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MANAGEMENT OF FOREST RESOURCES IN THE ZAGREB COUNTY

GOSPODARENJE ŠUMSKIM DOBRIMA U ZAGREBAČKOJ ŽUPANIJI

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Zagreb County with the City of Zagreb, encompassing 30,000 km², is a very densely populated and developed area. With regard to such distinct population density, the importance and functions of forests are very large. The paper gives a survey of the current condition of forests and forestland in terms of ownership structure, purpose of forests, structure per tree species, management classes, age structure per area and growing stock, as well as potential productive capacities. The forested area amounts to 139,275 ha, of which 35,027 ha (26%) are mainly privately owned coppice forests. Brushwood covers an area of 1,419 ha, while productive non-covered forestland extends over only 1,757 ha. Commercial forests cover an area of 136,650 ha with 22.31 million m³ of growing stock, which produces 750,000 m³ (6.38 m³/ha) annually. Although forests and forestland cover 1,400 km², which is 46.7% of the total area of the district, management with forest resources should be aimed at increasing potential productive capacities of all resources. With the support of the system dynamic model based on the defined management guidelines, the article discusses the predicted future development of these forests, which can be used as a starting point for rough long-term planning at a regional level. With regard to the trends in the area, growing stock and prescribed yield, simulation results have shown that consistent management could result in significant potential productive capacities of these forests. An increase in the area of high forests by 30,000 ha, an increase in the growing stock by 7.8 mil. m³, an increase in the annual prescribed yield by 215,000 m³, and an increase in silvicultural activities are some of the fundamental postulates of future management.

Key words: forest management, age class distribution, future management guidelines, trends in growing stock and prescribed yield, silvicultural activities, system dynamic modelling

INTRODUCTION
UVOD

Zagreb County, popularly known as the "Zagreb Ring", with a population of about 280,000, extends over about 3,000 km² between the boundary with Slovenia, Moslavina, and the River Kupa and the Bjelovar-Bilogora County. Together with the City of Zagreb of about 600 km² and 1,000,000 inhabitants, it is a very developed and densely populated area.

The total area of forests and forestland in the area is 139,275 ha with a growing stock of 22.31 mil. m³. Although the area under forests of 40% corresponds to the Croatian average, the highly complex and strained nature of the region requires that significant attention be paid to the forest resources of the area. Most forests and forestland occur in the lowland and hilly regions, and a smaller portion covers the belt of higher hills. In the past, when these forests covered much larger area and when they were stable, they were deliberately cleared in order to expand agricultural land and gain space for settlements. At present, over 50% of the families in the area of Zagreb County own agricultural land. Privately owned forests also make up 50% of all the forests and forestland. In the last hundred years, due to unfavourable impacts of harmful insects and fungi, climatic changes and hydro-ameliorative treatments (Mayer 1993), the stability of the lowland forest ecosystem has been disrupted and site conditions changed (Meštrović et al. 1996). With increased urbanisation, there is growing awareness of the need to maintain general sustainability and diversity and preserve the genetic potential of rare plant and animal species. Significant effort should be put not only into preserving and improving the existing forests in their present areas, but also into increasing the areas under forests. The task of foresters is to monitor and study the changing relations in forest ecosystems and predict trends so that management includes all the necessary procedures that are best suited to re-establishing disturbed stability. Extensive research has been carried out into lowland forests (Dekanić 1962, 1975; Klepac 1964, 1971, 1982, 1988; Pranjić 1970; Prpić 1974; Pranjić et al. 1988; Meštrović 1989; Rauš 1992; Matić and Skenderović 1993; Mayer 1993; Prpić et al. 1997), which have undergone significant changes in the past few decades.

The aim of this work is to present the characteristics of forests resources in the area of Zagreb County and the City of Zagreb, their potential productivity, the guidelines of future management and predicted development of the most important economic indicators in the studied forests. This will be done with the help of the system dynamic modelling (Čavlović 1996, 1999).

THE CONDITION OF FOREST RESOURCES
STANJE ŠUMA I ŠUMSKOG ZEMLJIŠTA

An overview of forest resources in Zagreb County has been obtained from the data in the forest management plan of the area. The data were obtained by allot-

ting the data from the management plan to the year in which the regional forest management plan in Croatia came into force. The four forest administrations within the area of Zagreb County include Zagreb with 6 forest offices and 27 management units, Bjelovar with 2 forest offices and 6 management units, Karlovac with 2 forest offices and 9 management units, and Sisak with 2 forest offices and 2 management units over 143,123 ha. The land under forests accounts for 139,275 ha, of which coppice forests cover 35,027 ha (2.6%), mainly within private forests. Brushwood covers 1,419 ha, while productive non-covered forestland accounts for only 1,757 ha.

There are three main forms of forest ownership in the area of Zagreb County. These are state-owned forests managed by "Hrvatske šume", other public forests and private forests.

The structure of the forests in Zagreb County according to ownership is shown in Table 1.

Table 1. The structure of forests according to ownership
Tablica 1. Struktura šuma prema vlasništvu

Owner *Vlasništvo*	Total area *Površina*		Total growing stock *Zaliha*		Annual increment *Prirast*	
	ha	%	m^3	%	m^3	m^3/ha
State - *Državne*	68,306.87	49.04	15,602,971	67.69	435,528	6.38
Private - *Privatne*	69,418.79	49.84	7,179,030	31.14	307,169	4.42
Other public - *Ost.*	1,548.89	1.12	269,259	1.17	7,309	4.72
Total - *Ukupno*	139,274.55	100.00	23,051,260	100.00	750,006	5.39

The proportion of state-owned and privately owned forests per area is equal, however, the growing stock in state-owned forests is twice as large as in the latter. This difference is due mainly to lower forest stocking in private forests, and partly to underestimated growing stock.

According to use, all the forests are categorised by their primary function into commercial, protective and forests of special assignment. Table 2 shows forests in terms of their assignment:

Table 2. The structure of forests according to assignment
Tablica 2. Struktura šuma prema namjeni

Kategory of forest *Kategorija*	Total area *Površina*		Total growing stock *Zaliha*		Annual increment *Prirast*	
	ha	%	m^3	%	m^3	m^3/ha
Comercial - *Gospod.*	136,650	95.48	22,307,643	96.77	750,006	6.38
Special assign. - *Spec.*	2,683	1.87	267,157	1.16	-	-
Protective - *Zaštitne*	3,790	2.65	476,460	2.07	-	-
Total - *Ukupno*	143,123	100.0	23,051,260	100.0	750,006	6.38

It is clear from the table that commercial forests are the best represented, while the forests with special assignment and protective forests are represented with only 4.52% per area.

Due to their high economic, ecological and social importance, commercial forests will be presented in more detail and their potential productive capacity shown.

COMMERCIAL FORESTS - THE EXISTING STATE AND POTENTIAL PRODUCTIVE CAPACITIES

GOSPODARSKE ŠUME – POSTOJEĆE STANJE I POTENCIJALNE PROIZVODNE MOGUĆNOSTI

THE STRUCTURE OF GROWING STOCK AND INCREMENT ACCORDING TO TREE SPECIES
STRUKTURA DRVNE ZALIHE I PRIRASTA PO VRSTAMA DRVEĆA

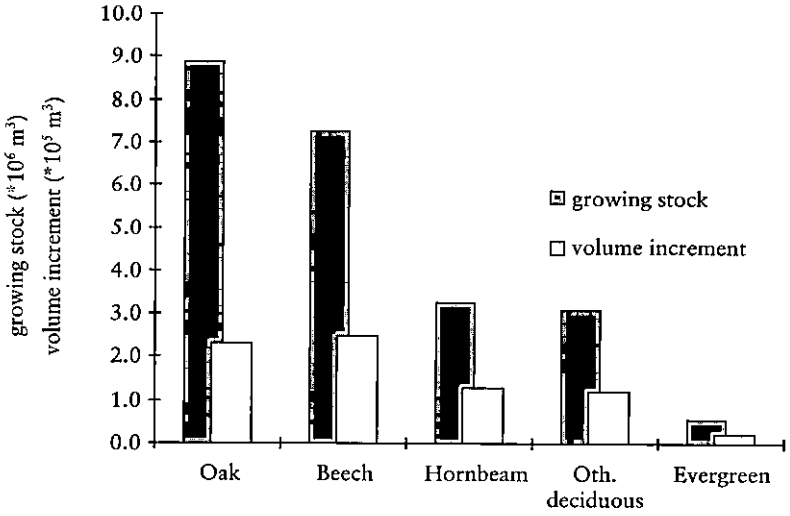
The proportion of growing stock and increment according to tree species is shown in the following table and figure:

Table 3. The structure of growing stock and increment according to main tree species
Tablica 3. Struktura drvne zalihe i prirasta za glavne vrste drveća

Tree species *Vrsta drveća*	Growing stock *Drvna zaliha*		Ann. vol. increment *God. vol. prirast*	
	m^3	%	m^3	%
Pedunc. and sessil. oak - *Hrast*	8,868,388	38.5	232,252	31.0
Beech - *Bukva*	7,256,020	31.5	248,088	33.1
Hornbeam - *Grab*	3,278,141	14.2	126,874	16.9
Other deciduous - *Ost. bjelogorica*	3,075,277	13.3	119,450	15.9
Total deciduous - *Ukupno bjelog.*	22,477,826		726,664	96.9
Evergreen - *Crnogorica*	573,434	2.5	23,342	3.1
Total - *Ukupno*	23,051,260	100.0	750,006	100.0

In terms of the basic division of trees into coniferous and deciduous species, the former are represented with only 2.5% in Zagreb County. The largest growing stock belongs to the most valuable tree species in Croatia, the pedunculate oak and the sessile oak, with 38.5% of the total growing stock. Beech accounts for a significant 31.5%, and the remaining 27.5% are shared equally by hornbeam and other deciduous species. In terms of proportional participation according to growing stock, the increment of beech, hornbeam and other deciduous trees slightly exceeds that of the oak.

Figure 1. The structure of growing stock and increment according to principal tree species
Slika 1. Struktura drvne zalihe i prirasta za glavne vrste drveća



These basic data are an indication of a very favourable structure in terms of tree species in the forests of Zagreb County. This is particularly true for state-owned forests, while poor utilisation of site potential in private forests points to extensive possibilities not only of increasing the growing stock but also of improving the structural relations among the tree species in these forests.

AGE STRUCTURE PER AREA AND GROWING STOCK
DOBNA STRUKTURA PO POVRŠINI I DRVNOJ ZALIHI

Table 4 shows the current age class distribution per area, growing stock and annual increment within 6 management classes. The normal age class distribution has been obtained on the basis of the current state and the related growth yield tables.

Table 4. Current and normal age class structure per area and growing stock for management classes of high forests
Tablica 4. Stvarna i normalna dobna struktura po površini i drvnoj zalihi za uređajne razrede visokih šuma

Management class of Pedunculate oak	AGE CLASSES							Total
	0-20	21-40	41-60	61-80	81-100	101-120	121-140	
	years							
Actual area (ha)	5557	2856	2883	4330	5150	4986	1939	27701
Normal area (ha)	3957	3957	3957	3957	3957	3957	3957	27701
Actual growing stock (m^3)		334152	570834	1052190	1845245	1635467	754298	6192186
(m^3/ha)		117	198	243	358,3	328	389	

Norm. growing (m^3)		629208	1210929	1673932	2014258	2255653	2421859	10205840
stock (m^3/ha)		159	306	423	509	570	612	
Management class of Sessiliflora oak	AGE CLASSES							Total
	0-20	21-40	41-60	61-80	81-100	101-120	121-140	
	years							
Actual area (ha)	1553	2557	4066,5	4027	1805	1245	311	15565
Normal area (ha)	2224	2224	2224	2224	2224	2224	2224	15565
Actual growing (m^3)		294055	792968	914129	608285	399709	113625	3122770
stock (m^3/ha)		115	195	227	337	321	365	
Norm. growing (m^3)		300182	500304	664848	791591	891652	969477	4118054
stock (m^3/ha)		135	225	299	356	401	436	
Management class of Beech	AGE CLASSES							Total
	0-20	21-40	41-60	61-80	81-100	101-120	121-140	
	years							
Actual area (ha)	3706	8143,2	9481,6	8145	4870	3053	763	38162
Normal area (ha)	7632	7632	7632	7632	7632			38162
Actual growing (m^3)		920182	1848912	1800045	1563270	952524	277819	7362751
stock (m^3/ha)		113	195	221	321	312	364	
Norm. growing (m^3)		923520	1808879	2564486	3175078			8471964
stock (m^3/ha)		121	237	336	416			
Management class of Ash	AGE CLASSES							Total
	0-20	21-40	41-60	61-80	81-100	101-120	121-140	
	years							
Actual area (ha)	455,4	576,0	531,3	370,0	369,6	202,4	25,3	2530
Normal area (ha)	633	633	633	633				2530
Actual growing (m^3)		54720	86602	73260	111250	64363	8400	398594
stock (m^3/ha)		95	163	198	301	318	332	
Norm. growing (m^3)		65148	132825	184058				382030
stock (m^3/ha)		103	210	291				
Management class of Hornbeam	AGE CLASSES							Total
	0-20	21-40	41-60	61-80				
	years							
Actual area (ha)	2075	4005	2526	413	91			9110
Normal area (ha)	2278	2278	2278	2278				9110
Actual growing (m^3)		492615	411738	78057	26783			1009193
stock (m^3/ha)		123	163	189	294			

Norm. growing (m^3)		275578	471443	589873				1336893
stock (m^3/ha)		121	207	259				
Management class of Black alder	AGE CLASSES							Total
	0-10	11-20	21-30	31-40	41-50			
	years							
Actual area (ha)	1114	1300	684	432	196	118	78	3922
Normal area (ha)	784	784	784	785	785	0	0	3922
Actual growing (m^3)		118300	99920	79813	50202	34945	23846	407025
stock (m^3/ha)		91	146	185	256	297	304	
Norm. growing (m^3)		48633	120798	163155	192178	0	0	524764
stock (m^3/ha)		62	154	208	245			

Table 5. Actual and normal age structure per area and growing stock for management classes of coppice forests

Tablica 5. Stvarna i normalna dobna struktura po površini i drvnoj zalihi za uređajne razrede niskih šuma

Management class of Pedunculate oak	AGE CLASSES							Total
	0-10	11-20	21-30	31-40				
	years							
Actual area (ha)	23	64	148	57	53	23	11	379
Normal area (ha)	95	95	95	95				379
Actual growing (m^3)		4897	20841	9494	14751	6777	3877	60636
stock (m^3/ha)		76	141	167	278	298	341	
Norm. growing (m^3)		4846	12038	16259				33144
stock (m^3/ha)		51	127	172				
Management class of Sessiliflora oak	AGE CLASSES							Total
	0-10	11-20	21-30	31-40				
	years							
Actual area (ha)	306	1064	2153	987	298	111	50	4969
Normal area (ha)	1242	1242	1242	1242				4969
Actual growing (m^3)		92568	299267	160881	81392	34907	16447	685463
stock (m^3/ha)		87	139	163	273	314	331	
Norm. growing (m^3)		60653	150654	203481				414787
stock (m^3/ha)		49	121	164				
Management class of Beech	AGE CLASSES							Total
	0-10	11-20	21-30	31-40				
	years							
Actual area (ha)	542	3925	4315	2357	786	542	1084	13551

Normal area (ha)	3388	3388	3388	3388				13551
Actual growing (m^3)		337533	582525	381834	211434	163154	366419	2042899
stock (m^3/ha)		86	135	162	269	301	338	
Norm. growing (m^3)		162256	403024	544344				1109624
stock (m^3/ha)		48	119	161				
Management class of Ash	AGE CLASSES							Total
	0-10	11-20	21-30	31-40				
	years							
Actual area (ha)	29	3	12	14	10	1		68
Normal area (ha)	17	17	17	17				68
Actual growing (m^3)		185	1480	2026	2897	398	0	6986
stock (m^3/ha)		68	128	149	284	293	329	
Norm. growing (m^3)		775	1924	2599				5298
stock (m^3/ha)		46	113	153				
Management class of Hornbeam	AGE CLASSES							Total
	0-10	11-20	21-30	31-40				
	years							
Actual area (ha)	2085	3675	3785	1922	782	0	780	13029
Normal area (ha)	3257	3257	3257	3257				13029
Actual growing (m^3)		312375	550718	292205	197780	0	255138	1608216
stock (m^3/ha)		85	146	152	253	356	327	
Norm. growing (m^3)		154491	383737	518294				1056522
stock (m^3/ha)		47	118	159				
Management class of Black alder	AGE CLASSES							Total
	0-10	11-20	21-30	31-40				
	years							
Actual area (ha)	193	347	308	180	116	77	64	1284
Normal area (ha)	321	321	321	321				1284
Actual growing (m^3)		23659	39839	25202	26249	21017	18579	154546
stock (m^3/ha)		68	129	140	227	273	289	
Norm. growing (m^3)		14927	37076	50076				102078
stock (m^3/ha)		47	116	156				

Table 6. Actual and normal age structure per area and growing stock of high and coppice forests in total

Tablica 6. Prikaz stvarne i normalne dobne strukture po površini i volumenu sveukupno za visoke i niske šume

Seed forests	AGE CLASSES							
	I	II	III	IV	V	VI	VII	
Actual area (ha)	14460	19437	20173	17716	12482	9604	3117	96990
Normal area (ha)	17508	17508	17508	17508	14598	6181	6181	96990
Actual growing stock (m^3)		1721409	3399235	3919437	4178251	3087008	1177987	17483327
Norm. growing stock (m^3)		2242269	4245177	5840351	6173106	3147305	3391336	25039544
Copice forests	I	II	III	IV	V	VI	VII	
Actual area (ha)	3177	9078	10721	5517	2045	754	1990	33280
Normal area (ha)	8320	8320	8320	8320	0	0	0	33280
Actual growing stock (m^3)		771217	1494669	871643	534503	226253	660462	4558746
Norm. growing stock (m^3)		397948	988452	1335052	0	0	0	2721452
Total	I	II	III	IV	V	VI	VII	
Actual area (ha)	17637	28515	30893	23233	14527	10359	5107	130270
Normal area (ha)	25828	25828	25828	25828	14598	6181	6181	130270
Actual growing stock (m^3)		2492625	4893904	4791079	4712755	3313261	1838449	22042073
Norm. growing stock (m^3)		2640217	5233629	7175403	6173106	3147305	3391336	27760996

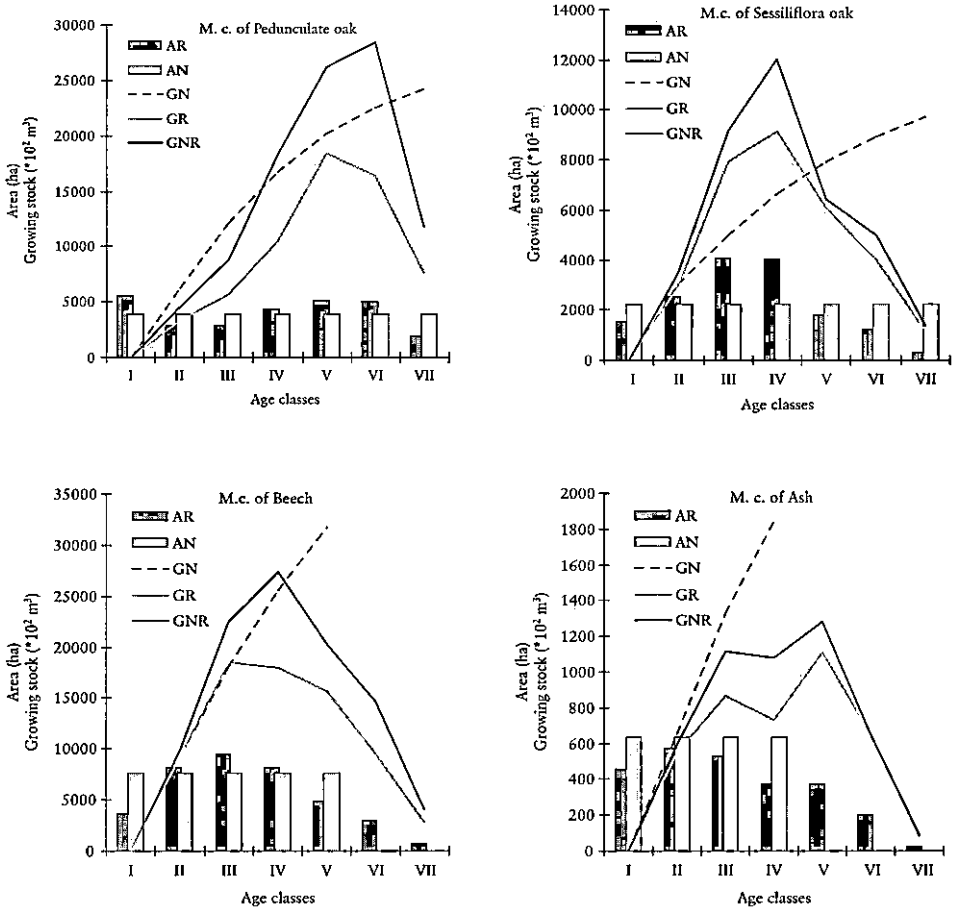
Comparison of the current and normal state per management classes reveals an irregular age structure and a reduced stand stocking. This is particularly prominent in the best-represented management classes of beech and pedunculate oak. The result is that the total normal growing stock in the management class of pedunculate oak exceeds the actual one by almost 4, and in the management classes of beech and sessile oak by 1 mil. m^3. Since the old stands in coppice forests are over-represented, the actual growing stock of coppices is almost double than that of the normal, which means that the total growing stock of 22.04 mil. m^3 in Zagreb County is less than the normal (27.76 mil. m^3) by 5.72 mil. m^3.

DISCUSSING FUTURE MANAGEMENT WITH FORESTS
RAZMATRANJE BUDUĆEG GOSPODARENJA ŠUMAMA

General guidelines of future management are based on achieving a normal age structure and stocking in stands, on transforming coppice silvicultural forms into high ones and on increased and sustainable production of general benefits from fo-

Figure 2. Actual and normal age structure per area and growing stock for the most important management classes

Slika 2. Stvarna i normalna dobna struktura po površini i drvnoj zalihi za najznačajnije uređajne razrede



rests and timber. The stability and diversity of the ecosystem in the complex region of Zagreb County should be preserved.

MAIN MANAGEMENT GUIDELINES IN MANAGEMENT CLASSES
GLAVNI CILJEVI GOSPODARENJA PO UREĐAJNIM RAZREDIMA

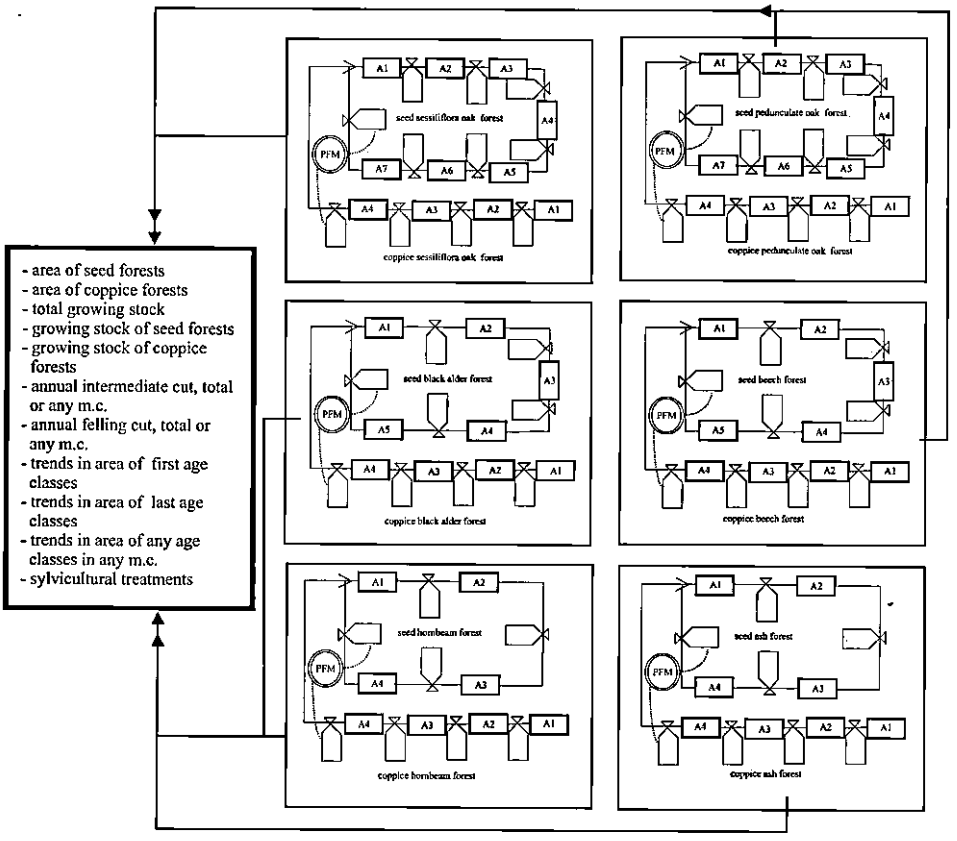
Along with high ecological functions and social benefits provided by the most valuable forests of pedunculate oak and sessile oak, the goal of management is to

produce high quality oak-wood, particularly veneer and saw logs of large dimensions and fine structure. Management goals will be achieved with long rotations, the shortest 140 years, with the application of intensive silvicultural treatments of tending and cleaning in young stands: thinning in the stands aged 20 to 130 years; the shelterwood method in two cuts.

In the management class of beech, pure and mixed stands of beech and sessile oak should be managed with the rotation of 100 years. Regeneration should be conducted with the shelterwood method in two cuts. The quality and stability of the stands should be increased with regular tending, cleaning and thinning operations.

In the management class of ash, pure stands of ash should be managed with the rotation of 80 years. Regeneration should be conducted with the shelterwood method in two cuts. In order to achieve technically and aesthetically valuable ash

Figure 3. System dynamic model of the commercial forests in Zagreb County region
Slika 3. Sustav dinamički model gospodarskih šuma Zagrebačke županije



wood, intensive silvicultural treatments of tending, cleaning, protecting from game and thinning should be applied to the stands.

The stands of hornbeam, both pure and mixed with other deciduous trees should be managed with the rotation of 80 years. These stands should be supported in order to increase the stability and diversity of the forests in the entire region.

Within the management class of black alder, there are mostly even-aged, pure stands of black alder from seed or those mixed with other soft broadleaved species. The stands should be managed with the rotation of 50 years. Natural regeneration in alder stands can be achieved with the shelterwood method accompanied with preparing the site or planting seedlings.

The stands of coppice forests with rotation periods of 40 years should be managed with clear and shelterwood cuts and should gradually be conversed into seed forests.

THE PROJECTION OF FUTURE DEVELOPMENT OF THE FOREST SYSTEM BY THE SD MODEL
PREDVIĐANJE BUDUĆEG RAZVOJA ISTRAŽIVANOG SUSTAVA ŠUMA POMOĆU SD MODELA

The entire forest system of the studied area consists of 12 sub-systems made up of management classes cited above. This system can be presented with the system dynamic modelling (Čavlović 1999).

The subsystems, which are dynamic systems by themselves, especially those of high and coppice forests within the same management class, are regulated by cause and consequence links defined by the chosen management form.

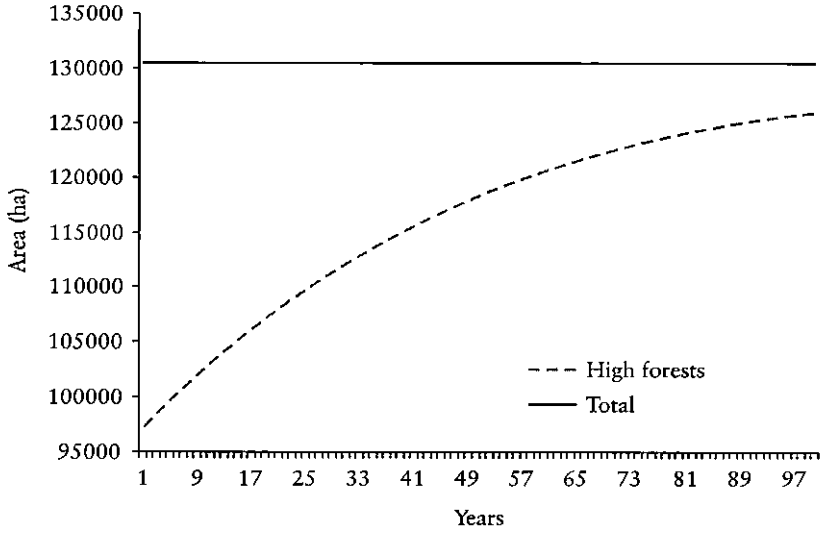
By implementing the set management guidelines and goals and by using the SD model, it is possible to obtain the future behaviour of the entire system or individual parts of the forest system in the studied area. Figure 3 shows a simplified model of a commercial forest system in Zagreb County region.

Some basic elements in the future behaviour of a part or the entire system can be shown on the basis of simulation results, within consistent implementation of the given scenarios.

TRENDS IN THE AREA
KRETANJE POVRŠINA ŠUMA

Although it is possible to show trends in the age structure per area for each management class with simulation results, only the trends in the area of seed forests within a total forest area will be given here for lack of space. The total forest area was assumed to be unchanged. The figure shows an increase in the area of high forests as a result of transforming coppice forests within the same management classes into a high silvicultural form. Thus, the area of high forests increased from initial 97,000 to 127,000 ha by the end of the simulation period at the expense of coppice forests.

Figure 4. Trends in the area of high forests in relation to the total forest area
Slika 4. Kretanje površine visokih šuma u odnosu na ukupnu površinu šuma



TRENDS IN THE GROWING STOCK
KRETANJE DRVNE ZALIHE

The conversion of coppice forests into high silvicultural forms, trends in age class distribution per area, the achievement of the normal age structure and normal stand stocking as the most important elements of future management have influenced the growing stock per age classes within management classes and that of the entire forests. Trends in the total growing stock for the entire forest and for high forests in all are shown here (Figure 5). The difference between the two shown curves is the trend in the growing stock of coppice forests. As seen from the figure, the total growing stock increases gradually, more rapidly at first and more slowly later, from the initial 23 million m^3 to 30.8 million m^3. Thus, the normal growing stock of 27.8 million m^3 from the beginning of the period was exceeded by the end of the period since the area of high forests increased by 30,000 ha at the expense of coppice forests. This means that with consistent management, the total growing stock would not only reach the level of the normal stock defined at the beginning of the period, but would also increase additionally by 3 mil. m^3 through the conversion of coppices into high forests. Within the total growing stock, the growing stock of high forests has increased from 18.8 million m^3 to 30 million m^3 as a result of a reduced growing stock in coppice forests.

Figure 5. Trends in the growing stock of high forests in relation to the total growing stock
Slika 5.. Kretanje drvne zalihe visokih šuma u odnosu na ukupnu drvnu zalihu

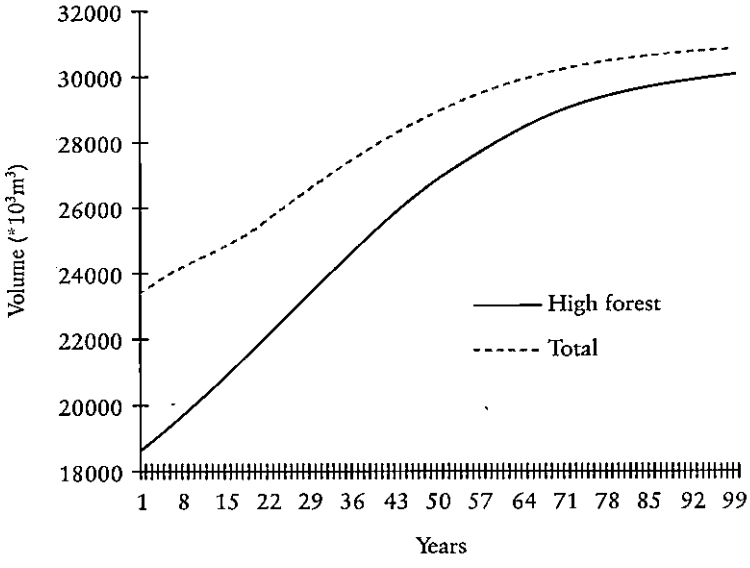
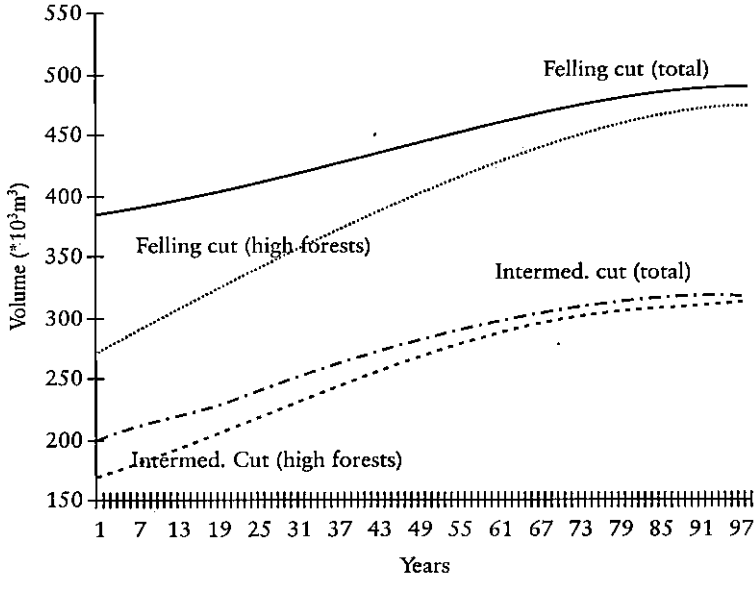


Figure 6. Trends in the annual cut
Slika 6. Kretanje godišnjeg etata



TRENDS IN THE TOTAL ANNUAL CUT
KRETANJE UKUPNOG GODIŠNJEG ETATA

Trends in the area structure, age structure, and growing stock have reflected on the trends in the total annual cut. Within assumed management in the SD model, the expected trends in the total annual cut are shown in the Figure 6. The annual felling cut is expected to rise gradually from 385,000 m^3 to 485,000 m^3, while the annual intermediate cut will rise from 200,000 m^3 to 315,000 m^3. The rise of the total annual cut in high forests in a beginning is intensive as a result of transforming coppice forests into a high forests.

TRENDS IN THE ANNUAL FELLING CUT AREA, THE AREA OF YOUNG STANDS IN THE FIRST AGE CLASS AND THE AREA OF MATURE STANDS IN THE LAST AGE CLASS

KRETANJE GODIŠNJEG POVRŠINSKOG ETATA GLAVNOG PRIHODA, POVRŠINE MLADIH SASTOJINA PRVOG DOBNOG RAZEDA TE POVRŠINE ZRELIH SASTOJINA ZADNJEG DOBNOG RAZREDA

Trends in the annual felling cut area, the area of young stands in the first and last age class at the level of the entire area are important in planning silvicultural treatments.

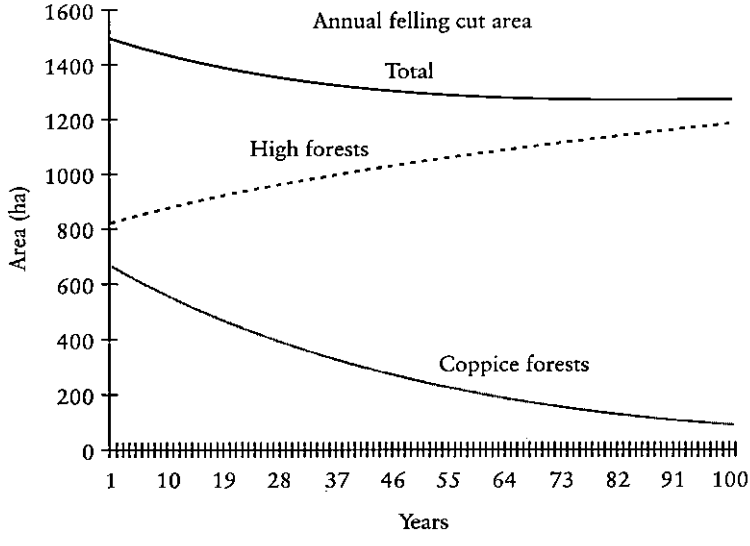
Preparation of the site for natural regeneration, repair sowing and planting with seeds and seedlings and tending young growth depend directly on the annual felling cut area. At the level of the entire region, the annual felling cut area will drop gradually from 1,500 ha to 1,270 ha. Such trends in the annual felling cut area consist of a slow rise in high forests (830 to 1,190 ha) and a stronger drop in coppice forests (680 to 90 ha).

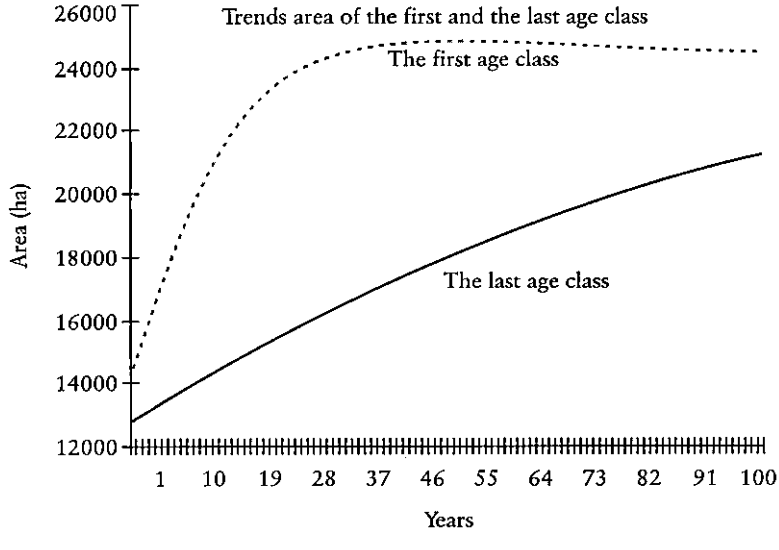
Trends in the area of the first age class are largely connected to silvicultural treatments (tending of seedlings and young growth, cleaning of stands at pole and sapling stages). According to the figure, during the first 30 years a very intensive rise from 14,500 ha to 24,800 ha may be expected in the area of the first age class, later to remain at the level of about 24,000 ha. This rise in the area of the first age class is partly the result of regeneration and the conversion of coppice forests into high forests. An equal rise in the quantity of mentioned silvicultural treatments may be expected.

Trends in the area of mature stands (the last age class) have a direct impact on silvicultural treatments to a small extent, but the information on the relationship and balance between old stands and stands in the initial developmental stages is also very important. As seen from the Figure 7, an equal and consistent rise in the area of mature stands from 12,800 ha to 21,300 ha can be expected.

Figure 7. Trends in the annual felling cut area, the area of young stands in the first age class and the area of mature stands in the last age class

Slika 7. Kretanje godišnjeg površinskog etata glavnog prihoda, površine mladih sastojina prvog dobnog razreda te površine zrelih sastojina zadnjeg dobnog razreda





CONCLUSIONS
ZAKLJUČCI

Forest areas are very significant features of Zagreb County for a variety of reasons. These are: very dense population, growing demands for forest functions of general benefit, rich diversity and multiple uses of forests, and the need to re-establish the disturbed stability of forest ecosystems.

In this region forests of beech, pedunculate oak and sessile oak are the most significant. Apart from their high ecological and social values, they are used for the production of high quality oakwood.

In terms of the irregular age structure of the forests and stand stocking according to the existing growth-yield tables, the growing stock of all the forests in the region is lower by 5.72 million m^3 compared to the normal state.

General guidelines of future management are based on achieving a normal age structure and stocking in stands, the conversion of coppice forests into high ones, the higher and sustainable production of both general benefits from forests and timber and the preservation of ecosystem stability and diversity.

Future development of these forests may be predicted with the SD model on the basis of defined guidelines. This can serve as a basis for rough long-term planning at a regional level. In terms of trends in the area, growing stock and prescribed yield, the results of simulation have shown that significant potential productive capacities of these forests may be achieved with consistent management.

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GOSPODARENJE ŠUMSKIM DOBRIMA U ZAGREBAČKOJ ŽUPANIJI

SAŽETAK

Zagrebačka županija zauzima 3720 km^2, vrlo je gusto naseljen i razvijen prostor kada se uzme u obzir i Grad Zagreb. Zbog naglašene opterećenosti ovoga prostora značenje i funkcija šuma su vrlo veliki. U radu se daje prikaz postojećega stanja šuma i šumskoga zemljišta s obzirom na strukturu vlasništva, namjenu šuma, strukturu po vrstama drveća, uređajnim razredima, dobnu strukturu po površini i drvnoj zalihi, te potencijalne proizvodne mogućnosti. Šumom obraslo šumsko tlo nalazi se na 139 275 ha, od čega su panjače na 35 027 ha (2,6 %), i to uglavnom u okviru privatnih šuma. Šikare se nalaze na 1 419 ha, dok neobrasloga proizvodnoga šumskoga zemljišta ima samo 1 757 ha. Gospodarske šume zauzimaju površinu od 136 650 ha s 22,31 mil. m^3 drvne zalihe, koja godišnje priraste 750 000 m^3 (6,38 m^3/ha). Iako šume i šumsko zemljište zauzima 1400 km^2, što je 46,7 % ukupne površine Županije, gospodarenje šumskim resursima mora voditi povećanju potencijalnih proizvodnih mogućnosti svih dobara. Uz podršku SD modela na temelju definiranih smjernica gospodarenja u članku je prikazan predvidivi budući razvoj tih šuma. To može poslužiti kao osnova za gruba dugoročna planiranja na razini regije. S obzirom na prikazano kretanje površina, drvne zalihe i sječivoga prihoda, rezultati su simuliranja pokazali da bi se uz dosljedno gospodarenje moglo očekivati postizanje značajnih potencijanih proizvodnih mogućnosti tih šuma. Povećanje površine visokih šuma za 30 000 ha, povećanje drvne zalihe za 7,8 mil. m^3, povećanje godišnjega sječivoga prihoda za 215 000 m^3, povećanje šumskouzgojnih radova – neke su od osnovnih značajki budućega gospodarenja.

Ključne riječi: gospodarenje šumama, razmjer dobnih razreda, smjernice budućega gospodarenja.