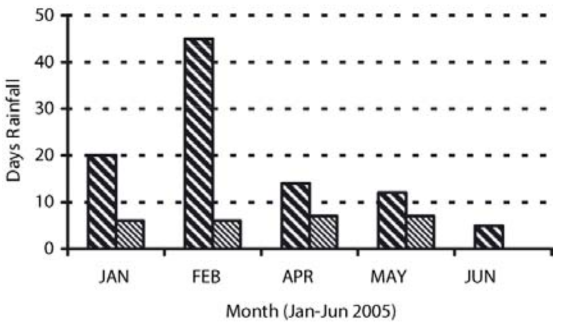


Figure 1: Clear line drawings are essential

4.2 Tables

Tabular presentation of data is an easy way to condense many items. Tables must be numbered in bold Roman numerals (e.g. **Table I**), and have a reference in the text. Captions should be as clear as possible, for an easy comprehension of the tables.

Table I: Overview of biomass resources available

Biomass Sources	Quantity	Moisture	Residue
Sewage Sludge	1.86	1.73	1.40
Septage	0.32	0.28	0.16
Fruit Pulp	3.78	3.89	4.02

4.3 References and notes

References and notes must not appear as footnotes in the pages, but should be listed together at the end of the text, in the dedicated sections.

When referring to them in the text, please type the corresponding reference number in brackets. Use round brackets for the notes (1) and square brackets for the references [1].

To make them easier to find, indent your notes and references from the second line, as in the examples (see sections 5 and 6).

4.4 Acknowledgements

Any acknowledgement should be added before the references and/or notes, in a dedicated section, as in the example (see section 9).

5 NOTES

(1) This section should have the progressive number before the title, exactly as for the previous ones.
(2) Do not add any unnecessary space between the listed numbers of your notes.

6 REFERENCES

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[2] Do not add any unnecessary space between the listed numbers of your references.
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[4] D. Reed, Evaluation of Biomass Resources in the southern regions in Nigeria, (2007), pag. 124.
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8 IMPORTANT SPECIFICATIONS FOR THE PDF

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If you are using **special fonts** make sure that the checkbox “Do not send fonts to distiller (“adobe pdf” for version 6.0)” is **not** selected.

8.2 Password / Security

Please **do not use any Password / Security when making the Pdf file.** As the header and page numbers will be added by us, we need to ensure that you pdf file is not password protected.

9 ACKNOWLEDGEMENTS

- We thank you for successfully following these instructions. This will make the Reviewers easier to read and avoid queues at the Technical Editors!
- The Authors are grateful to the students-members of DREN - Forestry Students’ Association for their helpful cooperation.
- …….

10 LOGO SPACE

If you wish, you may add your logos (e.g. Organisations, Project Partners, Supporters, Brands etc) at the end of the article.

11 IMPORTANT NOTICE FOR THE SUBMISSION

To ensure a convenient publication process, the authors are requested to follow these instructions. Submission of an article implies that it reports unpublished work and that it is not under consideration for publication elsewhere. If previously published tables, illustrations or more than 200 words of text are to be included, then the copyright holder's written permission must be obtained. Copies of any such permission letters should be scanned and attached with the article.

A **condition of submission** (with the abstract submission) is that the author nominates **two people** who are qualified to act **as reviewers** and who have not previously been involved with the article in any way. Both of the nominated reviewers must be working in a different country to the first named author.

Before the publication, the article will be reviewed by the members of the Editorial Board and a notification of acceptance will be send to the corresponding author. Editors may request that authors submit a revised version of their article before it can be accepted for publication. The Editor's decision on all submissions is final.

     

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