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Review paper

Forests in South-eastern Europe

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Abstract: Forests in South-Eastern Europe are with the smallest area and share of forest area, least annual increment and fellings (m³/ha) and – due to historical circumstances – with least share of private forests on the continent. This region is with highest percentage of coppice stands and forest plantations but in the same time possesses relatively highest number of valuable forest genetic resources in Europe. According to countries, share of forest area is the highest in Slovenia and Montenegro and lowest – in Moldova; the highest percentage of primary forests is in Bulgaria and Montenegro. In Moldova, Montenegro and Slovenia it is relied predominantly on natural regeneration and the share of afforestation is highest in Bulgaria. The share of public forests predominates in all countries in South-Eastern Europe with the exception of Slovenia and Serbia and, of course, mostly damaged by forest fires are more southern and xerophytic parts. Total wood removals towards total forest area by 2015 are most significant in Serbia, Slovenia and Romania and firewood dominates considerably in Moldova, Serbia and Albania. The worsened health status of forests, fires and illegal cuttings, as well as vulnerability of forest populations to climate changes, are significant challenges for the forest sector and society.

Keywords: natural regeneration, coppicing, forest plantations, growing stock, felling.

1. Introduction

During the last millennia, forests in the world are strongly influenced by anthropogenic activity and it is considered that about 40% of their area has been reduced. In Europe, civilisations of Ancient Greece, Roman, Byzantine and Ottoman empires have considerably influenced the forests, especially in the Mediterranean and in South-East Europe, where their degradation and fragmentation are clearly expressed.

Although Europe is third after Asia and Africa according to territory, it covers biggest forest area and together with South America possesses the highest share of forest area, respectively 46% and 50%. According to growing stock, the leaders are South America – 129 billion m³ with tropical forests (96% of its forest area) and Europe – 114 billion m³ with boreal forests (73%) and forests in the moderate belt (22%) (FAO, 2015; Forest Europe, 2015).

The contribution of the European forestry to the world is significant because the trend of growing of forest area is only in Europe and Asia and growing stock is increasing only in Europe and North America. Besides, Europe is the cradle of forestry education and forest science, whose initiation was in Tharandt, Dresden, Germany and St. Petersburg in Russia.

Nowadays Europe is divided into 5 regions according to geographical and economic subdivision: North, Central-West, Central-East, South-West and South-East, which to some extent are relative because they also include the Asia-Minor part of Turkey and exclude the European part of the Russian Federation.

2. Discussion

South-East Europe is a bridge between the flora of Europe and South-West Asia and a center of taxon formation.

During the glaciation in North and Central Europe in Pleistocene, the flora has been destroyed or shoved out to the south. Therefore, South-East Europe became a refugium for the European flora and contributed to its preservation during Deluvium and Holocene. Particularly important result is the conservation of the Tertiary flora in this region.

Today South-East Europe is with least forest area (30,446,000 ha) and share of forest area (23.5%) but it has the biggest biodiversity on the continent. This is due to the variety in geological structure, relief, hydrological network, vertical climatic zones and ancient human activity and the rich tertiary vegetation is of particularly big significance. In the present, three phytogeographic zones are typical for this region: European deciduous forest, European steppe and forest steppe, Mediterranean sclerophyllic forest.

According to naturalness, forests of South-East Europe are 79% semi-natural, i.e. with least percentage compared to other regions, at 87% average for Europe. Forest plantations in South-East Europe reach up to 16% at average 9% for Europe, which is due to the considerable afforestation activity in the Balkans in the beginning of the 20-th century, especially erosion control afforestations (Table 1).

Undisturbed by man forests are with highest percentage in Central-East Europe – 8% of its territory, followed by South-East Europe – 5% and North Europe – 4%, while these forests are absent in the western regions.

On natural regeneration is relied mostly in South-West Europe (85%), followed by South-East Europe (72%), at average 68% for Europe. Regeneration by planting and seeding takes second place in application in Europe (27%), with least values in South-West and South-East, reaching up to 42% for Central-East Europe. Coppicing is on third place in Europe (5%) and is applied predominantly in South-East Europe (13%) and considerably less in other regions (Table 1).

According to their property, forests in Europe are almost half public and half private but big differences are observed in separate regions. In North and South-West Europe private forests reach up to 72%, and in Central-East and South-East – only 15-17%. These differences are historically determined because in the Ottoman Empire forests belonged to the sultan and later on his successors are the newly established independent countries, where the privatization process has passed slowly.

The activation of this process after 1990, however, did not bring to positive results in the status of private forests in South-East Europe.

According to area, damages in European forests are most significant in South-West (10.4%) and Central-West (6.9%) and least – in North (1.8%), while in South-East they are 4% at average 3.1% for Europe. Factors, causing them in South-East Europe (in a descending line to area), are as follows: wildlife and grazing; pests and diseases; storms, winds and snow; forest fires.

According to growing stock in Europe (35,065 million m³), only 4,309 million m³ belong to South-East, outnumbering only South-West. According to growing stock per hectare, leading regions are Central-West (238 m³/ha) and Central-East (237 m³/ha), followed by South-East (142 m³/ha), and least stock per ha have North (116 m³/ha) and South-West (90 m³/ha).

According to annual increment per ha, it is highest in Central-West (7.2 m³/ha) and lowest – in South-East (2.2 m³/ha).

Big differences (up to 2-3 times) in growing stock and annual increment in forests in different European regions in great extent are due rather to geographical conditions in different parts of the continent than to their different management because forest is first of all geographic phenomenon. However, it is necessary to take into account that forests in different regions of Europe have been subject to various anthropogenic impact (fires, fellings, grazing, etc.), which has influenced on their present status.

Highest timber yield is carried out in Central-East, Central-West and North Europe, while in South-East and South-West Europe it is 3-4 times less. The intensity of fellings is leading in Central-West Europe (4.9 m³/ha) and most limited in the southern parts of the continent (1.5 m³/ha), at average for Europe 2.7 m³/ha.

From geographical point of view, the following countries should be referred to South-East Europe: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Former Yugoslav Republic of Macedonia, Greece, Moldova, Montenegro, Romania, Serbia, and European part of Turkey. The last territory, however, is excluded from the present study due to the absence of comparable data in publications of FAO and Forest Europe for 2015.

Slovenia and Montenegro are with highest share of forest area among the countries in South-East Europe – 62.0% and 61.5%, respectively, and Moldova has the least one – only 12.3%. At average forest area per capita in the region 0.39 ha, Slovenia takes first place with 0.60 ha, followed by Bosnia and Herzegovina (0.57 ha) and Bulgaria (0.52 ha); Moldova is on the last place with 0.12 ha (Table 2).

Primary forests are preserved mainly in Bulgaria (15.9%), Montenegro (13.2%) and Albania (11.0%) and these forests are absent in Greece, Moldova and FYR of Macedonia. According to the indicator other naturally regenerated forests, Moldova (99.5%), Greece (96.5%), Slovenia, Bosnia and Herzegovina (93.4%) and Serbia (92.0%) are outlined, while in Bulgaria this indicator is only 62.2% at average for the region 87.1%. Planted forests are most in Bulgaria (21.9%), followed by Albania and FYR of Macedonia, and least in Moldova (0.5%) and Montenegro (1.0%) at average for the region 8.5% (Table 2).

Forest tree genetic resources of Europe are successfully conserved through both methods: *in situ* – 501,567 ha and *ex situ* – 11,553 ha, and 1,027,434 ha are included for seed production.

Totally in Europe 3,132 genetic conservation units of 103 forest tree species have been selected, from which relatively big part are from South-East Europe – 876 units of 60 tree species. Most forest genetic conservation units in Europe and the region are selected in Romania – 652 units of 38 tree species, and in Bosnia and Herzegovina they are 112 and 6, respectively (Bozzano, 2016).

According to ownership of forests, differences in the countries of the region are too big. Most public forests are in Moldova (99.8%) and Albania (98.3%), and most private forests – in Slovenia (75.2%) and Serbia (57.4%).

According to growing stock per ha, i.e. highest productivity, forests in Romania (319.6 m³/ha) and Slovenia (267.5 m³/ha) are on the top, and it is least in Greece (39.2 m³/ha).

During the last decades, forests in South-East Europe and their management faced challenges, which could be differentiated in two groups:

- i. Climate changes (temperature and precipitations), often favourable for the occurrence of natural disasters (fires, torrents, windbreaks, snowbreaks, icebreaks), calamities of insect pests and diseases.
- ii. Anthropogenic impact as a result of human population growth/depopulation, migration, economic crises, illegal fellings, small-sized forest ownership, changed social status of foresters, etc.

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Table 1. Forest area characteristics, growing stock, annual increment and fellings of 5 European regions (Forest Europe, 2015).

Region	Forest area											Growing stock		Annual increment		Fellings		
	x 1000 ha	Of total land (%)	Per habitant (ha)	Undisturbed by man	Semi-natural	Plantations	Regeneration (%)			Ownership (%)		Damaged (%)	million m ³	m ³ /ha	million m ³	m ³ /ha	million m ³	m ³ /ha
				(%)			Natural	By planting and seeding	Coppicing	Public	Private							
North Europe	70,832	53.2	2.2	4	94	2	68	32	0	28	72	1.8	8,247	116	181.7	4.1	112.7	2.6
Central-West Europe	38,582	27.6	0.1	0	84	16	64	30	6	36	64	6.9	9,185	238	273.4	7.2	185.7	4.9
Central-East Europe	44,494	27.1	0.3	8	83	9	51	42	7	85	15	3.8	10,541	237	247.0	3.5	194.6	2.7
South-West Europe	30,913	35.0	0.3	0	86	14	85	11	4	28	72	10.4	2,783	90	69.6	2.4	43.5	1.5
South-East Europe	30,446	23.5	0.3	5	79	16	72	15	13	83	17	4.0	4,309	142	68.0	2.2	45.8	1.5
	215,267	32.8	1.2	4	87	9	68	27	5	49	51	3.1	35,065	163	839.7	3.9	582.3	2.7

Table 2. Forest area characteristics, growing stock and total wood removals of 11 South-East European countries (FAO, 2015).

Country	Forest area									Growing stock		Total wood removals
	Total	Of land area	Per capita	Primary	Other naturally regenerated	Planted	Ownership		Burned			
							Public	Private				
ha	%	ha	%	%	%	%	%	%	m ³	m ³ /ha	m ³	
Albania	771,500	28.2	0.27	11.0	77.3	11.7	98.3	1.7	0.56	76,327,800	98.9	430,000
Bosnia and Herzegovina	2,185,000	42.7	0.57	0.1	93.4	6.5	78.6	21.4	0.36	358,000,000	163.8	3,851,000
Bulgaria	3,737,000	34.4	0.52	15.9	62.2	21.9	87.9	12.1	0.34	699,000,000	187.0	6,205,000
Croatia	1,922,000	34.3	0.45	0.4	95.7	3.9	72.8	27.2	0.38	400,750,000	208.5	n/a
FYR Macedonia	998,000	39.6	0.48	0	89.5	10.5	90.6	9.4	n/a	102,000,000	102.2	n/a
Greece	4,054,000	31.4	0.37	0	96.5	3.5	77.5	22.5	n/a	158,788,000	39.2	1,742,900
Moldova	404,400	12.3	0.12	0	99.5	0.5	99.8	0.2	0.08	54,240,000	134.1	351,800
Montenegro	827,000	61.5	1.32	13.2	85.8	1.0	52.3	47.7	n/a	121,400,000	146.8	446,000
Romania	6,791,800	29.5	0.35	4.1	87.6	8.3	67.0	33.0	0.09	2,170,800,000	319.6	14,358,600
Serbia	2,718,600	31.1	0.31	0.1	92.0	7.9	42.6	57.4	0.41	418,301,300	153.9	7,904,000
Slovenia	1,247,800	62.0	0.60	3.9	93.4	2.7	24.8	75.2	0.05	333,740,000	267.5	3,387,900

Forests damaged by fires in percentage of their area are most in Greece, Albania and Serbia and least, as it could be expected, in the northern parts of the region – Slovenia, Moldova and Romania (RECCEE, 2015). Most numerous and most difficult surmountable due to the region's relief are torrents because the opportunities for fast prevention and reaction are strongly limited. Damages caused by natural disasters in single years in some countries reach up to tens/hundreds millions US dollars and mainly to tens of human casualties.

According to the health status of forests in South-East Europe, a negative trend is observed. Physiologically weakened forest tree populations are easily vulnerable to calamities and diseases. During the last years, large-scale withering is observed in groups of trees and even entire stands. In coniferous forests withering is caused by *Ips acuminatus*, *Ips sexdentatus*, *Cenangium ferruginosum*, *Sphaeropsis sapinea*, *Heterobasidium annosum*, etc. In oak forests, which are economically very important for the region, oak decline is caused by insects, pathogens and droughts. Major pests and diseases attacking oaks in South-East European countries are: Nectria cancer (*Nectria ditissima*), oak bark beetle (*Scolytus intricatus*), gypsy moth (*Lymantria dispar*), honey fungus (*Armillaria mellea*) (FAO, 2014).

In contrast to other regions in Europe, where human population growth is in process, depopulation runs in numerous countries in South-East Europe after 1990. The economic crisis in 2008-2009 caused additional demographic problems. During the past period the migration from South-East Europe and within – from villages to towns and cities, depopulated some regions. The population of Romania has decreased with 3.6 million, of Bulgaria – with 1.7 million, of Bosnia and Herzegovina – with 1 million, of Croatia, Albania and Serbia – with 0.5-0.6 million each. Moderate increase of the population is observed in Slovenia, FYR of Macedonia and slight increase – in Montenegro (Malnar, 2015). The big migration in the above mentioned countries has bipartite effect on their forests. On one hand, the impact on forests caused by fellings for firewood and timber material, as well as by grazing of cattle, especially goats, decreases, on the other hand – the withered grass in uncut meadows and pastures, the non-collected dry and logging residue are source of local fires. They are difficultly limited due to the strong reduction of active local population.

Illegal fellings in most countries in South-East Europe are difficult problem for forest authorities after 1990. In some countries it is hidden behind reduced data, especially if firewood is concerned. According to the statistics, illegal fellings in Montenegro are 4,857 m³ in 2009, 13,713 m³ in Serbia in 2008, 26,182 m³ in Bulgaria in 2016 (Markus-Johansson et al. 2010; EFA, 2017), and the analysis of consumption of wood shows higher values.

Small-area ownership of forests leads in most cases to non-efficient management, uncontrolled fellings, worsened health status and higher risk of fires. Better decision from the forestry point of view would be the restoration of property to small forest owners to be carried out not in actual outlines but in shares (Vassilev, 1993).

From many years now, decrease of the social status of the forestry guild in some South-East European countries is observed. In some cases this phenomenon is a part, in others – more spread because of underestimation of social functions of forests and even neglecting of the forest sector in the interest of other departmental and corporative profits.

3. Conclusions

The following general conclusions could be done for forests in South-East Europe and challenges they face:

- There is a constant trend to stabilizing and even extending of forest area – a process, which is typical for Europe;
- Management of forests in South-East Europe, compared to other European regions, is more complicated and requires more precise expertise because of the bigger variety of

- climatic and soil conditions at strongly expressed vertical zoning and numerous valuable forest genetic resources, including endemic and relic species;
- Multi-purpose management of South-East European forests provide nature conservation, biodiversity preservation, watershed regulation, carbon sequestration and recreation;
- Natural regeneration of forests in the region gets more and more importance and application, while coppice management, although relatively bigger in area compared to other parts of Europe, is in a process of reduction through methods for conversion into high-stem forests;
- The most large-scaled afforestation activity in Europe in the past century is carried out in its south-eastern part, where Bulgaria has established the most forest plantations;
- According to yield and increment, as well as fellings, southern regions concede twice to three times to other European regions, predominantly due to considerable differences in their natural conditions;
- According to ownership forests in the eastern parts of Europe are predominantly public and least – private, with the exception of Slovenia and Serbia;
- Health status of forests in South-Eastern Europe is worsened and the problem of withering of some coniferous and oak forests is particularly topical;
- Forest fires and illegal fellings are considerable challenges for forest administrations in the region;
- International forestry collaboration is being extended lately both on global (FAO, IUFRO) and continental (EU) level. However, it is not that indicative on regional level, where it is supposed to solve identical and more similar problems.

The current conference in Novi Sad is a very good example for discussion of regional forest problems and for development of regional collaboration. We highly appreciate this initiative of the Institute of Lowland Forestry and Environment, University of Novi Sad, and hope for good results for the regional forest science and practice.

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