European forest types for coppice forests in Croatia

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EUROPEAN FOREST TYPES FOR COPPICE FORESTS IN CROATIA

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Abstract

Coppice forests in South-Eastern Europe (SEE) cover a broad range of ecological conditions. So far approaches to structure the variety of coppice forests were either highly aggregated or relied on very specific local to regional phytocoenological classification systems which defy a coherent comparison between SEE countries and at European level. To bridge this gap this article presents a methodological approach to allocate current coppice forests in SEE to European forest types (EFT) using readily available information. The approach is presented by means of the example of Croatia, a country that shares many common features with other countries in SEE with regard to biogeographical and vegetation diversity of forests, but also with regard to the currently used methods for assessment of national forest resources and coppice forests in particular. In the presented approach the map of natural vegetation of Europe (Bohn et al., 2004) is combined with the area of regional forest offices (RFO), the forest area of Corine 2000 land cover map, and the area distribution of 12 coppice management classes within RFOs. Within each RFO, coppice management classes are linked with occurring EFTs. If more than one EFT could be linked with a particular coppice management class, random distribution of coppice forests over eligible EFTs is assumed. In total 499.687 ha (93.6% of the total coppice area) were classified, whereof for 76.4% the classification to EFTs was possible with high confidence, in other cases an approximation was made based on the available information. The presented methodology appears useful for a rapid stratification of coppice forest resources by the combined use of currently available national data on coppice forests in countries of the SEE region and available data sets at European level. As soon as plot-level national forest inventory data becomes available an evaluation and eventual improvement of the approach will be possible.

Key words: Coppice forests, South-East Europe, European forest types

INTRODUCTION

With rising interest in coppice forestry particularly during the last decade (Rydberg, 2000) and growing economical, ecological and social importance of coppice forests in South-Eastern Europe (SEE) (Vacik et al., this issue; Stajic et al., this issue, Wolfslehner et al., this issue) the fragmented knowledge on coppice forests in SEE became evident. Data on coppice forests in the region are usually available only on a very general level as total area of coppice forests in a particular country, as distribution of the coppice area per forest type characterized via dominating tree species, or structured into local to regional phytcoenological classification systems. While the former level of detail does not reflect the great diversity of coppice forests present in SEE, the latter does not permit any kind of meaningful comparisons of forest conditions and forest management between countries in SEE or with the rest of Europe.

Biogeographically, coppices in SEE cover a broad range of ecological conditions from shallow sites at steep mountain slopes in the temperate vegetation zone to the coppices of the Mediterranean climate (Tomic, 1992; Vukelic, Raus, 1996; Filipovski et al., 1996; Nedyalkov et al., 1961; Dubravac, Krejči, 2004; Chatziphilippidis, Spyroglou, 2004). Due to the large geographical area, the set of tree species and species mixtures in these forests is large. Apart from the different socio-cultural background of countries in SEE and differences in the management of coppice forests throughout history (see Stajic et al., this issue), the high tree species diversity is also a reflection of a greater floristic diversity of Southern European forests compared to the rest of Europe. About 2/3 of the species of European forest flora are present in the forests of SEE, mainly due to the presence of glacial refugia where most of the thermophilic and temperate tree species survived the last glaciation (Ozenda, 1994; Petit et al., 2002).

The variety of European forests presents a challenge also in a much broader context within the Pan-European framework for reporting on the development and implementation of sustainable forest management (SFM) in the context of Ministerial Conference on the Protection of Forests in Europe – MCPFE (Estreguil et al., 2004; EEA, 2007). So far, national reporting to MCPFE was done in three forest categories (broadleaved, coniferous and mixed forests). However, the information contained within these broad categories is not sufficient for the proper evaluation of some criteria and indicators of Pan-European Operational Level Guidelines for the SFM (De Heer et al., 2004; Bradshaw, Møller, 2004; MCPFE, 2008). Although it is likely that national classification systems better reflect the country-specific forest diversity, these systems are not harmonized at European level and defy direct comparability and aggregation. European forest types (EFT) (EEA, 2007) were established to circumvent this problem and to allow for harmonized reporting on SFM issues within Europe.

Although not yet formally adopted by MCPFE (EEA, 2007), the use of European EFT is gaining in importance. For instance, they were successfully applied to stratify Level I plots of the International Co-operative Programme on Assesment and Monitoring of Air Pollution Effects on Forests (ICP Forests) in order to optimize the reporting of biodiversity indicators (EEA, 2007), and some of the biodiversity indices are already given by the category of EFT in the ICP Forest Executive report for 2007 (ICP Forests, 2007).

In EFT classification scheme 14 main forest categories (first level classes) are structured into 75 forest types (second level classes). The arrangement of categories and types was made according to the principle of increasing similarity in natural and anthropogenic conditions affecting the values taken by five forest type specific MCPFE indicators: (1) naturalness, (2) occurring tree species, (3) growing stock, (4) age/diameter distribution, and (5) amount of deadwood (EEA, 2007). The category level identifies and reflects on a Pan-European scale the most significant breaking points in the continuum of natural and anthropogenic sources of variation of the indicators above, while the type level further describes the variety and the character of forest communities comprised by each category. The category level is recommended for reporting on biodiversity indicators to MCPFE, and the use of types is recommended for linking national data (e.g. national forest inventory, forest statistics) to EFT (EEA, 2007). To that end, to our best knowledge no attempt has been made to apply EFT system in a coherent way to classify coppice forests in SEE.

The objective of this article is to present a methodological approach to allocate current coppice forests to European forest types. For our approach we rely on readily available information. We demonstrate our approach by means of the example of Croatia, a country that shares many common features with other countries in the region with regard to biogeographical and vegetational diversity of forests, but also with regard to the currently used methods for the assessment of the national forest resources and coppice forests in particular.

MATERIALS AND METHODS

Forests in Croatia

Croatia is situated in the north-western part of SEE and is divided into four main biogeographical regions (Fig. 1): Panonnian, Continental, Alpine and Mediterranean (EEA, 2005). The diversity of Croatia's forest cover is reflected by over 65 phytocoenologically distinct forest communities (Vukelic, Raus, 1998). Apart from the biogeographical differences, the patterns of colonization, settlement and population dynamics throughout history also played a significant role in the development of the currently diverse and rich forest cover of Croatia. This is especially true in the case of coppice forests, a type of forests where intensive anthropogenic influence defines many of its current stand characteristics.

In the Mediterranean region early cities along the Adriatic coast and on the islands were dependent on the scarce wood supply in the harsh Mediterranean climate prompting for first written regulations concerning forest management as early as XII century (Dubravac et al., 2008). Early settlements in the northern part of Croatia (Pannonian and Continental regions) were smaller, and situated in the forest-rich area so that organized cuttings of large forest areas had not appeared until the middle of XVII century, when forest cover was rapidly reduced from 60% in 1880 to 35% in 1914 (Vukelic, Raus, 1998). Forest cover of the mountainous Alpine region suffered much less owing to the inaccessibility of the high mountainous regions to colonization and population development (Vukelic, Raus, 1998; Klepac, 1997).

Currently forests in Croatia cover 43% (2402.782 ha) of its land surface (Anonymus, 2006). The majority of the forest area (73%) is in state ownership and managed by the state-owned forest company 'Croatian Forests' Ltd. trough 16 Regional Forest Offices (RFO) (Fig. 1).

Total area of coppice forests in Croatia amounts to 533.828 ha, out of which 6.4% are protective forests (for the protection of soil, watercourses, etc.), protected forests (national parks) and other special-purpose forests. Thus, coppice forests in Croatia represent a significant source of wood products and provide a variety of forest services and functions (Cavlovic, 1993; Klepac, 1994). With regard to ownership coppice forests are evenly distributed between private owners (52%) and state (48%).

The most recent assessment of forest resources on national level is the 'National Forest Management Plan, 2006-2015' (Anonymous, 2006). The National Forest Management Plan (NFMP) is produced every ten years by the state owned forestry enterprise for the entire forest area in Croatia, including private forests and state owned forests managed by other state agencies (e.g. National parks, military forests, park forests, etc.). In it all forests are sorted into management classes. A management class is defined according to (i) the origin of the forest (seed, coppice), and (ii) the dominant tree species according to which rotation length and silvicultural interventions are prescribed. Management classes are named after the dominant tree species, for example management class of beech from seed (i.e. beech high forests), or coppice management class (CMC) of beech. For each management class the following information is available: (i) total area and growing stock by tree species summarized on national level, and (ii) distribution of area of the management class per RFO.

Area of managed coppice forest is divided into 10 management classes named after the dominant tree species and two aggregate classes of 'Other hardwood coppices' and 'Other softwood coppices' in which several minor coppice classes were combined. Management class of softwood coppices is composed mainly of lime (*Tilia* sp.) dominated

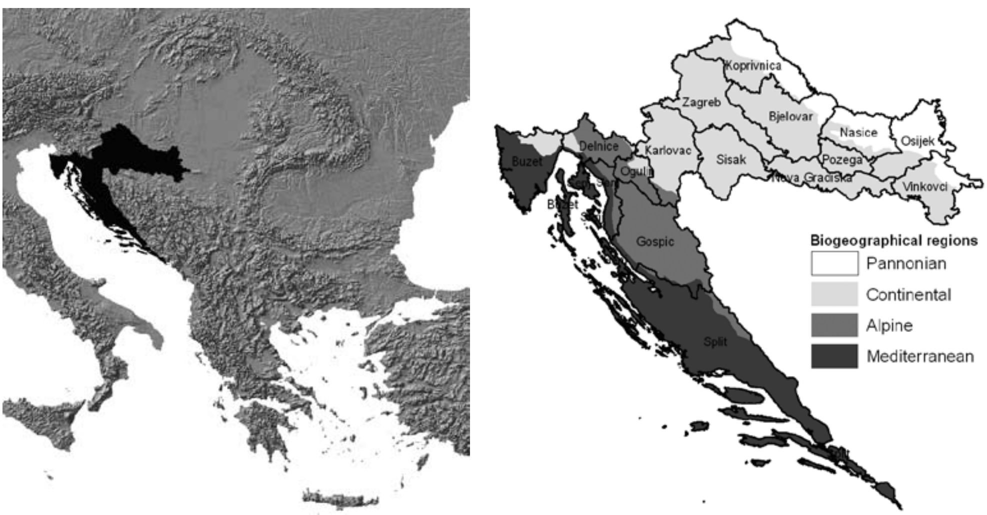

Fig. 1. Left panel: Position of Croatia within SEE region. Right panel: Biogeographical regions in Croatia with superimposed borders of 16 Regional Forest Offices

coppices with admixed pedunculate oak (*Quercus robur* L.), and its share in the total coppice area is very small (0.04%). On the other hand, CMC 'Other hardwoods' is important at national level both by area (17.7%) as well as by growing stock (18.1%), and is composed mainly of coppices dominated by Turkey oak (*Quercus cerris* L.), black locust (*Robinia pseudoacacia* L.) and sweet chestnut (*Castanea sativa* Mill.). The most important coppice management classes in Croatia are CMC of pubescent oak (*Quercus pubescens* Willd.) by area (23.8%), and CMC of beech (*Fagus sylvatica* L.) by growing stock (31.0%).

With regard to geographical distribution, the most widely distributed is CMC of beech, present in all but one RFO. Coppice MCs of sessile oak (*Quercus petraea* (Matt.) Liebl.)), hornbeam (*Carpinus betulus* L.) and 'Other hardwoods' are also widely distributed. Widespread distribution of beech, sessile oak and hornbeam coppices is partly a reflection of the good adaptability of these tree species to a wide set of forest sites present in Croatia. Shares of beech, sessile oak and hornbeam in the total growing stock of their respective coppice management classes is very high (77%, 61% and 69%, respectively), but due to the great geographic area covered, they are accompanied by a large number of other admixed tree species (32, 29 and 35, respectively). On the other hand, great extent of the geographical distribution of the CMC 'Other hardwoods' is a result of the aggregation of different coppice forests into one management class. The most important tree species by their share in the growing stock are *Q. cerris* (25%), *R. pseudoacacia* (23%) and *C. sativa* (17%) indicating the most prevalent coppice types, and the number of the other admixed tree species is the highest among all CMCs (n=38). Thus, the heterogeneity within CMC 'Other hardwoods' is very high, and additional expert knowledge from the foresters in the field is very important for the proper characterization of the actual situation within each RFO. On the other end of the spectrum of geographical distribution are the CMCs dominated by tree species with narrow ecological niche, such as holm oak (*Quercus ilex* L.), distinctively confined to the Mediterranean climate, or willows (*Salix* sp.), poplars (*Populus* sp.) and narrow-leaved ash (*Fraxinus angustifolia* Vahl.) confined to river valleys and riparian areas. Table 1 shows the available data on coppice forests in Croatia.

Linking coppice forests and EFT

One way to classify national forest areas into EFT is by establishing a direct link between forest types from national forest classifications and the EFT system. However, this is only applicable in cases where national forest classifications are based on the same principles and site attributes as the classification. Another approach is to use the classification key provided with EFT (EEA, 2007) and use data from the plots of the National forest inventory (NFI) as an entry into it. However, similar to the other countries in SEE region, these data are not yet available. In Croatia, NFI is currently in the stage of field work, and in many SEE countries, NFI has not yet started.

The simple assignment of CMC to the most likely EFT solely based on the dominant tree species and the tree species mixture of MC at national level would yield erroneous results. Some of MCs cover a wide geographical area and comprise very different forests

Table 1
Available data on coppice forests in Croatia (NFMP 2006-2015). Numbers in parentheses are share of tree species in the total growing stock of the respective management class

Coppice management class (CMC)	**Area**	**Growing stock**	**Geographical distribution**	**Tree species mixture**	
	Ha	m^3	Number of RFOs	No. of tree species	Most important tree species (>= 10% of growing stock)
Pedunculate oak *Q. robur*	886	255 218	8	19	*Q. robur* (58%); *C. betulus* (16%); *Fr. angustifolia* (13%)
Sessile oak *Q. petraea*	35 886	5 309 656	11	29	*Q. petraea* (61%); *C. betulus* (13%); *F. sylvatica* (10%)
Pubescent oak *Q. pubescens*	118 754	4 378 895	9	27	*Q. pubescens* (80%)
Holm oak *Q. ilex*	74985	4 783 238	4	12	*Q. ilex* (99%)
Beech *F. sylvatica*	108 820	15 553 770	15	32	*F. sylvatica* (77%)
Ash *Fr. angustifolia*	1539	236 464	3	11	*Fr. angustifolia* (76%); *Quercus robur* (16%)
Hornbeam *C. betulus*	58 871	8 795 536	14	35	*C. betulus* (69%)
Other hardwoods	88 659	9 103 858	14	38	*Q. cerris* (25%); *R. pseudoacacia* (23%); *C. sativa* (17%)
Alder *Alnus* sp.	9887	1 630 432	9	29	*Alnus glutinosa* (L.) Gaetrn. (78%)
Willow *Salix* sp.	883	106 829	4	7	*Salix alba* L. (93%)
Poplar *Populus* sp.	335	41 495	1	8	*Populus* sp. (47%); *Salix* sp. (21%); *Fr. angustifolia* (13%)
Other softwoods	183	59 497	3	13	*Tilia* sp. (76%); *Q. robur* (12%)
Total	499 687	50 254 888			

sites, and the actual tree species mixtures between the regions could vary significantly. With regard to forest diversity, the area of a single RFO is more homogenous compared to a nation-wide MC and should therefore contain less European forest types. Therefore, the transcription of MCs to EFTs at the RFO level should greatly improve the accuracy of our approach.

Key step in the proposed methodology is the estimation of areas of EFT in each RFO. To bypass the aforementioned limitations imposed by the data currently available on coppice forests in SEE region, and Croatia in particular, we decided to utilize available GIS data files. The digital polygons of RFO's were obtained from the state forest company 'Hrvatske šume' Ltd. The map of the natural vegetation of Europe (Bohn et al., 2004) was used to substitute for currently missing spatially explicit plot-level information from national forest inventories. The map of Bohn et al. (2004) is (i) available free of charge, (ii) covers whole area of SEE, (iii) the spatial resolution is suitable for the purpose, i.e. the mapping units of the vegetation map are small enough to capture the general vegetation pattern within RFO's, and (iv) the vegetation map is accompanied by a detailed description of each mapping unit in terms of forest cover, climate, geomorphology, site features, and main tree species. Furthermore, it provides complete European coverage in the form of the current natural vegetation corresponding to the actual climatic conditions, soil properties (nutrient and water budget as well as soil depth) and the native flora, thus reflecting the diversity and spatial arrangement of the natural terrestrial ecosystems. In the case of Croatia, where plantation forests make up only 3% of the total forest cover, this vegetation map closely represents the actual forest cover. The map is downloadable as an interactive CD-ROM containing GIS layer of the actual map (elemental mapping units) and extensive text describing the map and the development of the map in detail (http://www.floraweb.de/vegetation/dnld_eurovegmap.html). It has been used extensively for the development of EFT, and for some of the elemental mapping units the direct cross link to EFT is already provided (Barbati, Marchetti, 2004).

To exclude non-forest land from the analysis the Corine Land Cover (CLC) data base was used. CLC 2000 is an update of the first CORINE land cover database from the early 1990's updated jointly by the Joint Research Centre of the European Commission and the European Environment Agency (EEA). Main purpose of this dataset is to provide consistent information on land cover and land cover changes based on the photo-interpretation of satellite images (EEA, 2007). Currently, the database covers the 27 countries of the European Union (EU27) and Albania, Bosnia and Herzegovina, Croatia, Macedonia, and Liechtenstein. CLC 2000 database is available for download trough the web pages of the EEA (http://www.eea.europa.eu/themes/landuse/clc-download). In total, there are 44 different land cover classes hierarchically organized into first, second and third level classes. For the purpose of this study, only polygons of the second-level class 'Forest' have been used.

First, the borders of RFOs were overlayed with the vegetation map delineating areas of similar site features and the CLC forest map delineating actual forested areas. This generates polygons or forest patches within each RFO where each polygon contains data on site conditions and forest cover deduced from the vegetation map. These data were then used as entry into the classification key of EFTs (EEA, 2007) to assign polygons to the appropriate EFT, thus producing an estimate of EFT and their respective area per RFO. Finally, within each RFO the present coppice management classes were assigned to the most likely EFT. The habitats map (www.cro-nen.hr/map, Vukelic et al., 2008) as well as expert consultation was used to check whether the vegetation map reflected the current forest conditions. Fig. 2 shows the methodological scheme.

The assignment of coppice management classes by area to one or more EFT was based on (i) information contained within the CMC (dominant tree species, i.e. indication of site preferences with regard to soil fertility, soil acidity, climate, etc.), (ii) information aggregated into each EFT through previous working steps (description of EFT, descriptions of forest cover and site conditions of all mapping units sorted into EFT), and (iii) in cases where transformation was not so clear with the information available, forestry experts working in the respective RFO were consulted for additional information. In cases where more than one EFT was eligible for a particular CMC, random distribution of coppice forests is assumed, and the total area was divided among all eligible EFTs proportional to their area in the RFO.

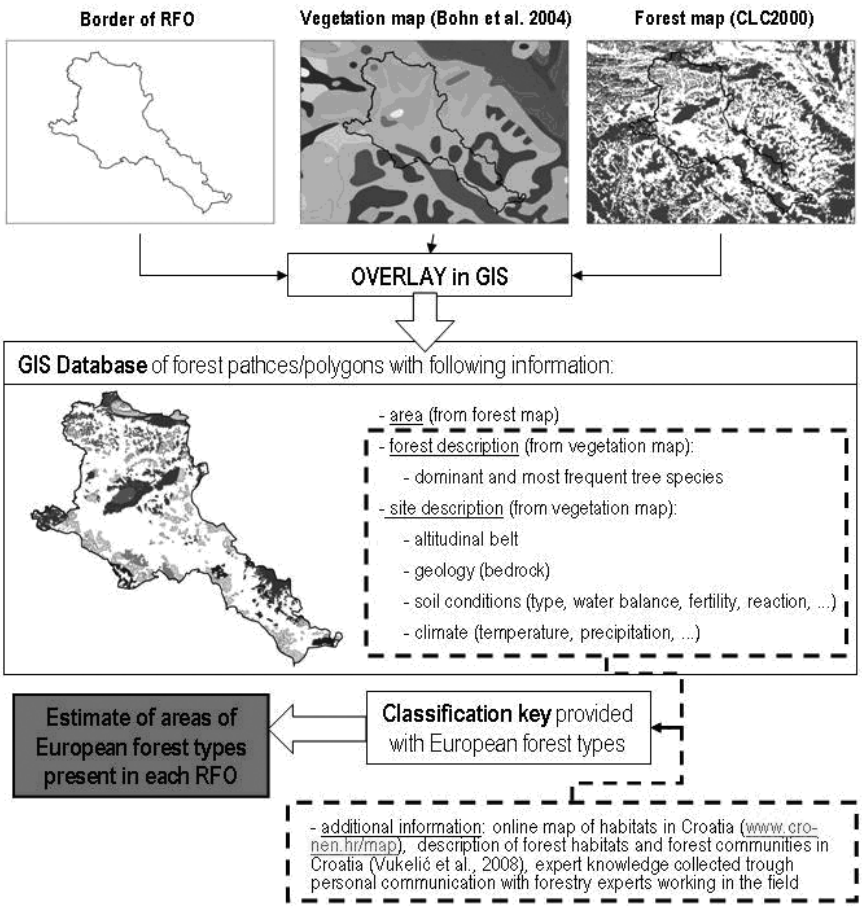

Fig. 2. Procedure and datasets used to estimate number and areas of European forest types present in RFOs

RESULTS

Estimation of European forest types per Regional Forest Office

The overlay of vegetation map (Bohn et al., 2004) with RFO polygons identified a total of 36 different forest vegetation types in Croatia from six main zonal vegetation formations, and one azonal vegetation formation. Inclusion of information on geographical distribution of actual forest areas contained within the CLC 2000 layer led to a change in shares of different main vegetation formations in the total area as derived solely from the overlay of the vegetation map and borders of RFO (Fig. 3). Namely, shares of lowland U, termophylous G and Mediterranean J vegetation formations decreased. This is a reflection of historical development of forest cover caused by conversion of forest area to arable land in the case of U formation, and long-lasting population pressure in the case of Mediterranean G and J formations. Forests of the vegetation formation F are distributed in low-populated mountainous areas, where they could better realize their potential in the absence of the population pressure.

To check for accuracy of the data on forest cover the forest area derived from CLC 2000 per each RFO was compared with the data from the National Management Plan (Fig. 4). The data are highly correlated. At national level total forest area obtained from CLC 2000 is 4.4% higher compared to the forest area in the NFMP. This is in concordance with other published results (e.g. Pekkarinen et al., 2009).

Each of the 36 vegetation types occurring within RFOs was then assigned to one EFT by using the information on forest cover and site conditions of each mapping unit

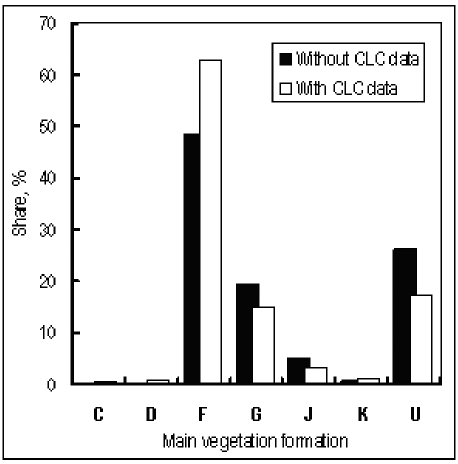

Fig. 3. Shares of main vegetation formations (Bohn et al., 2004) defined in Croatia in total land area (without CLC data) and in forest cover (with CLC data).
C = sub-arctic boreal and nemoral-montane open woodlands as well as subalpine and oro-Mediterranean vegetation, D = mesophytic and hygromesophytic coniferous and mixed broadleaved-coniferous forests; F = Mesophytic deciduous broadleaved forests and mixed coniferous-broadleaved forests; G = Thermophilous mixed deciduous broadleaved forests; J = Mediterranean sclerophyllous forest and scrub; K = xerophytic coniferous forest, woodlands and scrub; U = vegetation of floodplains, estuaries and fresh-water polders and other moist or wet sites

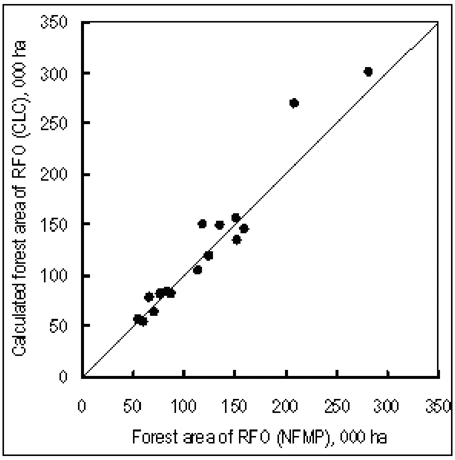

Fig. 4. Comparison of actual areas of RFO's and areas obtained with the use of CLC 2000 dataset. $r = 0.97$, $p < 0.05$, $n = 16$

as an entry into the classification key of EFTs (Table 2). In cases where the assignment was not straight forward additional information was also used (compare Fig. 2). The data were summarized to produce the area of each EFT for each of the 16 RFOs.

In total, we have identified 16 EFTs from 9 categories. Their number per RFO varies from three in RFO Ogulin up to eleven in RFO Split and accurately describes general biogeographical differences between the RFOs. In northern, geomorphologicaly more homogenous RFOs (e.g. Nova Gradiska, Karlovac, Sisak, Vinkovci, etc.) number of EFTs is smaller compared to large and diverse southern RFO (e.g. Split, Gospic). The number of options for the linkage of coppice management classes to EFTs at RFO level is further reduced by eliminating coniferous forest types.

Coppice forests in Croatia by European forest types

Finally, coppice forests in Croatia were assigned to eleven EFTs from seven categories (Table 3). For each linkage a qualitative degree of certainty is indicated. For 76.4% of the area of coppice management classes the link to EFT scheme was clear and straight forward. In other cases, the assignment represented an approximation made on the basis of the available information.

As expected, the area of geographically widely distributed management classes (e.g. sessile oak, pubescent oak and hornbeam) was distributed among more than one EFT (three or four). The management class 'Other hardwoods' is also distributed over four EFTs, but these relationships were supported by local expert judgement. Although geographically widely distributed, the management class of beech is assigned to only two EFTs (6.6 Illyrian sub-mountainous beech forest, 7.4 Illyrian mountainous beech forest). The actual distribution of beech coppice forests between these two forest types and categories of forest types could be different from the results we have obtained. The

Table 2
Number of coppice management classes and eligible EFTs per Regional Forest Office

Regional Forest Office	Forest cover (ha)	Number of coppice management classes	Number of EFTs in RFO	Number of EFTs eligible to contain coppice forests in RFO
Bjelovar	158 887	5	6	5
Buzet	135 562	6	6	6
Delnice	119 010	3	6	5
Gospic	281 691	7	9	7
Karlovac	150 429	5	6	6
Koprivnica	113 723	6	7	7
Nasice	83 574	9	6	5
Nova Gradiska	87 502	7	5	5
Ogulin	65 821	4	3	3
Osijek	59 424	9	6	6
Pozega	55 280	7	4	3
Senj	77 212	5	6	4
Sisak	124 841	6	4	4
Split	208 272	5	11	8
Vinkovci	70 449	4	6	6
Zagreb	152 576	9	7	6

reason for this lies in the distinction between these two forest types and categories made in EFT classification. Main distinction between the two categories is the altitudinal range and presence of coniferous species in the mountainous beech forests. Within each category, forests are sorted into forest types solely based on the geographical distribution. Information we have used on altitudinal range of the elemental mapping units of the vegetation map to classify them into EFTs are only broad guesses and the actual distribution of beech categories in the field could be different. Therefore, the actual share of beech coppice forests in these two categories of EFT could also be different from the results obtained in this study.

Hornbeam (*C. betulus*) is not a tree species according to which forest types are classified, it is an ancillary tree species in forests where other trees dominate (e.g. pedunculate oak, sessile oak). In that sense, hornbeam coppices are the result of particularly strong anthropogenic influence. With that in mind, the area of hornbeam coppices was allocated to all EFTs present in RFO in which hornbeam is usually part of the forest tree species composition. In the absence of these EFTs, an approximation was made and hornbeam coppice area was allocated to the EFTs '6.6 Illyrian submontane beech forest' and/or '4.1 Acidophilous oakwoodland'.

Table 3
Assigning coppice management classes to European forest types

Coppice management class	European forest type	Area (ha)	Confidence of linkage
Pedunculate oak	5.1 Pedunculate oak–hornbeam forest	782	Clear
	12.2 Fluvial forest	104	Clear
Sessile oak	4.1 Acidophilous oakwood	18691	Clear
	5.2 Sessile oak–hornbeam forest	16 794	Clear
	8.1 Downy oak forest	35	Approximation
	8.2 Turkey oak, Hungarian oak and Sessile oak forest	365	Clear
Pubescent oak	4.1 Acidophilous oakwood	4389	Approximation
	8.1 Downy oak forest	118 497	Clear
	8.2 Turkey oak, Hungarian oak and Sessile oak forest	102	Approximation
Holm oak	9.1 Mediterranean evergreen oak forest	75 015	Clear
Beech	6.6 Illyrian submountainous beech forest	49 745	Clear
	7.4 Illyrian mountainous beech forest	54 810	Clear
Ash	12.2 Fluvial forest	1538	Clear
Hornbeam	4.1 Acidophilous oakwood	11743	Approximation
	5.1 Pedunculate oak–hornbeam forest	11155	Clear
	5.2 Sessile oak–hornbeam forest	24202	Clear
	6.6 Illyrian submountainous beech forest	11 773	approximation
Other hardwoods	4.1 Acidophilous oakwood	31 570	approximation
	5.2 Sessile oak–hornbeam forest	12 997	approximation
	8.2 Turkey oak, Hungarian oak and Sessile oak forest	2672	approximation
	8.8 Other thermophilous deciduous forests	41 420	approximation
Alder	5.1 Pedunculate oak–hornbeam forest	1234	approximation
	12.1 Riparian forest	8654	clear
Willow	12.1 Riparian forest	883	clear
Poplar	12.1 Riparian forest	335	clear
Other softwoods	5.1 Pedunculate oak–hornbeam forest	171	approximation
	12.2 Fluvial forest	11	clear
Total		499 687	100.0

Coppice forests dominated by oak tree species (pedunculate, sessile, pubescent and holm oak) were classified with the highest degree of certainty. Only in a few cases an approximation had to be made because no EFT dominated by the particular oak tree species was present in the RFO. But even in those cases, oak coppices are sorted into EFTs dominated by other oak tree species. CMCs dominated by tree species with narrow ecological niche (ash, willow, poplar) were also easily classified to the corresponding EFTs.

On the category level coppice forests in Croatia are sorted into seven categories (Fig. 5). The category with the largest area is the termophilous deciduous forest. Together with broadleaved evergreen forests, in total composed of Mediterranean holm oak coppices, these two categories make up 48% of the area of managed coppice forests in Croatia. Coppice forests in two categories distributed mainly in hilly, colline areas (acidophilous oak and oak, birch forest and mesophytic deciduous forest) are the second largest group of coppice forests in Croatia with a share of 27% of the coppice area. Coppice forests in beech categories (beech forests and mountainous beech forests) make up 23% of the coppice area, and only 2% of coppice area is found in the lowland floodplain forests.

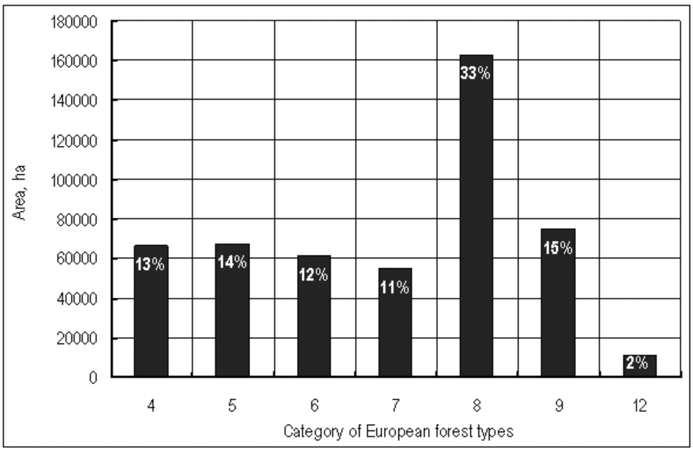

Fig. 5. Coppice forests in Croatia by categories of European forest types (4 – Acidophilous oak and oak-birch forest; 5 – Mesophytic deciduous forest; 6 – Beech forest; 7 – Mountainous beech forest; 8 – Thermophilous deciduous forest; 9 – Broadleaved evergreen forest; 12 – Floodplain forest)

DISCUSSION AND CONCLUSIONS

In this contribution an approach was presented to assign coppice forests in Croatia to EFT system. In total 499.687 ha (93.6% of the total coppice area) were classified, whereof for 76.4% the classification to EFTs was possible with high confidence, in other cases an approximation was made based on the available information. The NFMP does not contain information on the distribution of protected forests per RFO's, so we can not apply our approach to this smaller share of coppice forests (6.4% of total coppice area).

The classification of coppice forests into EFT by this approach presents a significant improvement in the quality of information on coppice forests, especially with regard to sites they occupy, compared to information previously available. The methodology was able to describe the major biogeographical differences over the area of Croatia. This methodology may be able to capture the major biogeographical patterns within other SEE countries as well. Therefore, the information obtained seems suitable for comparisons at national and regional levels.

There are also some limitations which will be discussed in turn. While the vegetation map used in this approach is a good representation of general vegetation patterns some deviances from the actual vegetation could be involved. Vegetation units mapped in Bohn et al. (2004) usually represent a mixture of different forest types where one forest type is dominating. The spatial resolution is too coarse to describe fine-grained differences in actual forest cover types. EFTs themselves are still work in progress, and a definitive classification is still not available. Like in many classifications dealing with mapping vegetation cover over large areas there are also some limitations contained within the EFT system. Substantial shares of European forests have been managed intensively since centuries, subsequently they deviate more or less from natural forests. EFTs appear as some compromise between natural forest types and actual vegetation. Coppice forests largely shaped by anthropogenic influence could depart significantly from the structure and tree species composition as described in the particular EFT. Thus, care must be taken in using species dominance as major determinant of EFTs. A major potential problem are areas of forests composed of introduced tree species. However, in general the vegetation map by Bohn et al. (2004) appears as a reliable substitute for inventory data even more, when we consider that the main input for East-European areas of this map were mainly maps of the actual natural forest cover, in concordance with the East-European phytocoenological praxis (compare Bohn et al., 2004). In cases of substantial uncertainty additional comparison with a habitat map as well as expert consultations were added.

Summarizing, the presented methodology appears useful for a rapid stratification of coppice forest resources by the combined use of currently available national data on coppice forests in countries of the SEE region and available data sets at European level. As soon as plot-level national forest inventory data becomes available an evaluation and eventual improvement of the approach will be possible.

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