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Dear readers,

Joyfully we announce that the second edition of SEEFOR journal has emerged! Five papers in this edition are bounded with concept familiar to all of us- the concept of Sustainable Forest Management (SFM). It is about taking care of ecological, economic and social aspects in forest management in order to maintain continuity of myriad of benefits forests provide to society. In a time when all scientific community is buzzing on climate change this is more salient than ever.

Assessment of SFM in Croatia is dealt with Lovrić et al. by using quantitative Criteria and Indicators brought by Forest Europe (previously MCPFE). Continuous measurement of forest stock, stand structure and like is important quantitative input for all further research on forests. Novotny et al. brings overview of forest measurement data in well-known protected area in Croatia and UNESCO heritage site- The Plitvice Lakes. How to maintain provision of forest services by using different payment mechanisms (i.e. green tax and carbon credits) is topic of two papers written by Nijnik et al. and Vuletić et al. These two papers were presented at the International Conference-Forum Emerging Economic Mechanisms: Implications for Forest-Related Policies and Sector Governance held in FAO, Rome on 5-7 October 2010, which together with Committee on Forestry Week gathered significant number of participants from all over the world. The last, but not the least, Kiš in paper on social conflicts between forestry and nature protection sector on Velebit Mountain in Croatia brings some results from his master theses. This study was included in regional study of forestry related conflicts in SEE region as a part of FOPER project (Forest Policy and Economics Education and Research).

Until next edition wish you a pleasant reading.

Dijana Vuletić, Editor-in-chief

Contents

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Original scientific paper

Assessment of progress towards sustainable forest management in Croatia through usage of quantitative Improved Pan-European Criteria and Indicators

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Abstract

Background and purpose:
Paper analyzes the transition of forestry in Croatia from 1995 up to the situation in 2006. The comparison between these two situations is made through quantitative Improved Pan-European Criteria and Indicators (C&I) for sustainable forest management (SFM). The paper also tests the applicability of the framework on a national reporting scale, and comments on the format of the framework itself

Material and methods:
This secondary research compiles data in the framework of quantitative Pan-European Criteria and Indicators. Data comes out of many national and international sources, out of which most important ones are the MCPFE/FAO forest assessments and the General forest management plans for Croatia. For the reasons of comparison, all respective data is equated to 2000, and all forest types have been presented through MCPFE systematization scheme.

Results and Conclusion:
According to this framework, the forestry in Croatia has made a progress in 15 out of a total of 35 indicators while no indicator showed a negative trend, 8 showed no significant change and 12 could not be calculated. The main impediment to the calculation of the indicators was the format of the requested information, notably division of total forest area to forests and other wooded land, and division of total forest land according to availability for wood supply.

Key words:
MCPFE's criteria and indicators, sustainable forest management, national reporting

INTRODUCTION

After the United Nations Conference on Environment and Development (UNCED) in Rio 1992 focus of international policy came to issues of environment and sustainability, and on this wave of attention a generic criteria and indicators for sustainable management of forests have been developed, both for Europe (Helsinki process, formulated by the Ministerial Conference on the Protection of Forests in Europe – MCPFE), and for the rest of the World (Montreal process).

The starting point for MCPFE C&I was the definition of sustainability, which was agreed upon in 1993 at the second Ministerial conference in Helsinki, under H1 resolution, and it states: "Sustainable management means the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and the potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems".

The MCPFE C&I were adopted on expert level in 1994, endorsed on the third Ministerial Conference in Lisbon in 1998 (L2 resolution), and subsequently improved in fourth MCPFE in Vienna in 2003 [1]. They consist out of 6 criteria, 35 quantitative and 12 qualitative indicators. The quantitative indicators cover through 122 parameter issues from all three side of sustainability – ecological, economical and social, and have been frequently used as a basis for reporting on the status of forests [2-5]. The qualitative indicators disseminate status of forest from a policy perspective, and have not been as frequently used as were the quantitative indicators. The successful usage of C&I mostly depends on wide participation on all levels; so far that acceptance has occurred among intergovernmental organizations, but not on national levels; Finland and Austrian National Forest Report are the only ones that follow MCPFE's C&I.

Paper provides an insight to the changes that occurred in forestry of Croatia in the 1995 – 2006 period through the framework of MCPFE's quantitative criteria and indicators. This time span is chosen because majority of C&I is designated for ten year periodicity of data collecting. Due to the abundance of information indicators are depicted as shortly and as precisely as possible, for it is the objective of the paper to demonstrate weather it is possible or not to cover all the aspects that are prescribed by the methodology on national level.

MATHERIAL AND METHODS

The intention of this secondary research was to report on Croatia's forest in the respective C&I framework. The usage of framework [6] implied a 10 year span of reporting, as did the data from one of the most used data sources in this paper – the General forest management plans of Croatia for 1996-2005 [7] and for the 2006-2015 period [8].

Data on annual changes of the values of indicators were mostly drawn from Annual business reports of Hrvatske šume Ltd. The same source was used for financial parameters, which were equated to real values in the year 2000 using the official inflation rates from the annual reports of the Croatian National Bank [9]. The abundance of data also had its shortcomings; the calculation of indicators often required compiling of data from various sources, which on some instances gave equable results (defoliation data, occupational health and safety), and on some instances unequaled data (carbon stock, forest sector workforce). These effects can probably be assigned to differences in the methodologies applied in the sourced researches, and their magnitude with the respect of the context of this research is of no significant importance. The bolded text in the following chapter represents the names of the indicators of interest, and the two-number code represents the number of the respective indicator in the MCPFE C&I system (eg. Forest area 1.1. – Criterion 1, indicator 1). The analogies between different systems of classification of protected and protective forests are based on the work of Martinić [10] in Table 9.

Most of the indicators comprise out of several parameters, and they have been assessed only through the parameters for which appropriate data exists. Since data has been collected for 23 out of 35 indicators, this research cannot be used for valid assessment of progress of forestry in Croatia, rather as an introductory study to a main research. This data could be used for such an assessment only if was incorporated in a system which adequately depicts sustainable forest management [11, 12], where appropriate weights and feed-back loops have been assigned to the indicators.

RESULTS

<u>Criterion 1:</u>
Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles

Forests area (1.1.) together with other wooded land covers 2.6 mil ha, which is about 46% of land surface of Croatia (Table 1). There are many private forest owners (estimated to 600 000) which own 21% of forests. In the period of research there has been an increase in forest cover in all types of forest (≈ 65 000 ha in every group – Economic, Protective and Special purpose forests), and in every ownership category – although the increase in forest cover was mainly private forests (120 632 ha) due to the increase in abandoned agricultural land. The percentage of other wooded land in total forest area is constant (≈12.5%) in all ownership categories and forest types in both 1996 and 2006. Almost all state owned forests (96%) are managed by "Hrvatske Šume" Ltd., which is in State ownership.

TABLE 1
Forest coverage in Croatia (source [8])

Type of forest	Year	State forests - HŠ	State forests - Other	Private forests	Total
		ha			
Economic	1996	1 878 790	3 051	459 642	2 341 482
	2006	1 838 782	492	576 833	2 416 108
	Δ	-40 008	-2 558	117 191	74 625
Protective	1996	88 838	20	1 454	90 312
	2006	145 634	4 884	4 022	154 539
	Δ	56 796	4 864	2 567	64 225
Special purpose	1996	23 909	29 867	40	53 816
	2006	33 570	82 555	917	118 041
	Δ	10 661	52 690	876	64 225
Total	1996	1 991 528	32 936	461 136	2 485 611
	2006	2 018 986	87 930	581 771	2 688 688
	Δ	27 450	54 994	120 632	203 077

Similar to the area, the growing stock (1.2.) of all ownership categories has increased (Table 2). It has to be stated that according to the General forest management plan 2006-2015 the growing stock of private forests has doubled in 10 years, which has to be most probably a result in different inventorying methodologies.

Regarding the age structure (1.3.), almost half of all even-aged forests (46%) in all ownership categories fall in III and IV age class (40 – 80 years), which is a good indicator of future forest stability (no danger from over-mature stands). Similar analysis of diameter – class distribution according to land coverage could not be performed due to the lack of appropriate data.

In the line with increase in forest area and growing stock, there is also an increase in carbon stock (1.4.) of forests (Table 3).

TABLE 2
Summary of growing stock distribution (source [8])

Year	State – HŠ	State – Other	Private	Total
	1 000 m^3			
1996	278 324	7 905	38 028	324 256
2006	302 417	17 245	78 301	397 963
Δ	24 094	9 340	40 273	73 707

TABLE 3
Carbon stock of forests (source [2, 6])

Year	Carbon stock of woody biomass total	Above ground living woody biomass	Below ground living woody biomass	Dead wood
	Mt of C			
1990	196	117.2	31	20.8
1996*	115.28	97.38	17.89	
2000	211.1	146.4	38.7	26
2005	219.4	152.2	40.2	27

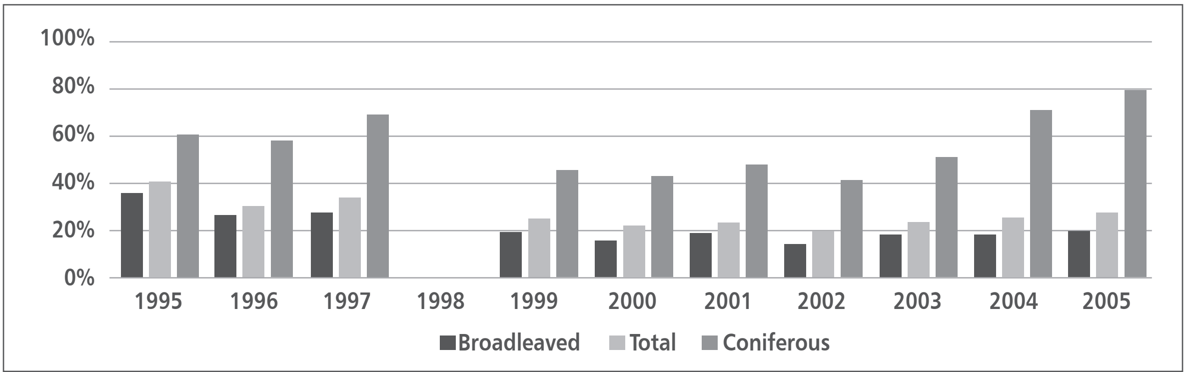

FIGURE 1
Percentage of trees with more than 25% crown defoliation

Criterion 2:
Maintenance of forest ecosystem health and vitality

No representative data regarding deposition of air pollutants (2.1.) and forest soil condition (2.2.) could be found. No defoliation (2.3.) trend can be observed; only that the defoliation is more strongly pronounced among coniferous trees (Figure 1 – [13, 14, 15]).

Related to forest damage (2.4.), only data regarding forest fires could be obtained. It is evident from the Table 4 that there was a peak in the number of forest fires and in the burned area in the year 2000. Although the year 2000 was very hot (+1.74 Standard deviation from mean annual temperature in 1961 – 1990 period) [16], since 90% of forest fires in Croatia are induced by man, no conclusion can be drawn regarding the management of forest and occurrence and coverage of forest fires.

TABLE 4
Distribution of forest fires and burned area (based on [17])

Year	Number of forest fires	Burned area (ha)
1995	109	4 651
1996	305	11 214
1997	305	11 122
1998	441	32 056
1999	223	6 053
2000	706	68 171
2001	299	16 169
2002	176	4 853
2003	536	27 091
2004	204	3 378
2005	147	3 135

Criterion 3:
Maintenance and encouragement of productive functions of forests

Unlike forest coverage, increment and fellings (3.1.) have significantly changed in the period of research; although annual gross felled timber has almost doubled from 1996 to 2006 (from 2,6 mil m^3 to 5,0 mil m^3), it equals just to half of the annual increment (Table 5). The difference between felling and increment is smaller in state forest (fellings are 61% of increment) than in private forests (23% of increment). Although that this kind of felling policy is sustainable in the short run, it will lead the growing stock in the long run further away from the normal series of age and diameter distribution, which could be a major drawback to forest health and vitality. On European level it is expected that the growing need for wood [18] will be compensated by diminishing the difference between increment and fellings, so the current level of fellings in Croatia will probably increase. Some explanation of current levels of felling in Croatia can lie in the fact that there were 148 823 ha of suspected mined areas in 2006, and that the realized level of felling in private forests amount to 37% of planned, but further explanation of the issue would require a discussion beyond the scope of this paper.

TABLE 5
Value and quantity of felled roundwood for "Hrvatske šume" Ltd. Real prices, equated to 2000

Year	m^3	kn	kn/m^3
1995	2629563	1068342047	406,2812138
1996	2934177	1050989056	358,1887038
2000	4366652	909289000	208,2348216
2005	4694727	1041391676	221,821562
2006	4200409	1101041173	262,127134

TABLE 6
Quantity and value of non-wood forest goods (source [6])

Year	Mushrooms and truffles		Resin, raw materials, medicine, aromatic products		Other plant products	
	Quantity (t)	Value (1000 €)	Quantity (t)	Value (1000 €)	Quantity (t)	Value (1000 €)
2005	400	319,1	40,0	33,2	1200,0	202,7

Despite the fact that the quantity of felled roundwood (3.2.) in forests managed by "Hrvatske šume" Ltd. has increased by 62% in the 1995-2006 period, its value has remained relatively constant; accordingly, the value of one m^3 has decreased by 55% in the same period. These prices are in line with the trends on European timber market, where the value of roundwood has decreased by 38% in 1995-2002 period [3].

No data regarding the value or the quantity of non-wood forest goods (3.3.) in Croatia prior to 2005 could be found, and the only information on this topic with national coverage is presented in Table 6. Similarly, no representative data regarding value of marketed services on forest and other wooded land (3.4.) could be found.

When it comes to proportion of forest and other wooded under a management plan or equivalent (3.5.), the situation is almost dichotomous; nearly all state owned forests in Croatia are covered by forest management plans (95%). The situation is inverse in private forests, due to a number of reasons [19] out of which the prevailing one is the high degree of plot dissemination (average size 0,42 ha). Although it was prescribed that the annual coverage of private forests with forest management plans should be 60 000 ha per year [7], Table 7 shows a deviation from that plan. It also has to be noted that in 2005, 32.6% of private forests had expired management plans. The low percentage of private forest with forest management plan can be explained by a fact that in 2005 "Hrvatske šume" Ltd., who at that time were managing private forests, had a total of 222 out of approximately 9500 employees designated to deal with issues of private forestry. The situation is even more evident in the fact that in the same year the employees of "Hrvatske šume" Ltd. reported 63 247 working hours related to private forests, which is equivalent to full time occupation of just 31 employee [20].

Criterion 4:
Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems

According to different sources, Croatia has around 250 tree species, out of which 50-60 have economic values. Although no comparable data could be found that would show the trend in tree species composition (4.1.), based on the trends from the linked indicators 1.1 and 4.3. it can be said that the tree species composition in Croatia is relatively constant.

Compared with the planned forest regeneration (4.2.) activities of the following decade (2005 – 2015), the area of natural regeneration is expanding (1.57 mil ha to 1.83 mil ha), while the area of natural regeneration enhanced by planting (33 492 ha to 13 730 ha) and the area of regeneration by seeding (28 350 ha to 16 894 ha) is contracting. The area designated for coppice sprouting (504 901 ha to 533 828 ha) has remained relatively constant.

The naturalness (4.3) of forests in Croatia in the period of interest has not changed – almost all of the forests and OWL are modified natural forests (2.02 – 2.06 mil ha), while the share of forests undisturbed by man (10 000 ha) and plantations (56 000 – 61 000 ha) is not significant.

There is no data regarding the area of forests under introduced tree species (4.4.).

TABLE 7
Annual coverage of forest by forest management plans (source [8])

Year	Annual coverage of forest by forest management plans										Coverage by management plans	
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	1996 - 2005	
	ha										ha	%
State – HŠ	43455	112899	185123	243086	210541	253707	782025	234255	162334	272974	1900399	95
Private	0	6726	3682	7708	2120	5756	3153	0	3521	1862	34528	7

Under FSC certification scheme for state forests managed by "Hrvatske šume" Ltd. there was an obligation (minor non-compliance) in 2002 that was fulfilled in 2003 regarding the deadwood (4.5.) in forests; it is an observed practice that 3 – 5 fallen or standing trees are left in the forest after the final cut. A similar obligation was prescribed by the General forest management plan of Croatia 1996 – 2005 [8]. It can be stated that the situation regarding deadwood in forest has remained unchanged in the time period of interest.

Areas managed for in situ (5162 ha – 4997 ha) and ex situ (75 – 80 ha) genetic resources (4.6.) preservation have remained relatively constant, while the area managed for seed production has grown from 23 ha to 75 ha in the time period of interest

There is no usable data regarding landscape patterns (4.7.) of forest cover.

There is a total of 32 flora threatened forest species (4.8.) in Croatia, out of which 2 are trees (Betula pubescens – critical; Taxus baccata – vulnerable) and one is a shrub (Ilex aquifolium). According to different sources, there are from 813 [21] up to 1198 [2] forest flora species. And although no such information could be found for the year 1996, it can be presumed that the situation has remained relatively unchanged.

It can be observed that the extent of protected forests (4.9.) under MCPFE classification has changed in the period of interest mostly in the class 3, which represents protective forests under national classification (Tables 8 and 9). Further dissemination of MCPFE class 3 represents in fact Indicators 5.1. and 5.2. of the Criterion 5.

Criterion 5:

Maintenance and appropriate enhancement of protective functions in forest management

Since no such data could be found for the beginning of the period of interest, such analysis could not be performed – it can be only states that in 2006, 97% of protective forests were managed protection of soil, water and ecosystem functions, and that such ratio was similar in 1996.

TABLE 8
Extent of protected forests according to MCPFE classification system

MCPFE* class		MCPFE objective	Year	
			1996	2006
			ha	
1.	1.1.	No active intervention	6 003	5 685
	1.2.	Minimum intervention	20 235	41 279
	1.3.	Conservation through active management.	312 668	317 502
2.		Protection of Landscapes and Specific Natural Elements	1 557	11 396
3.		Protective Functions	47 624	81 530
Total			388 087	457 392

TABLE 9
Analogies between different classification systems of protected and protective forests (modified on the basis of [10])

EEA	MCPFE*		IUCN	National classification of Croatia
A	1.	1.1.	I	Strict reserve
		1.2.	II	National park
		1.3	III	Nature monument
B	2.		IV	Special reserve
			V	Significant landscape, Park forest, Nature park
			VI	Regional park
				Monument of park architecture
-	3.		-	Protective forests

Criterion 6:
Maintenance of other socio-economic functions and conditions

In the period of interest almost all of the forests, both state and private, were managed by "Hrvatske šume" Ltd. a predominant forest holding (6.1.); the exception were the 4.3% of state forests that were managed by other legal entities (total of 11), out of which the largest one is the Ministry of defense. However, there has also been a strong activity of private entrepreneurs, who have in the same period doubled their share in timber transportation niche, while their share in felling and skidding and hauling (Figure 2).

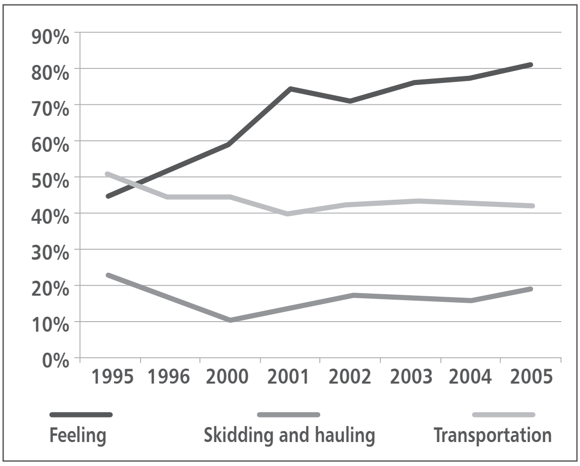

FIGURE 2
Trend in entrepreneurial activities in forestry in Croatia

Contribution of forestry sector to GDP (6.2.) has moved slightly downscale (1995 – 1.6%; 2005 – 1.3%.; [22]).

Although no data regarding net revenue (6.3.) of forestry in total could be found, a good indicator of economic viability of forestry in Croatia is the annual net revenue of "Hrvatske šume" Ltd., whose profits have decreased from 32 million Kuna's (4.32 mil €) in 1996 to 19 million Kuna's (2.57 mil €) in 2006 (real values, equated to year 2000, [23]). The net revenue figures actually represent a stabile 1.5% of all revenues, indicating planned financial results of the company.

Expenditures for services (6.4.) that are publically available and that forests in Croatia provide can be seen through a "green tax" prescribed by the Law on forests, by which all subjects in the economy are obliged to pay 0.07% of their annual revenues for the "Publically useful functions of the forests", which are as follows [24]: Protection of soil, roads and other objects form erosion and flood; influence of forests on water regime and hydropower system; influence of forests on soil fertility and agricultural production; influence of forests on climate; protection and improvement for environment; creation of oxygen and atmosphere cleansing; recreative, touristic and health function; influence on fauna and hunting; protective and special purpose forests. The amount of the "green tax" has increased from 150 million Kuna's in 1996 to 268 million Kuna's in 2006 (real prices, equated to year 2000).

No data on national level that would show the forest sector workforce (6.5.) in the years 1996 and 2006 could be found; however, the most reliable source on the sectors' workforce is the National Forest Policy and Strategy (25), which states the forestry and logging activities employ 19500 people (9500 in "Hrvatske šume" Ltd., 6000 employed by private entrepreneurs and 4000 of part time employees), that wood industry employs 23100, and that pulp and paper industry employees 6250 people, which sums up to a total of 49000 of people. Since the number of employees in "Hrvatske šume" Ltd. has remained constant, that there is an increase in the activities of private entrepreneurs and that the annual fellings have increased, it can be said that the employment in forestry and logging in Croatia has slightly increased in the period of interest.

Number of non-fatal occupational accidents has steadily decreased from 736 in 1995 to 505 in 2005. The number of fatal injuries in forestry has grown from 1 to 5 in the same period, but this information should not be treated as a trend, since the annual number of fatal injuries in forestry varies in the period of interest from none (in 1999) to seven (in 1998) in a way from which no conclusions can be drawn. With this information, it can be concluded that the situation regarding occupational safety and health (6.6.) has improved [26, 27].

No comparative data on wood consumption (6.7.) could be found; only that annual wood consumption in 2007 was 0.8m^3/capita [28].

Trade in wood (6.8.) has made a strong turn in the period of research: imports of roundwood have downsized from 135 000 m3 in 1996 to 70 000 m^3 in 2006, while exports have grown from 281 000 m^3 in 1996 to 907 000 m3 in 2006, which amounts to one third of annual felling.

Share of energy from wood resources (6.9.) in total energy consumption has approximately stayed on the same level from 1996 (3.8%) to 2006 (4.08%), while the intermediate values have randomly fluxed no more than a half of a percent around the ending value [29].

With some minor exceptions (like forests owned by the Ministry of defense), all forests in Croatia have accessibility for recreation (6.10.). Recreation as a primary function of forest is present in protected areas that fall into IUCN's categories II (National Park), III (Natural Monument) and V (Protected landscape), which amounts to 334 412 ha in 1996 and 370 148 ha in 2006.

No viable data regarding number of forest sites with cultural and spiritual values (6.11.) in the period of research could be found.

DISCUSSION AND CONCLUSIONS

The evaluation summary of the former section reveals that forestry in Croatia has made a progress in the 1995 – 2006 period; 15 out of 35 indicators show a positive trend, no indicator shows a negative trend, 12 have unknown values, and 8 have recorded no significant change. This result were obtained by having sufficient data for calculating at least basic parameters for 23 indicator, while out of a total of 122 parameters 42 were calculated.

The main impediments in the calculation of parameters related to the indicators were:

Division to forests and other wooded land

When reporting on forests, few international data sources (like UNECE and FAO) use this demarcation. On national level this kind of demarcation exists just for basic information like forest cover, thus excluding a large number of parameters.

Division of parameters related to availability for wood supply

No data exists for forests in Croatia that would disseminate the information of a parameter related to availability for wood supply. Such division is not used in national reporting, and the authors have not found a clear definition what the availability for wood supply means in the respective literature. This impediment has also excluded many parameters.

COMPLEXITY OF INDICATORS

Some indicators (notably 4.8 - Threatened forest species; 4.9- Protected forests and 6.10. - Accessibility for recreation) have many parameters, whose level of detail and related comment is adequate for a separate report

Weak reporting on forestry on national level

Very small percentage of data required for the calculation of indicators that came from national sources showed information on national level; Data related to state forests, especially those managed by Hrvatske šume Ltd. was very abundant, unlike information related to private forest. Many parameters (notably 1.4.; 2.3.; 3.1.; 4.8.; 4.9.; 6.5. and 6.6.) required compiling different data sources, which introduces an issue of data credibility due to the differences in methodologies of data calculating.

No separate reporting on forestry by the Central Bureau of Statistics

Central Bureau of Statistics keeps much of the information that is required for the calculation of indicators; unfortunately majority of information is presented in statistical data bases jointly for agriculture, forestry and hunting, thus disabling the usage of information

MCPFE's quantitative indicators represent a comprehensive framework for reporting on forestry, a framework whose application can be simply evaluated and just as easily compared to any other application regardless of the scale. However, as any theoretical framework, it has its weak sides, one of which is the format of the data. This paper could not provide the figures on most of the parameters simply because the data sources do not show information in such formats that would enable the calculation of the parameters. This could be the prevailing reason for the lack of broad support to this reporting framework.

One of the ways to deal with this issue would be to make on international level a data base of national forestry reporting system, and to modify the parameters of indicators to a format which suits national reporting systems most fittingly. Another issue is the volume of information that the parameters of the indicators cover; if it would be possible to calculate all the parameters on a national level and to comment on them, the paper would fit a volume of a standalone report. Compiling this information on an international level requires compression and selection of data, which is evident from the respective documentation [2, 6], and this process introduces the issue of data viability.

Due to the nature of the policy cycle, this framework will most probably be revised in the same manner it was improved previously, and to become more and more closer to its full potential of operability.

Aside from these shortcomings, quantitative C&I for sustainable management of forest are a clear, though-through and internationally agreed upon system for reporting on forests that covers all the aspects of the sector, and whose logic and outputs are easily understandable to a broad filed of audience.

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Original scientific paper

Payments for environmental services (PES) in Croatia – public and professional perception and needs for adaptation

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Abstract

Background and purpose:
Croatia is one of the countries with a long practice of payments for environmental forests' services (PES). Following the implementation of green tax in Croatia and present European trends, the aim of this research is to investigate state of economic mechanisms and possible need for change or adaptation to the new trends.

Material and methods:
Primary data were collected by interviewing forestry professionals in charge of collection and distributions of green tax to gain an insight of their perception on importance of green tax, their comments on recent decrease in prescribed rate and what are the issues related to tax collection. Also very short telephone questionnaires were conducted with taxpayers to get an impression on how taxpayers perceive their obligation, their awareness of the purpose of this payment, their participation in discussion related to green tax and do they receive annual reports from Croatian Forest Ltd. company related to money collected and spent. Secondary data consisted of review of relevant literature, legislation overview and analysis of reports on collection and distribution of green tax provided by Croatian Forests Ltd. company.

Results and conclusion:
Collected amount of green tax grew constantly given the period 1993-2009. Important factor was increased monitoring of tax collection. Main problems with green tax were constant change of governmental decisions and lack of transparency of tax distribution. Green tax was perceived as burden by taxpayers and their knowledge of its purpose was general at best.
Transparency of tax distribution and better public relations by Croatian Forests Ltd. company could improve public acceptance of green tax.

Key words:
environmental services, green tax, implementation, perception, Croatia

INTRODUCTION

Forests are highly complex ecosystems contributing to society's welfare through their ecological functions. Ecosystem functions are considered by contemporary environmental and ecological economists as services. If something is declared as service, that means that the price or value is attached to it, and therefore it could be bought or sold. Maintaining forests in sustainable way is costly. Hence, prevailing stance is that somebody should pay for it.

The concept of ecosystem services was introduced in 1981 [1]. A term ecosystem services is interchangeably used with environmental services, ecological and nature's services.

The concept was mainstreamed in 1990s with expansion of valuation methods, with milestone paper by [2] on the value of global natural capital and ecosystem services, but gained policy importance when it was included in MEA Report [3]. In MEA framework emphasis was put on human dependency on environmental services and ecosystem functioning [4].

The original purpose of environmental services, i.e. of utilitarian approach to ecosystem functions in 1960s and 1970s, was to warn about increasing deterioration of natural resources and importance of biodiversity conservation [5, 1, 6].

In the last two decades some environmental services (e.g. carbon sequestration, watershed protection, provision of habitat for endangered species, landscape protection) were articulated in markets in order to provide economic incentives for conservation by employing PES (Paying for Environmental Services) and MES (Markets for Environmental Services) schemes [e.g. 7, 8, 9].

The most cited definition of PES says that PES is a voluntary transaction where a well-defined environmental service is being bought by at least one buyer, from at least one provider, but only if provider is able to secure provision [10]. Most literature refers to PES as market based or market-like mechanism. In reality only a few PES schemes meet these criteria, so the definition has recently been criticised for being too narrow and leaving out other schemes.

Muradian et al. provide broader definition where PES is defined as "a transfer of resources between social actors, which aims to create incentives to align individual and/or collective land use decisions with the social interest in the management of natural resources" [11, p. 1205].

Environmental taxes, as public financial mechanisms, have a long history. Results of the questionnaire developed in FORVALUE study showed that environmental taxes are most frequently used financial instruments in EU for non-market forest goods and services [12]. Advantages of these negative incentives are that simple forms of taxes are easy to administer and applicable for most forest benefits. On the other side simple taxes do not provide funds that are directly available for forest measures and could be perceived as burden by those who are obliged to pay [12].

In this paper the Croatian experience will be presented through collection of green tax, its distribution, issues related to tax collection, as well as perception of green tax by forestry professionals and taxpayers. The information presented in this paper works as a small preview of larger project that is proposed to Croatian Forests Ltd. company. Project will deal with PES in a way to provide policy recommendations for improvement related to payments for forest services and their perception by taxpayers.

MATERIAL AND METHODS

For the purpose of this article authors employed secondary data analysis comprising of literature and legislation overview, as well as analysis of reports on collection and distribution of green tax provided by Croatian Forests Ltd. company.

Interviews with forestry professionals in charge for collection and distributions of green tax were conducted to gain an insight of their perception on importance of green tax, their comments on recent decrease in prescribed rate and what are the issues related to tax collection.

Telephone interviews with taxpayers were conducted in a manner of very short questionnaire for the purpose of probing and not of getting representative sample. Therefore, telephone calls with numbers randomly acquired from telephone book were conducted to get an impression on how taxpayers perceive their obligation, their awareness of the purpose of this payment, their participation in discussion related to green tax and do they receive annual reports from Croatian Forest Ltd. company related to money collected and spent.

RESULTS

Environmental tax for forest services in Croatia

Forests are considered as resources of special importance for Republic of Croatia and therefore under state's special attention [13, article 2]. Forestry sector in Croatia understood importance of being a good master of these valuable natural resources long time ago, which led to almost 30 years long experience with paying for forest services.

Croatian forestry is characterised by high share of public forests (78%) and 43% (1.143.250 ha) of total amount of forests are forests on karst [14]. Forests on karst are highly valuable for providing forest functions but their management can not be financed only by wood selling, since income from wood from these forests is insignificant.

Forest Law [13, article 3] recognizes/identifies following forest services:

- soil protection from erosion caused by water or wind,
- water balance and prevention of floods and high water waves,
- water purification by filtration through forest soil and contributing to sources of potable water,
- positive impact on climate and agriculture,
- air purification,
- influence on landscape beauty,
- creating favourable conditions for human health,
- providing space for recreation,
- contributes to development of forest based tourism and hunting,
- secures gene fund of forest species,
- protection of diversity of species,
- ecosystems and landscapes,
- supporting general and special nature protection (national parks etc.) of forest landscape,
- mitigation of "greenhouse effect" by carbon sequestration and provision of oxygen,
- enhancement of human environment,
- protective function in a case of war operations and contribution for development of local communities."

Total value of forest services in Croatia was estimated according to methodology prescribed in Rulebook of Forest Management [15] to 43.40 billion euro [14, p 222]. Rulebook prescribes valuation method based on estimation of 10 elements [16].

In the 1980, while Croatia was still socialistic republic and part of Yugoslavia, forest service, the Republic and communities made a deal, based on Forest Law from 1977, to provide funding for afforestation, forest renewal and protection of forests against the fire for forests in karst areas [17], but it has not achieved expected effect [18]. Initial attempt to collect environmental tax for forest services dates in 1983 [19, articles 80, 81]. Aim of this fund was to secure money for forest regeneration and afforestation, in order to improve management of forests in karst areas. In karst areas productive function of forests is of secondary importance and forestry is not in position to finance forest reproduction from wood selling. Nevertheless, collecting has failed due to lack of monitoring [20].

After fall of Yugoslavia and establishment of democratic Republic of Croatia, new Forest Law [21, article 70] imposed obligatory payment for all economic subjects who are registered in Croatia, in amount of 0.07% of annual income for using forest services. Collection started in 1991 and money went straight to the special account of Public Forest Enterprise Croatian Forests, empowered by state for management of forest resources. Companies in charge of forest management, e.g. Croatian Forest, were excluded from this payment scheme until 2006. All of those obliged to pay do it quarterly based on annual income for previous year, and after the current year ends calculated difference between advance payment and actual tax based on actual income for that year.

In the meantime Public Forest Enterprise Croatian Forests has transformed into Limited Liability Company and new and the latest Forest Law has been brought. The latest Forest Law [13] did not brought significant change related to environmental tax, but after the amendment in 2006 entrepreneurs were excluded from this obligatory payment scheme [22], as a part of governmental scheme to support small entrepreneurship, which means that from that year on only legal subjects are paying this environmental tax.The most important change occurred very recently when Government decided to reduce the rate of environmental tax for 25%, from 0.07% to 0.0525% of annual income, starting with 1 July 2010 [23], as a part of anti-recession measures [24]. It is still too soon to foresee the impact of this change, but Croatian Forests Ltd. has already planned to reduce funding for mine sweeping and afforestation. Fund is managed by Department for Public Welfare Fund Programme at Croatian Forests Ltd. company. It is used for financing renewal of forests, forest protection, management of forests in karst areas, restoration of forests threatened by dieback and diseases, forest roads' building, mine sweeping, protection of gene diversity, establishment of clone plantations, forestry-based scientific work, forest management programs for private forest owners [13, article 64].

Croatian Forests Ltd. company is obliged to send annual report to Croatian Parliament on tax collection, its distribution, as well as planned distribution for next year.

Distribution of fund

In this section distribution of collected tax will be presented based on information provided by Croatian Forests Ltd. company. For some years numbers were not available, but numbers serve here for illustration.

Collected amount of green tax grew constantly given the period 1993-2009 for which data is available (Figure 1). Starting with year 2008 much more attention is paid for monitoring tax collection which is one possible explanation for its increase in comparison with years when collection was not monitored. The total amount spent for supporting forest services in each year does not have to coincide with amount collected for each year, because money not spent in a current year is transferred to next year. The peak in 2001 is result of concerted action by forest management company to enhance green tax collection [20].

TABLE 1
Share of green tax in 2009 according to economics activities (based on National Classification of Economic Activities, OG 58/2007) (source: Croatian Forests Ltd.)

Economic activity according to National Classification of Economic Activities (2007)		No.of econ. subjects	Share in 2009
A	Agriculture, Forestry and Fishery	2.312	2,6%
B	Minning	248	1,4%
C	Processing Industry	10.945	24,2%
D	Provision of electivity, ga, steam and air conditioning	191	4,3%
E	Provision of water, waste water disposial, water management and environmental sanation	515	1,1%
F	Constraction	12.151	10,0%
G	Trade; Repairment of motor vehicles	27.262	35,1%
H	Transport and warehousing	3.522	4,7%
I	Acommodation and food servicing	4.833	2,1%
J	Information and communications	3.576	4,8%
K	Financial acitvities and assurances	671	0,8%
L	Real estate	4.134	1,5%
M	Professional, scientific and tehnical services	12.926	4,6%
N	Administrative activities	3.262	1,3%
O	Public administration and defence; Mandatory social security	37	0,1%
P	Education	828	0,1%
Q	Healt and social service	917	0,3%
R	Art, entertrainment and recreation	791	0,6%
S	Other services	2.194	0,4%
T	Household help	2	0,0%
Total		91.320	100%

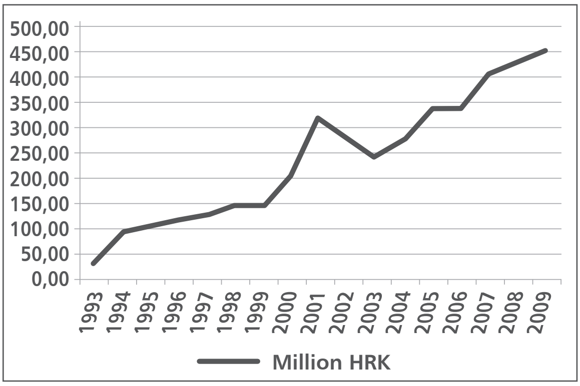

FIGURE 1
Green tax collection 1993-2009 in million HRK (1 HRK=0,137 € on 30 August 2010)

Trade sector, processing industry and construction had the biggest share in green tax collection in year 2009 (Table 1).

Biggest percentage of money is spent for financing activities of forest renewal, prescribed in article 28 of Forest Law [13]. Apart from green tax, these activities are financed by allocation of 3% from wood selling, from annual business plan of Croatian Forests Ltd. company and other sources [13, article 61].

So far Croatian Forests Ltd. company spent 160 million HRK (approx. 22 million €) for mine sweeping [25], but still a lot of forest area is out of reach due to mines. Company started with these activities in 2002 (Table 2).

TABLE 2
Money invested in mine sweeping including green tax (2002-2008) (source [25])

Year	m^2	HRK
2002	414.688	4.340.270
2003	626.230	3.144.518
2004	938.828	8.316.413
2005	1.999.398	20.460.251
2006	3.105.853	27.839.847
2007	3.827.770	44.298.010
2008	5.366.813	52.127.604
Total		160.526.913

According to Law on Fire Fighting [26] 5% of collected green tax is allocated for supporting fire departments in karst areas based on forest area covered by these fire departments. Fire is a big problem during summer months. Only in 2009 occurred 140 fires, of which 104 in karst area and causing in total 2.213 ha burnt area [27].

Problems with tax collection

Lack of control over tax collection caused that a great amount could not be collected, especially at the beginning of collection. The amount varied especially in the 1990s with seven time raise between 1993 and 2000 (Figure 1).

Governmental decision in 2006 to exclude entrepreneurs caused decrease in collected tax. Forestry professionals argue that this was not a valid criterion because a lot of eligible tax payers have low income, resulting in small amounts of green tax they have to pay. On the other side, entrepreneurs' incomes could be much higher, but according to Law they are excluded from payment scheme (personal communication).

In 2008 record amount of approx. 436 million HRK (approx. 60 million €) was collected, but due to economic recession expected decrease in income for 2009 was 17.5% [28]. Croatian Forests Ltd. company has intensified tax collection by sending reminders to tax payers and paying lawyers and public notaries to pursue those who avoid paying. In 2008 database of taxpayers were adapted to facilitate tax collection. These measures, even though causing additional costs, proved successful. Reminders were sent in 2009 to tax payers who owed in total 226.81 million HRK (approx. 31 million €) for the period between 2004 and 2009, what resulted in 39.4% of collected debts [27]. Still, some of the biggest debtors avoid paying (personal communication). Croatian Forest Ltd. company pays interests for money not spent in current year, and sometimes big payments are received in December. These payments are transferred to next year.

Perception of tax by professionals and tax payers

Forestry professionals argue that proposed amount is insufficient and poor compensation for all services forests provide (personal communication). Recent change in amount of tax that needs to be paid resulted in estimated loss of 100 million HRK (approx. 13.7 million €) (personal communication).

Since the beginning of environmental tax collection, it has been heavily criticized, especially by those who were obliged to pay it (e.g. Croatian Association of Employers). The tax was perceived as just one burden more on the back of some taxpayers, probably because it was imposed as obligatory and the prescribed rate was pure political decision (personal communication).

Contacted taxpayers, no matter how big they are or how big is amount they pay, perceive obligatory tax payment for forest services as unnecessary burden. Some are aware of importance of this payment for social welfare, but as a company they would prefer not to pay. Taxpayers' knowledge on purpose of this payment is general at best, and many do not know specific purpose of payment. Some are not even informed on recent tax reduction. They do not receive annual report on tax collection and distribution from forest management company or any other information related to how collected payment was spent. Interesting question is their opinion on participation in decision making related to payment for forest services. Majority expressed opinion that it is not necessary. Since this sample is not representative certainly it would be interesting to investigate this question further and obtain more relevant answers.

DISCUSSION AND CONCLUSIONS

Introduction of green tax in Croatia certainly contributed to preservation of forest resources given the money collected so far and its distribution. Nevertheless, there is still margin for improvement. Decisions related to green tax implementation were brought in non-participatory manner, i.e. solely by governmental directives. The prescribed amount was not based on valuation of forest resources, but was pure political decision. Therefore it is a reasonable question to ask is this fund enough to fulfil all aims it is meant for and to answer on questions of those who perceive this obligation as too high and somebody else's business. The process of selecting the financial mechanism comprises of following steps: identification of need to act and the demand for the forest good/service, identification of cause-effect relation between the forest and the good/service provided, identification of provider and beneficiary, valuation of the environmental good/service and selecting of financial mechanism [e.g. 29, 30]. It was not the case in implementation of Croatian green tax. Forestry sector is weak and unable to advocate for itself probably due to the fact that contribution of forestry sector to GDP in case of Croatia is only 1%. Lack of political power of forestry sector led to it facing some governmental decisions, brought without analysis on possible impact on forest resources or company in charge of their management. Croatian Forests Ltd. company has been a holder of FSC certificate since 2002 for all forest area the company is in charge for. Forest management according to FSC principles is more expensive than business as usual so it is easy to conclude that cost of forest management has increased.

The scariest fact is that latest report on tax collection and distribution, i.e. report for 2009, reveals significant forest acreage contaminated by mines from latest war (1991-1995). Almost 140 thousand ha is still contaminated, comprising 17.5 million m3 of wood out of reach. With current level of activities on mine sweeping it will take 300 years to decontaminate all area under suspicion. This is only one example in support of green tax in our case and its importance for entire society.

Efficient tax acquisition and monitoring of payment proved important in this case, even though it raises costs for Croatian Forests Ltd. company.

Transparency of tax distribution and better public relations could improve public acceptance of green tax, raise awareness of values of forest resources and important issues forestry sector is dealing with, like preservation of forests on karst and mine sweeping. Furthermore, it could tackle discussion about alternative and/or additional sources of funding for forest services.

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Original scientific paper

Opportunities and challenges for terrestrial carbon offsetting and marketing, with some implications for forestry in the UK

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Abstract

Background and purpose:
Climate change and its mitigation have become increasingly high profile issues since the late 1990s, with the potential of forestry in carbon sequestration a particular focus. The purpose of this paper is to outline the importance of socio-economic considerations in this area. Opportunities for forestry to sequester carbon and the role of terrestrial carbon uptake credits in climate change negotiations are addressed, together with the feasibility of bringing terrestrial carbon offsets into the regulatory emission trading scheme. The paper discusses whether or not significant carbon offsetting and trading will occur on a large scale in the UK or internationally.

Materials and methods:
The paper reviews the literature on the socio-economic aspects of climate change mitigation via forestry (including the authors' research on this topic) to assess the potential for carbon offsetting and trading, and the likely scale of action.

Results and conclusions:
We conclude that the development of appropriate socio-economic framework conditions (e.g. policies, tenure rights, including forest carbon ownership, and markets) and incentives for creating and trading terrestrial carbon credits are important in mitigating climate change through forestry projects, and we make suggestions for future research that would be required to support such developments.

Keywords:
forestry, climate policy, carbon sequestration, carbon trading, the Clean Development Mechanism

INTRODUCTION

Since the Kyoto Protocol of 1997, climate change has become one of the most important global environmental policy issues. Its various aspects have been widely discussed in the literature, and have been major items on the agendas of numerous international conferences and meetings.

In the light of recent international agreements on climate change, Annex I countries (developed and transition economies that are signatories to the Kyoto Protocol) are striving to reduce their greenhouse gas (GHG) emissions, and/or to remove CO_2 from the atmosphere. Since the Conference of the Parties (COP-7) in 2001, afforestation, reforestation and forest management have become eligible policy measures to address climate change. The Annex I countries are allowed to meet part of their targets through the use of Land Use, Land Use Change and Forestry (LULUCF) 'sinks'.

Each country has been allocated a number of tonnes of carbon sequestration that can be used to progress its emissions target through forestry. The Stern Review [1] increased awareness of the socio-economic aspects of climate change, placing scientific observations in a conventional economic framework. It showed that the extent to which the mitigative role of forests can be enhanced is mediated by externalities and uncertainties and is shaped by a range of market signals, policies and governance structures, as well as public attitudes and behaviour patterns.

The UK, in general, and Scotland in particular, have put in place some of the most far-reaching greenhouse gas reduction policies of any country in the world. Emissions reductions targets of 80% (of the 1990 baseline figure) by 2050 have been set for the UK as a whole in the 2008 Climate Change Act. These reductions were to be overseen by an independent monitoring body: the Committee for Climate Change. In Scotland, in the Climate Change (Scotland) Act (2009) a more robust definition of emissions is used and an interim target of 42% emissions reduction on the 1990 baseline is set for 2020. Progress towards the reduced emissions target is also guided by the UK Climate Change Committee [2].

The last decade has seen an upsurge in the number of papers addressing forestry and climate change in the UK. Some studies have focused on the physical potential in terms of climate change mitigation, addressing sequestration in trees and in timber products, or mitigation benefits offered by the use of wood as fuel [3, 4, 5, 6]. They show that UK forests contain 150 MtC (roughly a year of emissions) and have sequestered between 12 and 16 $MtCO_2$ per year since 1990. Timber products have also been shown as a significant carbon stock also contributing to reducing emissions, either as a substitute for fossil fuels (energy generation) or for carbon intensive materials (concrete, steel, aluminium). Other studies have focused on the economic dimension of carbon sequestration in forests [7, 8, 9, 10], estimating the costs of carbon sequestration and the social value of carbon sequestered in trees and timber products. These papers stress that socio-economic issues are important in determining the amount and type of land available for forestry development [11, 12, 13, 14]; that the main difficulties associated with the use of wood for energy and in wood products have been socio-economic [15]; and, further, that comparative indicators of the cost-effectiveness of climate change mitigation strategies are needed to achieve the carbon reduction targets at least cost [16]. The role of forestry in climate change mitigation is especially relevant in those regions that have good potential for forestry-based carbon sequestration activities, especially in Scotland within the UK, where consideration of biophysical conditions and of institutional and economic aspects of carbon offsetting merit special attention. This paper discusses the opportunities and challenges of forest-based carbon offsetting and trading, and the implications for carbon forestry from a UK perspective, and suggests future research that would be required to support the extension of such activity.

RURAL POLICY DIMENSIONS

In spite of the acceptance by governments that climate change is a serious problem [17, 18] and notwithstanding the interventions through mechanisms such as the Climate Challenge Fund and the efforts of the Turner Committee [19], Giddens [20] argues that there is currently no effective politics of climate change. It is certainly questionable whether there are appropriate governance mechanisms in place to support the development of the mitigative capacities of forests, both in the UK and elsewhere.

The optimum carbon offset forestry projects will likely be those which link long-term carbon capture and storage with long-term substitution opportunities (of low-embodied carbon products for high-embodied carbon products), and of using wood for fuel [4] capable of bridging existing gaps between rural development policy priorities and those of climate policy [17]. In remote rural areas with timber-growing possibilities, forestry development could generate win-win outcomes [21], providing benefits to the environment, people and the economy [22]. Because of the wide range of benefits it delivers to different stakeholders, multi-functional forestry, which has both carbon sequestering and other functions, is expected to be more popular than purely carbon and/or timber production oriented forests [23].

There is necessarily a difference, however, between the wider benefits provided by forests and the financial benefits that arise to forest developers. In the EU, intra-European credits from activities enhancing carbon sequestration are not included in the regulatory schemes [24]. Therefore, establishment of tree plantations for carbon sequestration, principally driven by grant aid, requires appropriate institutional settings, sources of investment and sound incentives. For example, as part of the Scottish Rural Development Programme, grant support will now be delivered through a number of options, both forestry-specific (e.g. short rotation timber plantations of willow or poplar) and non-specific (e.g. support for renewable energy projects relating to forestry), including those of carbon sequestration [25] To date the Mid-term Evaluation of the Scottish Rural Development Plan indicates 60 forestry challenge fund bids having been supported [26]. Carbon sequestration is only one of the purposes but was rated highly by respondents as a reason for adopting the forestry measures.

Forestry with carbon sequestration as a motive (and forestry more generally) is likely to be inhibited where high farm policy payments are capitalised into land values and where, if grant-aided farm woodland planting occurs, farm subsidies are lost to the occupier. In the UK, rural land use decisions are likely to have been shaped less by market signals and more by the distortions generated by public policy measures. There is evidence [25] that low rates of tree-planting have been in part a function of the subsidies to farming.

Moreover, it is not only in production support that grant aid can influence afforestation for carbon sequestration. Guyomard et al. [25] analyse the effects of agri-environmental policies on land allocation decisions and the effects of general tax and monetary policies on agricultural land prices, all of which have had a significant impact on forestry [26]. Rural policy and environmental drivers, e.g. the reform of CAP, will frame future possibilities [27].

There is evidence that forest and woodland development is related to landowners' willingness to take on forestry-based carbon credits rather than the biophysical possibilities for carbon capture and storage [28]. Therefore the diversity of forest owners' values must be acknowledged in new governance mechanisms [29]. Landowner preferences for carbon sequestration measures are likely to be influenced by institutional arrangements, by available information concerning potential profits, and by landowners' eligibility for grants. If forest-based activities are neither financially viable nor desired land management options, there can be little likelihood of large-scale carbon offsetting [30].

The complexity of landowners' motives to adopt forestry-based carbon credits, institutional and policy arrangements and potential for profitability require an improving of transparency, accountability, and equity in forestry within and among public sector, private sector, and civil society initiatives. Adger et al. [31] argue that governments could create deliberative processes, involving stakeholders who acknowledge different values, for implementing climate change mitigating measures.

There is a need for information campaigns, training facilities, pilot schemes and mutual learning, especially of the type that generates contagious (viral) diffusion processes, to demonstrate forestry sector-based opportunities for carbon sequestration, and make them attractive for forest land-owners and managers. It is important to consult people to get to know which climate policy alternatives are desirable for them, and why, as well as developing understanding of public perspectives on the role and place of forestry in mitigating climate change.

ECONOMICS OF CARBON SEQUESTRATION

Carbon sequestration through forestry is commonly considered: as cost-efficient [32]; synergistic (when incorporated in multifunctional forestry, it can co-deliver a variety of ecosystem services, providing concurrently economic incentives for sustainable forest management, [33]); technically feasible (most countries have a legacy of tree-growing); effective in the short term (providing an almost immediate effect after tree-planting); and a low resource/energy consuming climate policy measure. However, a meta-analysis of 68 studies to estimate carbon sequestration costs, with a total of 1047 observations worldwide, has identified huge variability of estimates of sequestration costs across countries. Van Kooten et al. [34] show that the costs of carbon sink in forests range from €35 – €199 per tonne of carbon and, when opportunity costs are taken into account, they range from €89 - €1069/tC. These costs suggest that by no means can all forestry be seen as cost-effective carbon sequestration.

To assess whether forestry development offers an economic opportunity for carbon sequestration, marginal costs per tonne of sequestered carbon have been computed across a number of countries [35, 36, 8, 23, 37]. This is explored in the McKinsey Report [38] by comparing marginal abatement costs. Research demonstrates that even if all carbon sink pools (i.e. carbon savings) are taken into account, it is unlikely that 'additional' forestry in an EU country will be a cost-effective means for mitigating climate change [39]. Tree-planting in Europe generally is costly, opportunity costs of land are high, and distant returns to forestry make the investment unprofitable [40]. Slangen et al. [41] and Pussinen et al. [42] show that the costs of carbon sequestration in EU forests seldom fall below €65 - €202/tC. However, despite high-cost estimates of carbon sink in some EU regions [40] large amounts of carbon may be sequestered by forestry at low costs elsewhere (e.g. in some regions in transition and developing countries, and even in some localities in Europe, including the UK [32, 43, 23].

The stock change approach has been used to estimate carbon capture and storage in UK forests, under the requirements of DEFRA [44]. The carbon sequestration costs appear to range from £30.5 per tonne of carbon (afforestation of sheep grazing areas) to £174.9 per tonne of carbon (agro-productive land) at a discount rate of 3.5% [10]. According to Global Atmosphere Division [45], average costs of carbon sequestration in the UK range from €72 - €116/tC. These estimates provide some evidence in support of prospective afforestation of some marginal land in the UK. However, large-scale afforestation is hardly an option in the UK at aggregate country level. The scope for carbon capture is thus likely to be concentrated on particular areas of land, where opportunity costs are lowest (e.g. lightly stocked hill farm land with low-carbon soils and high tree growth potential).

In the UK, it is clear that alleviation of climate change through carbon sequestration in forests is now a significant rationale [46, 47]. Given the extensive agricultural and sporting use and the prevalence of less favoured areas in Scotland, the opportunity costs of afforestation with respect to other productive rural land uses ought to be relatively low in this country compared to more fertile areas of the UK. However, much depends on the impact of forestry on soil carbon, as many less favoured areas are characterised by high carbon soils, and that carbon may be lost by ground preparation for afforestation. Additionally, where forestry delivers multiple ecosystem services in more densely peopled areas, the desire for permanent forest cover may be greater and fit well with multifunctional forestry. However, either option needs to be supported by appropriate policy frameworks. Further, to date there is little comprehensive and spatially explicit evidence on the value of carbon sequestration in the UK, let alone the wider values of other non-market ecosystem services, which might guide locational premia on grants for afforestation (for carbon sequestration or multiple forest benefits).

In forestry, many effects are long-lived, and growing forests provide some of their benefits far into the future. Mitigative capacity for forests in relation to climate change varies across the territory, and the aggregated costs are likely to increase over time. Tackling climate change, therefore, should include strategies that are pre-determined by long-term carbon stabilisation targets in the atmosphere, which take into account dynamic and scale effects, and which consider both potential damages from the changing climate and the co-benefits related to mitigation-adaptation linkages within rural land use. The choice of location for carbon sequestration projects, and of appropriate tree species and management regimes to be applied, are important factors in ascertaining cost effective climate policy actions [12].

In addition to the question of whether forestry offers a generally cost-efficient option for mitigation, it may be desirable to construct spatially explicit cost-benefit analysis (CBA) of climate policy scenarios for forestry-based projects. The scenario analysis could identify: (i) which options are economically sound; and (ii) which regions are likely to benefit most (or be most adversely affected) from forestry development. The basic forestry options that merit attention are: (1) carbon capture and storage in forests, (2) production of wood for energy, (3) wood products, and (4) tree-planting/growing for the provision of multiple ecosystem services, including sequestration, e.g. floodplain tree-planting.

Some of these scenarios have been economically assessed across several countries, including the UK [41, 8, 48, 12, 10]. However, the multifunctional nature of forestry requires careful scenario design that reflects the realistic possibilities for delivering multiple ecosystem services through well designed forestry projects at local and regional scales.

In England, for example, tree-planting for multiple purposes rather than solely for carbon sequestration commonly enlarges social benefits and helps to address potential conflicts relating to trade-offs, e.g. between biodiversity and carbon sequestration, or between landscape amenity values and those of climate change mitigation [49]. Although multi-functional forestry may result in lower rates of carbon sequestration, it is expected to be more attractive to people, because of the provision of multiple ecosystem services and contribution to sustainable development [24]. The answer as to whether it is pertinent to consider forest multi-functionality in a vertical sense (with each lot of land or forest stand fulfilling two or more functions, [50]), or horizontally (when “effective multiple use is merely organized and coordinated specialization” on different areas of land [51]) depends on the case and scale of observation and on the issue in question. The question then would arise as to the type of woodland we want to create, and where, and how it is to be managed to maximise the total ecosystem services output at lowest costs.

In addition to afforestation, it is also possible to increase carbon density at the stand level. This can be achieved by maintaining a permanent forest cover; increasing rotation lengths; minimising soil carbon losses; increasing growth rates; and managing drainage. However, lengthening of rotations reduces opportunities to use wood for energy generation and/or wood substitution for GHG-intensive materials [52, 10]. The effects of avoiding carbon release to the atmosphere through a continual cycle of forest harvesting, regeneration, and replacing carbon intensive materials and/or fossil fuels with wood, are repeatable, and locally, therefore, more sustainable. The social benefits of wood product and bio-energy scenarios in the long run are expected to be higher than those arising from the strategy of carbon fixation alone [30]. However, the rising demand for wood fuel and wood products could result in the increase in timber harvesting elsewhere, for example, in the tropics. Therefore, a holistic view, with consideration of displacement effects and of possible “leakages” is needed. Estimating the carbon sink must take into account the carbon debit from land use changes and timber harvesting, carbon stored in wood product sinks (not considered under the Kyoto Protocol), various carbon “leakages”, and additional carbon sequestered as a result of forest management.

In the UK, forestry projects for carbon sequestration combined with wood production and/or renewable energy strategies offer better opportunities for innovation, employment, development of markets and enhancement of rural economies than narrowly based carbon sequestration forests [13]. In some localities, short-rotation plantations for bioenergy might generate cost-effective emissions reductions [30]. However, it is important that measures for carbon sequestration in forests are considered within spatial planning; in relation to forest, agricultural and rural policies; and as part of measures for sustainable energy systems and sustainable rural development [24]. This will save costs, deliver cost-effective outcomes and assist in coping with environmental problems associated with climate change.

CARBON OFFSETTING AND MARKETING

The Kyoto Protocol flexibility mechanisms provide opportunities for countries to tackle climate change from an economic perspective [53]. However, it is unlikely that credit and permit (allowance) trading will occur on a large scale internationally, and even nationally [54]. While voluntary (e.g. not regulated through the Kyoto Protocol flexibility mechanisms) carbon offsetting and trading schemes involving forestry are spreading, "carbon trading so far appears ineffective in terms of actually reducing GHGs" [55]. Moreover, in future, countries are likely to have even fewer incentives than nowadays to commit themselves to international agreements, due to undefined yet potential damages/losses from climate change, and because of either unwillingness or inability of some countries to meet their emission reduction targets. Among the reasons for such failures is the proclivity of countries to rely primarily on administrative measures and voluntary actions, based on common values and norms, and on behavioural changes [30]. The administrative measures and voluntary actions are very important, indeed. However, consequently, the costs of climate change mitigation appear to be higher than they need to be, and these high costs reduce the efficiency of policy implementation, setting the stage for more difficult negotiations on emissions reduction in the future. Carbon trading presumes transfers of credits, allowances, permits and quotas, all of which have to be linked directly to GHG emissions reduction. It is important here to distinguish between permit trading and credit trading. Permit trading is where the authority sets an emissions quota and issues tradable permits for that amount (or sells them at auction). This is true cap-and-trade. Credit trading occurs when the government mandates that each emitter reduces emissions by a certain amount. Firms that reduce emissions below the required target point receive credits that can be sold to firms that cannot meet their targets. However, credit trading could result in countries satisfying the Kyoto Protocol but with growing emissions, e.g. when new firms enter the market as the economy expands. Credits might be created by carbon sequestration in terrestrial ecosystems and traded for emission reduction credits. The Kyoto Protocol therefore permits countries to achieve illusory emission reductions in ways that did not actually reduce GHG emissions [30].

The cap-and-trade system designed to reduce mitigation costs now includes carbon offsets from forestry [54]. However, under the regulatory scheme of the Clean Development Mechanisms (CDM), the share of forestry projects in total expected CERs (certified emission reductions) until 2012 comprises less than 1%. There are 17 such projects, compared to total number of over 2400 registered CDM projects [56]. Although the biophysical potential to sequester carbon through afforestation is high in some countries, the tree-planting activities are constrained by numerous internal economic, social and environmental factors in these countries (e.g. land use planning; economic development; or financial consideration). Further, the potential of regulatory carbon offset trading is limited to carbon balances, resulting from the eligible mitigation forestry projects subject to cap, as well as by the costs of GHG inventory preparation [53], and too high transaction costs.

The evidence on institutional considerations of terrestrial carbon offset trading is very complicated. European investors are clearly showing interest in investing in Joint Implementation (JI) and CDM projects. However, the potential gains from international projects are seldom seen as priorities for land use and climate policies in the host countries. Therefore, unless the necessary institutional infrastructure is developed and the barriers for investment are identified and addressed, the UK cannot expect to benefit widely from crediting JI and CDM systems. In order to utilise the potential of forests to contribute to mitigation of climate change effectively and efficiently, it is imperative to clarify international agreements and rules on forest carbon capture and storage accounting, to increase technical effectiveness and accuracy, and to develop further policies, tenure rights (e.g. forest carbon ownership), economic incentives, and where possible, carbon markets.

Regulatory trading schemes (as compared with voluntary markets) largely fail not because of lack of interest, but primarily from negative economic conditions (market and governance failures), including imperfect information and too high transaction costs [57]. "Corporate power also is shown to be a major force affecting emissions market operation and design. The potential for manipulation to achieve financial gain, while showing little regard for environmental or social consequences, is evident as markets have extended internationally and via trading offsets" [55]. An obstacle to emissions trading at international level is that many countries have low capacity in terms of social capital and institutions to develop effective market systems. Also, regulatory trading schemes address only a small proportion of potential global emissions and there is no effective international penalty for non-compliance.

Moreover, as shown by Van Kooten [30], the cap-and-trade system that includes carbon offsets from forestry faces challenges in the creation and acceptability of carbon trading exchanges. The costs per tonne of carbon removed must be compared with the costs of decreasing carbon stocks in the atmosphere in ways other than through forestry (e.g. through emission reductions). When CO_2 emissions are considered, the emissions cap is set at the same level as the emissions reduction target. In addition, where carbon offsets by forestry are concerned, a cap is not only required on emissions, but also on permissible offsets. Therefore, in the light of carbon trade negotiations, the conversion factor or exchange rate between emission reductions and carbon offsets needs to be set. Also, there is concern that countries have been given sink credits for ongoing activities, so that credits can be claimed even though there has been no additional carbon sequestration [30].

Carbon offsetting from forestry, and numerous problems with its inclusion into regulatory emission trading schemes, are caused largely by: the challenges of ensuring “additionality” and permanence of forestry projects; setting the level of baseline emissions; coping with “leakages” that may occur when the CO2 emissions which a project is meant to sequester are displaced beyond its boundaries; reliable measurement, assessment and monitoring of carbon sequestration and of the costs; concerns over double counting; acceptability of carbon trading; establishment of proper carbon offset certification and of its “conversion” into emission permits; assurance that actual carbon sequestration has taken place; development of both property rights and institutions for exchanging carbon offsets; and the legal aspects and verification of sustainable development requirements, particularly when CDM afforestation projects are concerned [57, 30, 14, 11].

Many of these challenges are also pertinent to voluntary carbon offsetting and marketing. However, the voluntary carbon market is less regulated and less costly. In the UK, the current focus is on implementing climate policy measures within its national boundaries. Therefore, the Kyoto Protocol cap-and-trade system is hardly applicable to the forestry sector. However, various carbon capture and storage projects that adapt voluntary carbon offsetting schemes are now performing successfully [58], including in the UK. The voluntary carbon market is becoming popular worldwide and comprises 37% of total voluntary transactions by the forestry sector [59]. The founders are government and non-government organisations (NGOs), businesses, and individuals. Projects include tree-planting and forest conservation, and in the majority of cases these offer cheap carbon savings [60]. However, evaluation and inclusion of carbon offset credits in a trading system remain difficult because of the difficulties in assessing and monitoring terrestrial carbon, due to its (usually) temporary and ephemeral nature [30], and for other already mentioned reasons. Discussions of opportunities and challenges pertaining to terrestrial carbon offsetting and marketing, both regulatory and voluntary [55], and to the mechanisms for assuring that the associated emissions reductions in forestry are relatively long-lived and are not double-counted by the countries, are available in the literature [57, 61, 62, 30, 63]. The temporary nature of terrestrial carbon, which is eventually released back into the atmosphere through wood decay or burning may be addressed through partial credits accounting for the perceived risk of carbon release; insurance coverage against the destruction or degradation of forest sinks; assurance that the temporary activity will be followed by one that results in permanent emission reductions (e.g. always through replanting after harvesting); and using a conversion factor to translate years of temporary carbon storage in forest into a permanent equivalent, etc. It is possible to cope with “leakages”, for example, by expanding the scope of the system to internalize “leakages” or to design the project so as to be “leakage”-neutralizing [57]. Some studies [30, 13] provide evidence that, although carbon capture and storage in a tree is carbon neutral in the long-run (at 0% discount rate for carbon uptake benefits), terrestrial carbon sequestration assists in delaying climate impacts and in avoiding and/ or reducing damage caused by global warming. Carbon sequestration forestry projects are particularly relevant, when represent a low-cost measure of coping with the changing climate and when offer multiple benefits. For doing this, carbon sequestration forestry projects need to be coherent, effective, cost-efficient, widely acceptable by the public, and consistent with other aspects of sustainable development policy.

New insights are needed into the connection between climate policies and strategies to promote sustainable forestry and to enhance integrated sustainable land use. Efficient and feasible forestry-based carbon sequestration initiatives need to be well embedded into existing policy areas, and if flexible mechanisms are implemented, then considerable scope exists for multifunctional land use systems and win-win solutions for sustainable regional development.

However, any assumption that forestry-based carbon sequestration is a universal remedy may discourage other efforts to address GHG emissions reductions [64, 55]. Terrestrial carbon offsetting does not always complement economic growth, and large-scale afforestation and short-rotation plantations may result in negative environmental and social consequences through other ecosystem services being compromised or reduced. These challenges are often further multiplied by a great number of institutional challenges and uncertainties associated with land/forest tenure and with property rights on carbon offsets, as well as with managerial aspects, particularly concerning large-scale afforestation and carbon trading. Changes in government policies, market fluctuations, and social norms and behaviour patterns contribute to uncertainties, and the extent to which the strategies can be justified on efficiency grounds also depends on the rate of discounting employed in the economic evaluation of forestry-based climate policy projects.

Among motivating research topics for socio-economists to consider are: who is responsible for carbon sequestration after the Kyoto Protocol commitment period of 2012; what is the value of (temporary) terrestrial carbon sinks, and how will this value change, as markets develop and institutions evolve to handle numerous uncertainty aspects affecting terrestrial carbon capture and storage. Further critical research questions relate to the relative weight of carbon sequestration in different regions where multifunctional forestry is practiced (in particular, spatially explicit cost-benefit modelling for multifunctional forestry) and to the policy design challenges that enable appropriate and cost-effective policies, low transaction costs and uptake of measures on appropriate land.

CONCLUSIONS AND DISCUSSION

Forestry contributes modestly to climate change mitigation, even though large amounts of carbon are locked up in forests. There are many uncertainties and challenges pertaining to carbon sequestration in forests. However, forestry-based projects have considerable relevance for national carbon budgeting in countries where wooded cover has potential to expand significantly. They are also important in the context of reducing collective carbon emissions at least cost by trading carbon offsets across countries. The prevailing vision is that carbon sequestration in forests is important as it may be a relatively low-cost option and, further, it postpones and reduces climate change, allowing time for adaptation, learning and technological innovation.

New forest development is an important carbon sequestration activity, especially when combined with substitution of wood for fossil fuels and construction materials (some of which may be particularly GHG-intensive). The current UK policy context acknowledges this potential and gives an important role to forestry in the search of cost efficient options to tackle climate change.

The UK Biomass Strategy [65] considers forestry as an important source of fuel for the future, for both heat and electricity generation purposes. This is reinforced in more recent, and also more general policy documents, like the UK low carbon transition plan [66] and the UK Renewable Energy Strategy [67]. Some incentive mechanisms are put in place, both on the supply side (e.g. the Carbon Code) and on the demand side. In Scotland, the Scottish Forestry Strategy [46] aims to increase the forest cover from 17% currently up to 25% by the second half of the century.

That is considered as an ambitious target as this would involve for Scotland the plantation of 650,000 hectares over the period (in the last decade, the afforestation rate in the UK was ca. 11,000 hectares per year [68]). A rationale for woodland expansion has been published by the Forestry Commission [69]. It justifies the Forestry Strategy (amongst other reasons) on the grounds of carbon sequestration in trees and also the substitution potential of timber products (fuels and wood materials).

The UK Climate Change Committee recently produced guidance for the Scottish Government [70] in which they highlight both new afforestation and more biomass heating as two key areas in the non-traded emissions with the potential to significantly reduce carbon emissions. They note in particular that 'Scotland has a particular advantage in access to local forestry for biomass and with rural homes off the mains gas grid that may currently have emissions-intensive heating systems.'

However, it is unlikely that the most effective type of forest from the perspective of carbon sequestration (like mono specific even aged conifers plantations or production of wood energy) will fit well with other environmental amenities. An interesting example of that relates to the afforestation of the Flow Country in Northern Scotland, in the late 1970s. Plantation of large areas of conifers (involving construction of drainage, soil preparation etc.) has caused the drying of the peat, and subsequently a loss of habitat for birds etc. To perpetuate the environmental amenities of these areas, some land has even been bought by RSPB (Royal Society for the Protection of Birds) and trees have been removed.

Further, the high non-market values of forestry for recreation, landscape and biodiversity in more densely populated areas makes multifunctional forestry with carbon sequestration a plausible option in areas such as those where community forests have been promoted in the UK. These policy options and the spatially variable suite of ecosystem services need to be analysed further. Accounting challenges for carbon storage in wood products need to be resolved. Incentives and mechanisms to combat deforestation in some regions of the world, particularly in the tropics, also need to be addressed.

The Kyoto flexibility mechanisms (e.g. CDM) provide opportunities for countries to improve the cost-effectiveness of climate change mitigation. However, our analysis indicates it is unlikely that either credit or permit (allowance) trading will occur on a large scale. The primary reasons are the unsupportive economic and market conditions, especially imperfect information and excessive transaction costs. The development of carbon trading systems involving forestry requires the solution of these problems and the reduction of transaction costs associated with terrestrial carbon offsetting and marketing. Concerns about overestimation of carbon sequestration through forestry development focus on the following considerations:

- Carbon sequestration in forestry is not equivalent to permanent emissions reduction. Often, terrestrial carbon sinks are relatively short-lived, and this makes it difficult to compare them with more permanent emission reductions (but the techniques to do so exist [30]).
- Wider use and promotion of offsetting may distract the attention of policy makers and practitioners away from emission reductions and from the development and application of novel means of climate change alleviation, including technological innovation. According to Spash [55] "...there is the potential for emissions trading to have undesirable ethical and psychological impacts and to crowd out voluntary actions...the focus on such markets is creating a distraction from the need for changing human behaviour, institutions and infrastructure". Identification of a baseline scenario and additionality of carbon sequestration activities is difficult, as is the avoidance of carbon "leakages" (e.g. displacement) and of double-counting.

Moreover, it is often unclear how to translate sustainability requirements for woody biomass production into rural policy guidelines; how to implement flexibility mechanisms for more effective and cost-efficient use of forestry opportunities to mitigate climate change; how to overcome market limitations and institutional obstacles for terrestrial carbon offsetting and trading; and how to develop incentive mechanisms and governance structures to implement carbon offsetting projects and make them acceptable/desirable to the different stakeholders. Another important matter is the question of scale. It is clear that, in the search for means to tackle climate change and to supply fossil fuel free energy, forestry has an important part to play. If the scope for large-scale afforestation is limited, the scope for smaller scale projects will also influence the range of forest types, as well as the goods and services they provide:

- at the regional scale, depending on the current intensity of land use and competition with agricultural activities, which will be affected by changes in the CAP;
- at the local scale to decentralise energy production (community forests for district heating, or public buildings such as schools and hospitals etc.); or provide amenity spaces (suburban forests).
- at the individual holding scale, planting trees on farms could become an "offset-generating" option if a cap-and-trade mechanism (or a tax) on GHG emissions was put in place. In this case, forestry would reduce the burden in farmers, as a carbon market without offsets would affect negatively farm profits [71]. Forests could also be used to generate energy on the farm, which should help farmers diversify their activities while reducing the reliance on fossil fuels.

However, norms, values and behaviours of key actors will influence the development of forestry. On the "supply side", there is often an innate resistance to forestry-based carbon sequestration by the farming community, and on the "demand side", for many people, there are advantages to having "clean" and easy energy systems based on gas or oil. Decisions to change behaviour patterns are also influenced by price and other economic incentives, e.g. subsidies, and other considerations (discussed in [13]). Behaviour may also be shaped by citizen values, and the drivers of change are thus many and varied. There is a need for "viral" social processes to help diffuse changes to help nurture low-carbon lifestyles. Currently, there is only modest evidence of these changes taking place. Voluntary offset schemes provide an example of individuals or organisations choosing to offset their carbon use, and there may be scope for greater citizen engagement if their interests are embodied in offset options on offer. It is evident that leadership and innovation have greatest effect where there are strong partnerships between the public sector, research organisations and private sector interests [72].

In the National Assessment of the potential of the UK forestry to mitigate climate change (known as the Read Report, [13]), the authors of the current paper extended the socio-economic analysis of climate change mitigation forestry options for the UK, emphasising the need to widen research on the cost-effectiveness of terrestrial carbon sequestration, as well as on carbon offsetting and marketing. Forestry will necessarily remain a legitimate object of attention with regard to land-based carbon sequestration, but until the technical, policy, institutional and behavioural obstacles are effectively addressed, progress is likely to be limited.

However, we consider that the opportunities for effective carbon sequestration in forestry may be considerable and cost effective in some parts of the UK (and other countries), especially when connected to a multifunctional vision of forestry that is properly supported by spatially explicit benefit models.

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Understanding social conflicts between forestry and nature protection sectors: case study Velebit Mountain

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Abstract

Background and purpose:
The last couple of decades brought significant changes in forest and nature protection policy worldwide. Rising environmental awareness, over-utilization of scarce natural resources and global climate change set high goals for the forest and nature protection policy makers. This paper is about a case study of relations among various stakeholders on Velebit Mountain, a coast-by mountain in Central Croatia. Velebit Mountain is both: a nature protection area and a forest exploitation site, which raises various conflicts between these two sectors and major stakeholders. Purpose of this research was to investigate the relations among various interest groups and coalition parties, their opinions, aspirations and interests and, especially, the way to resolve issues or manage conflicts.

Material and methods:
This case-study research was conducted in form of interviews held with the representatives of each of the defined stakeholder groups within the target area, i.e. Velebit Mountain Nature Park. Interviews consisted of several groups of questions (introductory part, conflicts, conflict management and policy development), while stakeholder groups included "Croatian Forests ltd.", a state-owned company in charge of the management of state forests, Nature Park Velebit, National Park Paklenica, National Park "Northern Velebit", hunters' associations, private forest owners, fishermen associations, representatives of the local administration and mountaineers' associations. The questionnaire consisted of open-ended questions regarding various issues divided into these four groups. The data was analyzed by using the NVivo qualitative data analysis software. Theoretical framework used in this research was Walker and Daniels' Social Conflict Theory (1997, p.13) which describes types of conflicts, ways to address them and typical sources of occurring conflicts.

Results and conclusions:
The results showed which the most salient conflict sources are, what are in stakeholders' opinions the most efficient means to manage them, what the best conflict management strategies would be and which are the best policy development options. As stated by the majority of stakeholders, the most salient conflict sources regard irregularities and lack of harmonization of laws, forest roads and entry gates, poaching and generally illegal hunters' activities, mountain paths and illegal logging. The interviewees stated that the most effective conflict management strategies are meetings, workshops, public debates and dissemination of information. Main policy development means are harmonization and implementation of laws, increased media attention, increased education and public awareness on the issues, public relations and increased cooperation among the stakeholders involved. Qualitative analysis of the coded text showed that the most emphasized aspects of conflicts regarded through the Walker & Daniels' conflict management triangle (1997, p. 22) are procedural (14 363 words), relational (8774 words), substantive (6 971 words) and cultural background (1 063 words). The most abundant aspect of conflicts is procedural, which means that the majority of conflicts pertain to the way issues are addressed. Most interviewees emphasized legislation and non-harmonization of laws as the most accentuated aspect of conflicts, meaning that the most parties have created relationships among themselves, are aware of the problems, but did not generate any concrete measures or ideas on how to manage them. The final conclusion can be made that there are no capacities on higher levels which actually have the executive and judicial power to alter things.

Key words: conflicts, forestry, nature protection, conflict management, legislation, stakeholders, Velebit Mountain.

INTRODUCTION

Until recently, social conflicts barely existed in the Croatian forestry sector. No major studies have been conducted in this field before the transition age. Environmental conflict-based sociological researches have been conducted in the past [1, 2], but seldom observed conflicts in forestry sector as a separate issue. The situation changed dramatically after the fall of Yugoslavia and the war that followed. Although the questions of nature protection, forestry and similar were put aside for the time being, nevertheless they emerged fiercely after the situation has calmed down and the conditions for conflict emergence were fulfilled. These conflicts were greatly encouraged by the global environmental awareness rising [3], increased importance of nature protection and the amount of protected areas and similar, followed by the major social changes such as increased depopulation and mortality rate in rural areas since the end of World War II (source: Croatian National Bureau of Statistics), decay of the agriculture sector and the most important contemporary phenomenon - globalization. The time for changes has come, and it is up to forest policy experts to manage it the best they can. The word "manage" is essential here, since it is the only legitimate way to deal with conflicts - it is a never-ending process of creation of the most suitable policy for conflict management with accentuation on integrative approach which includes all stakeholders in the decision creation [4]. As opposed to resolution or transformation, conflict management is the most suitable and the only applicable approach when it comes to complex conflicts which include multiple parties [5].

Velebit Mountain, a coastal mountain in mid-Croatia, was chosen for this case-study for several reasons

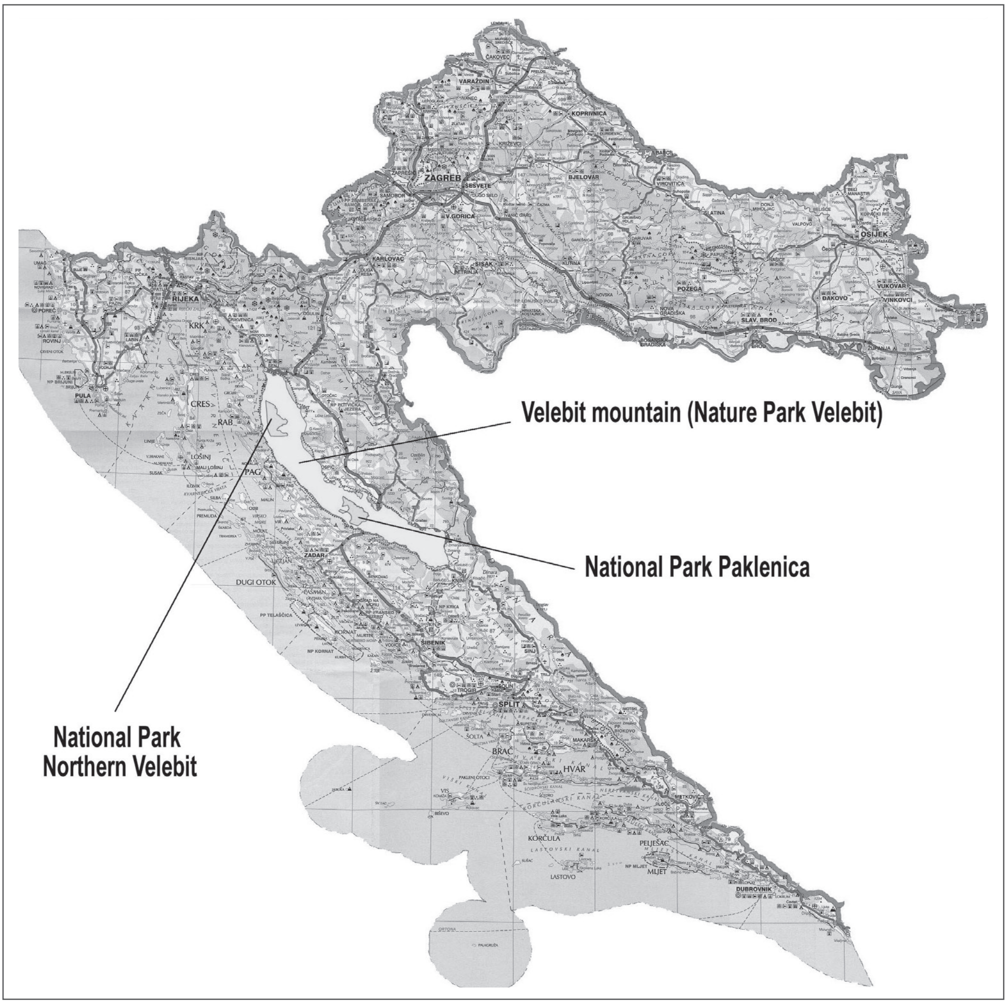

FIGURE 1
Position of Velebit mountain in Croatia

(Figure 1). It is a karst mountain, rich in biodiversity and geomorphologic phenomena, which embeds two national parks within its borders. It was proclaimed a UNESCO site in 1979, and in 1981 a nature park by the Croatian parliament. According to the Croatian legislation on protected areas, commercial activities (i.e. forestry) are allowed in nature parks. This creates a perfect environment for conflict emergence, since there are two parties which are basically in charge of the same area. Although national parks represent a higher protection level where no commercial activities are allowed, they are nevertheless a very important conflicting party. The most important parties involved in conflicts are Nature Park Velebit, public institution in charge of managing the Nature Park Velebit, and Croatian Forests ltd. The majority of other parties are somehow connected with these two, thus forming coalition groups (the national parks, mountaineers, environmental NGOs, hunters), or act as independent entities in the persuasion of their interests (private forest owners, fishermen, local authorities and similar).

The objective of this research was to get a clear, holistic picture of the social conflicts in the study area as well as to suggest future guidelines for policy makers. In its essence, this is an investigative, descriptive, explanatory case-study research. Preliminary insight into conflict relations in the forestry sector on Velebit mountain generated the following hypothesis: "The insufficiencies and problems in the implementation part of the conflict management process on Velebit Mountain are not due to lack of human capacities in the forestry, nature or any other inherent sector - they are, before all, due to lack of capacities in the country's political, decision-making structures".

MATHERIALS AND METHODS

This research was mainly based on Walker and Daniels' theory conflict dimensions triangle [6] broadened by Eeva Hellström's environmental conflicts framework [7]) which suggest that conflict management process consists of four basic elements: conflicts, culture, conflict management and policy development, whilst conflicts and conflict management process manifest in three dimensions: substance, procedure and relationship. These four major categories were used in order to analyze and interpret qualitative data acquired by a series of interviews within the study area. There are a number of reasons why case-study was chosen as the most appropriate research category for this particular purpose. All social research strategies are based upon three conditions:

1. The type of research question,
2. The control an investigator has over actual behavior events and
3. The focus on contemporary as opposed to historical phenomena [8].

Case-study is an in-depth, deep observation of a particular situation on a specific area, and its main goal is to understand complex social phenomena, which is exactly what conflicts are. It is typically oriented to questions "how" and "why", which are the basic questions of an explanatory purpose of a research. The main objective of this work is to describe and explain forestry and nature protection related social conflicts on the respective area.

The research was conducted through a series of interviews with the representatives of the most relevant parties within the study area. The questionnaire on which the interviews were based upon was created by the SPI project[1] working group, and was specifically designed to target the most emphasized sources of conflicts and to inquire on interviewees' stands, attitudes and opinions. The questionnaire was designed from semi-structured, half-opened questions which were divided into four groups:

1. Introductory questions about an interviewee (age, education, gender, specific function within the study area, main actors with whom the interviewee is concerned);
2. Questions on conflicts (regulations and legislation, most important tasks in respective institution, main conflict actors, opinions on human activities, opinions on forest exploitation etc.);
3. Questions on conflict management issues (how are the conflicts managed - dealing with present conflicts, future steps in management, need for conflict management tools, attitude towards conflict actors etc.);
4. Questions which regard forest policy (familiarity with laws, management plans, suggestions for improvement, policy instruments etc.).

Twenty-four interviews were conducted in the period from late August till mid September 2008 and form a majority of data for this research, together with internet forums, texts, news articles and informal conversations with a wide variety of local people with different cultural backgrounds and professions (Table 1).

The data acquired from filled questionnaires were processed with the qualitative data analysis software

1 - SPI - Science-Policy Interface - a regional project started in 2008 and conducted by the EFI and respective institutions in five Western Balkan countries: Albania, Croatia, Bosnia and Herzegovina, Serbia and Macedonia. The project was about comparative research of social conflicts in the forest sector.

TABLE 1
Basic information on the interviewees

STAKEHOLDER GROUP	Age	Education	Years on duty	Specific functions	Gender
PFE "Croatian Forests"	49	Bsc	4	Head of Forest District	M
PFE "Croatian Forests"	42	Bsc	10	Head of Forest District	M
PFE "Croatian Forests"	41	Bsc	3	Head of Forest Office	M
PFE "Croatian Forests"	33	Bsc	3	Head of Forest Office	M
PFE "Croatian Forests"	32	Bsc	2	Head of Forest Office	M
Natural Park Velebit	46	High school	6	Ranger	M
Natural Park Velebit	41	Msc	1	Senor advisor	F
Natural Park Velebit	37	Bsc	1	Head of Natural Park	M
Natural Park Velebit	34	High school	6	Head of Ranger Service	M
Natural Park Velebit	28	Academy	6	Ranger	M
Natural Park Velebit	25	Academy	5	Ranger	M
National Park Paklenica	46	PhD	13	Head of the Conservation Service	M
National Park Paklenica	31	Bsc	3	Head of Natural Park	F
National Park Paklenica	31	Bsc	5	Expert assistant	M
National Park Sj. Velebit	40	Bsc	3	Head of Natural Park	M
National Park Sj. Velebit	30	Bsc	1	Expert assistant	F
Hunters' Associations	47	High school	8	Head of a Hunters Association	M
Hunters' Associations	39	Bsc	3	Head of a Hunters Association	M
Private Forest Owners	56	High school	n/a	Head of a weather station	M
Private Forest Owners	46	High school	n/a	Private Forest Owners	M
Fishermen Associations	49	Bsc	8	Head of a Fishermen Association	M
Local Administration Rep.	55	Bsc	7	Head of the Physical Planning Dep.	M
Environmental NGO	38	Msc	8	Head of the environmental NGO	F
Mountaineers Associations	66	High school	10	Head of the Mountaineers' Society	M

NVivo, a useful tool in categorizing and organizing textual data. Text was coded and divided into multiple categories which were compared, linked, analyzed and organized graphically into models which pointed to contingent trends or phenomena. Nevertheless, the majority of the work was on the researcher, since the interpretation of qualitative data is before all a hermeneutical process [9]. No statistical analysis was conducted, since it is irrelevant in this type of research (qualitative).

Guided by Hellström's theoretical framework [7] about conflict management process, all interviewees' answers were distributed in four major categories - cultural background, substance, procedure and relationship. The answers were than coded and classified, according to which group did the interviewee belong to and what category does the answer fall into. According to Neuman [10], the work of a qualitative data analysis was conducted in five steps:

- Sorting and classifying
- Open coding
- Axial coding
- Selective coding
- Interpreting and elaborating.

The first step was to sort and classify data according to the interviewees' backgrounds, thus forming sets of the research, while each of the interviewees was also labeled with some basic personal data which represents a case of the research (default categories in the NVivo software). The next step in the research was to perform open coding, i.e. to divide all the text into four major categories. These four major groups form primary nodes in the research. The third step was to perform the so-called axial coding, which

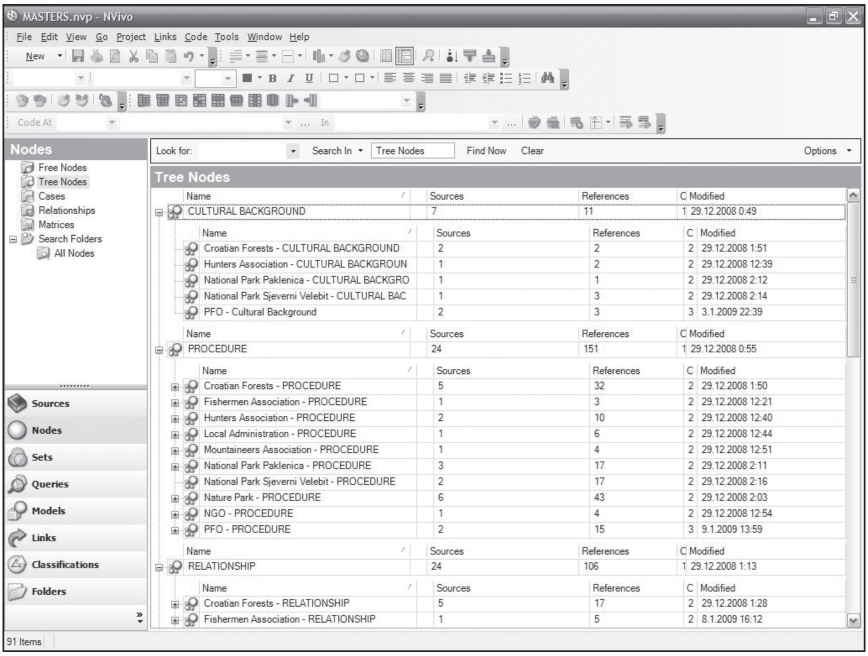

FIGURE 2
Tree nodes in NVivo

actually means to take the second pass through the primary nodes and sort this data according to groups or sets of stakeholders (interviewees). So, each of the primary nodes (cultural background, substance, procedure and relationship) was now divided into sub-categories according to groups of stakeholders. Such division is called tree nodes (Figure 2).

The last step was to perform the third pass over the coded data and seek for specific statements, opinions, attitudes or other verbal elements which illustrate certain themes, issues or topics, i.e. - a conflict. Some basic answers were analyzed as a whole, regardless to what group does a stakeholder belong to (for example, who are the most relevant actors or what is the relevant legislation), while all other groups of questions were analyzed with regard on the stakeholder group that provided them - these answers were additionally compared and analyzed, which provided the final results of the research.

RESULTS AND DISCUSSION

The analysis of interviews showed that there is a distinct difference between the two major conflict actors: Croatian Forests ltd. and Nature Park Velebit accompanied by the two national parks and the “Green Action” environmental NGO. It is indicative that the majority of interviewees from the state forest enterprise do not perceive the situation as one of conflict. The reason for this lies in a shared cultural background of a long tradition and conservative approach towards the forest management, dominant not only on Velebit Mountain but in the whole country. Foresters do not perceive their performance and forest road construction as conflict. Most of the problems Croatian Forests ltd. is dealing with are obtaining various permits and procedures for construction sites (mostly forest roads).

The nature protection coalition, however, emphasizes a number of conflictive and, in their opinion, quite serious issues like illegitimate and inappropriate road construction, overhunting and illegal construction sites (e.g. weekend houses with no construction permits, mountain lodges built with no respect on prescribed construction conditions and adherent permits, illegal quarries etc.).

Other, smaller stakeholders have in most cases joined one of the major parties. Hunters are, due to their common background, closely bound to foresters, while mountaineers stand against the allegedly bad performance of Croatian Forests ltd. within the protected area and are often quite radical in their attitudes (it is important to note that this stakeholder group mainly consists of lame persons, but their opinion is nevertheless accounted for). This attitude makes them the part of the nature protection coalition group [11].

The third group of stakeholders consists of neutral attitudes based on personal opinions and experiences - some PFOs[2] share foresters' traditional, conservative attitudes on forestry, while others pertain more to the nature protection issues and appreciate more the ecological and social functions of forests.

Hunters, mountaineers and PFOs are secondary parties in the conflict management process, while all other stakeholders (fishermen, local government) represent peripheral parties with no direct interest in conflict, but are nevertheless somehow connected with it. Due to too small a size of the sample, no correlation between age, time spent on duty and educational levels of the interviewees could have been investigated - a more comprehensive quantitative research can provide answers to these questions. The qualitative insight in the interviews provided some valuable information nevertheless. The most salient conflicts, as stated by all the interviewees, are laws, forest roads, illegal hunters' activities etc (Figure 3). two primary parties: foresters strive for intensive forest management and exploitation, whilst environmentalists fight to protect nature from the negative influences those roads could create, i.e. torrents, erosion, habitat splitting etc. Lesser group of conflicts consists of mountain paths, illegal logging and bad performance of some institutions (NP Northern Velebit and various inspections). Peripheral parties' perception of conflicts is the same as that of the major parties, except that their importance is much lesser. Individual opinions of each group clearly show that the irregularities and lack of harmonization among laws affect the nature protection sector much more than the forest one (foresters didn't even mention it).

When it comes to forest roads, conflict perception is ambiguous - while foresters consider forest roads an essential part of their work, nature conservationists are strongly against some of them. It is interesting to notion that the nature conservation coalition is not coherent in their attitudes towards this issue, since Nature Park Velebit is against the closure of roads due to negative impact on tourism, while National Park Northern Velebit strives for the closure of roads for unelaborated reasons. An interesting notion is that the National Park Paklenica, situated on the coastal side of the mountain,

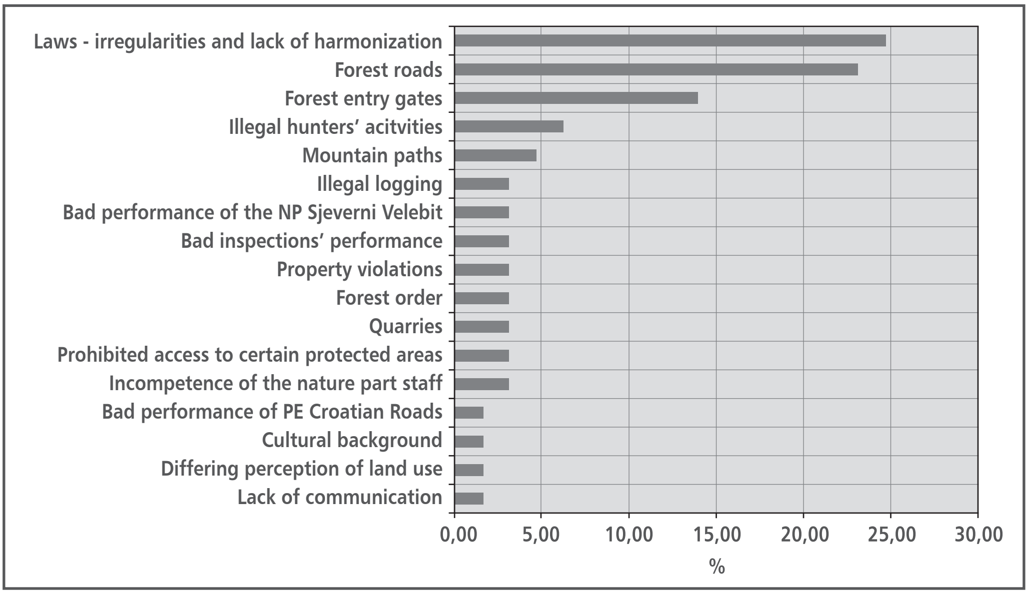

FIGURE 3
The most abundant conflicts as stated by all stakeholders

Most interviewees, regardless to the coalition group they belonged to, stated that the most salient conflicts were irregularities and lack of harmonization among and within laws, then follow forest roads, forest road gates and illegal hunters' activities (n.b. this is not the synonym for poaching). Forest roads seem to be the most conflicting issue between the

2 - Private forest owners

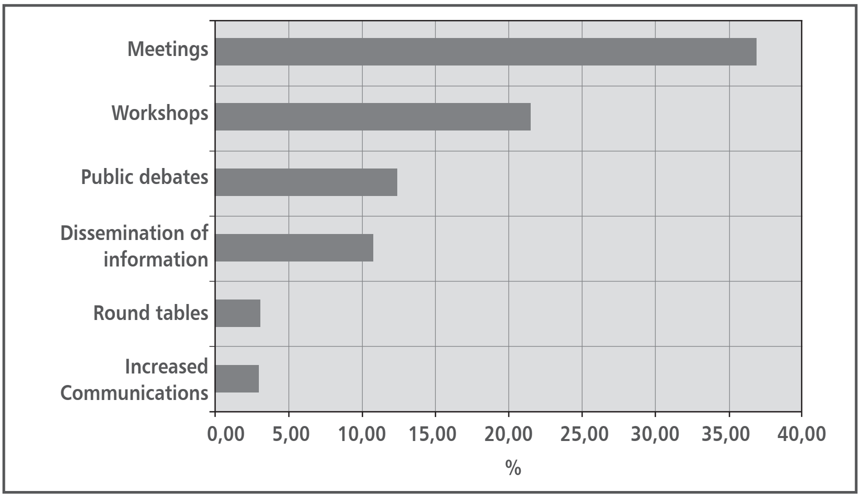

Figure 4
Main conflict management strategies as stated by all stakeholders

did not point out any conflicts with foresters. The reason is that it's mostly covered with degraded forests of flowering ash and pubescent oak where no commercial logging is performed - their main problem is with illegal hunters' activities. Croatian Forests ltd. could almost be considered a secondary party in this matter. Other, peripheral parties' major conflict sources are somehow always connected to the respective legislation (environmental impact assessment, inspections' jurisdictions, unclear articles of some laws etc.). When it comes to conflict management strategies, all interviewees more or less agree on several (Figure 4).

When compared to the latter chart, it is obvious that there are fewer items than in conflict sources - most parties stated more or less the same strategies, which shows that conflict management is either something they are not too familiar with or that their attitudes converge. The most frequent responses were meetings, workshops and public debates, regardless of the party or sector. All parties agree that collaboration is the most effective way of conflict management and that it should consist of meetings, workshops, public debates and increased communication in general. Minor parties at this point either seek a coalition partner, or choose the strategy of evasion or withdrawal [6]. For example, land owners who would rather give away their land instead of having to argue about it. Although it seems that the main conflict management strategy on Velebit Mountain is collaboration, this is not true. If Croatian Forests ltd. wanted to collaborate, it would have declared the existence of conflicts instead of obliterating them in majority of cases. The contemporary conflict management strategy on Velebit is, therefore, competition. If collaboration were at hand, all the conflict management strategies mentioned would have been applied, which is not the case so far.

Regarding policy development means, all parties provided more or less the same, broad answers, stating that they are not exactly sure what does the term mean. Most of the answers overlapped with those on conflict management strategies. The basic difference is that conflict management is the beginning of the Walker and Daniels's conflict management framework comprised of assessment, strategy and implementation [12].

Assessment showed that there are conflicts, some strategy was undertaken, but what clearly lacks in this case is the third part of the cycle - implementation. This actually means that the alleged cycle is not a cycle at all - policy development should have been the consequence of the ending of the first cycle (i.e. policies should have been improved) in order to mitigate conflicts and create pre-conditions for the second cycle of the conflict management framework. Apparently, it never happened. In other words - it is impossible to develop something that does not yet exist. This stage has obviously not been reached when it comes to forestry and nature protection related social conflicts on Velebit Mountain.

The analysis of text frequency among the four categories (cultural background, substance, relationship and procedure) showed that the procedural part of the conflict triangle is the most abundant one:

- cultural background - 1 063 words
- substance - 6 971 words
- relations - 8 774 words
- procedure - 14 363 words.

These figures were derived from the initial coding of the textual data. Procedural aspect of conflicts addresses the way conflicts are managed and decisions made, which means that the majority of conflicts pertain to the way issues are addressed. Most of the interviewees stated non-harmonization and non-implementation of laws as the most important conflict source, and that is the procedural issue - the ways how to address a conflict. Most interviewees stated that they are aware of problems, they did create certain relations among themselves, but most of them did not provide any concrete ideas on how to actually start the conflict management process. The conflict management triangle (substance - relationship - process) is embedded in a wider conflict management framework developed by Hellström [7], which consists of conflicts and their inherent dimensions (substance, relationship and processes), cultural background - an important component of this research, since forestry highly relies on its 250-years long tradition; conflict management strategies which are again connected to the three basic dimensions and, eventually, the whole process results with policy development measures. Policy development measures can be considered as an executive, implementation part of the procedural element in this triangle. The interviews showed that the absence of implementation of the enhanced, developed policy measures in conflict management is what halts the whole process.

CONCLUSIONS

In conclusion, it can be stated that the point of qualitative research is the hermeneutic approach [9] to the text analysis, which means drawing accurate conclusions based on the meaning of the text, i.e. the interviews. The conclusions were drawn by the use of the triangulation method - validation of data from several different sources [13]. Qualitative analysis showed eventually that there is a huge gap in communication between the executive and decision-making bodies within the nature protection sector, although certain changes in policy development have happened (joined supervision of road construction, jurisdiction of issuing permits shifted from government bodies to regional and local administration etc.). Policy development measures have to be initiated from the highest levels (ministries, CEO of Croatian Forests ltd.). It is pointless and useless to create policy development measures if there are no concrete changes afterwards. Apparently, Walker and Daniels's conflict management framework got stucked at the implementation phase. What's essential is the political will to change the situation and manage conflicts, which is lacking at the time.

According to the qualitative analysis of the data and interviews statements, the conclusion is that the preliminary hypothesis - "The insufficiencies and problems in the implementation part of the conflict management process on Velebit Mountain are not due to lack of human capacities in the forestry, nature or any other inherent sector - they are, before all, due to lack of capacities in the country's political, decision-making structures" - is confirmed.

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Preliminary communication

First results of monitoring of stand structure changes in unmanaged beech stands in NP Plitvice Lakes

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Abstract

Background and purpose:
It is possible to monitor and study the natural growth and development of the forest ecosystems in the example of protected forest stands, which were excluded from management, and which are not under a negative influence of human activity. Therefore the aim of the research through the repeated measurements is to estimate the stand structure development on the Medveđak permanent experimental plot in the Plitvice Lakes national park area. In this paper we presented the first preliminary results of established monitoring, i.e. comparison of results of stand structure elements between two measurements (1998 and 2008). Furthermore, obtained results were compared with data from growth-yield tables for common beech stands similar characteristics as researched stand. In this case data from growth-yield tables present managed pure beech stands.

Material and methods:
The permanent experimental plot was set in 1998 in the natural stand of mountain beech forest (Lamio orvale-Fagetum sylvaticae *Ht. 1938). It is in rectangular shape, dimensions 100×100m, with subplot 60×60 m and 30×30 m. The plot is founded according to the experimental plot setting methodology (Dubravac & Novotny, 1992 and Novotny, 1997) extended on the ICP Forest workgroup demand. Tree crown damage assessment was repeated in 2003, and in June 2008 another measurement of basic stand structural elements was done.*

Results and Conclusion:
The results in this paper show the development of the observed structural elements of the pure beech stand in the natural conditions without the management activities.
According to the results of stand structure development (shape of diameter distribution, number of trees, stand basal area and volume) and results obtained in other research at the same plot [9] (number, vitality and quality of beech young growth) it can be concluded that our stand is developing towards the optimum phase of the secondary virgin forest. Furthermore, obtained results show discrepancies in relation to managed pure beech stand from growth-yield tables.
Decrease in the number of trees, increase of the proportion of dead trees and proportion of significantly damaged trees in the monitoring period indicate the decrease of the stand vitality and health. Therefore, the question arises: Should protected forests today be absolutely left to the natural process of growth, development and dying? Since ten years is a brief period for research and conclusions about structural changes in the stand, further research efforts are necessary. They must be expanded with additional information and data from other permanent experimental plots which are also founded in other special purpose forests within project as well.

Key words:
common beech, protected forest ecosystems, growth and development, stand structure elements

INTRODUCTION

Last few decades we are globally witnessing an increasing technological development. One of the results of that process is also a negative influence on the natural resources. Since usually selfish run after "benefit", "development", "progress" and finally "profit" causes negative phenomena, our obligation is at least to try to harmonize ecological, social, economical, and other demands with the natural development of the forest ecosystems [1].

It is well known that many of the human activities endanger forest ecosystems. Specific feature of every single ecosystem is how it reacts and how big the endurance capacity on those problems is. The growth and development of some forest ecosystems are more measurable indicators of ecological and biological influence and relationship parameters as well as anthropological activities in and around them. Protected forest ecosystems are mostly not under a negative influence of human activity, therefore the development of the wildlife as well as any other features of those ecosystems occur in natural life conditions and represent a natural development. That is the reason why such ecosystems are so significant and suitable for scientific research [2-14]. With help of a continuous monitoring we have a privilege to monitor and study the natural growth and development and in that way come to certain conclusions about the natural development regularities as a potential goal.

In Croatia the development research of some structure elements in protected pure beech stands is best managed in the national park The Plitvice Lakes.

Due to its natural values, the exceptionality of flora and fauna in the harmony with geomorphological figures of sedra and travertine, and because of a large number of water springs, streams, lakes and waterfalls, because of its speciality and uniqueness, the area of The Plitvice Lakes was made a national park. The park was inscribed on the UNESCO world heritage list in 1979, in recognition of its outstanding natural beauty, sensitive for natural changes and direct human activity.

Organized forestry within today's area of the national park has begun during the period of the Military Frontier in 1746. The first data of forest management in Plitvice originate in 1883, when a management plan was established in German. In 1913 "Royal forest management" made a management plan where the whole area was divided into three economic categories (A, B, C). This groundwork regulated that the C- economic category including protection forest zone rules out any intervention in the forests [4].

Development of the forest ecosystems in Plitvice Lakes national park area was the object of research of many authors. After conducted typological researches in 1976, Hren [15] indicates that applied management method was not favorable for the regeneration of the stands. Cestar et al. established four forest reserves (1,347 ha) in the Plitvice Lakes national park from the 1976 to 1986, "Medveđak" in 1976 [16], "Čorkova uvala-Čudinka" in 1977 [17], "Kik-Visibaba" in 1979 and "Riječica-Javornik" in 1986 [18] with the aim of monitoring the development of forests in natural conditions in the national park. In 1984 Klepac suggested an active forest protection [3], and in 1994 recommended ecological forest management that should provide a permanent natural forest regeneration [4]. Lukić and Kružić (1992) researched development of common beech on the Medveđak permanent plot [19]. Krejči and Dubravac (2001) researched the conditions for natural forest regeneration [8]. Dubravac et al. (2004) studied development of structure and continued with researches of natural forest regeneration on two experimental plots in forest reserve Medveđak [9].

Permanent experimental plot in the national park area, that is, inside the "Medveđak" forest reservation, was founded in 1998 with the aim of researching in the "Forest Growth and Development for special means" multidisciplinary project. Project is conceived as a permanent monitoring of special purpose forests, which primarily include forests of national parks and nature parks. Beside from monitoring establishment, project objectives are also studying and analyzing growth and development of special purpose forests and researching of structural changes of those stands.

The basic hypothesis of this paper is that some changes occurred without an anthropological influence in a certain period of time, and that a tree as a unit, and a forest as a whole were growing in natural conditions. The aim of the research is to estimate the stand structure development within the natural development regularities of pure beech stand via repeated measurements on the permanent experimental plot.

In this paper we presented the first preliminary results of established monitoring, i.e. comparison of results of stand structure elements between two measurements (1998 and 2008). Comparison the data of first (1998) and second measurements (2008) gave inside into diameter and height growth, as well as volume and basal area increment during the last ten years.

MATERIAL AND METHODS

Forest reservation "Medveđak" is situated in the north east part of the national park "The Plitvice Lakes" and represents a part of a vast complex of beech forests. The whole area of the Plitvica Lakes is abundant mostly with the forest community of mountain beech forest [20].

A very important postulate in choosing a site for placing the permanent experimental plot was finding a stand of very homogenous ecological and structure characteristics, as well as beech density as a researched tree species above 0,8 which is classified to normal stands according to the Forestry management regulations [21]. According to Miletić [22] the stand structure, in the widest sense, is formed out of all elements that make wood mass and dispose it in space.

The plot is set in a natural mountain beech forest stand (Lamio orvale-Fagetum sylvaticae Ht. 1938), of the I-D-10 ecological management type. The plot coordinates are N = 44°53'09''E= 15°38'01'', with the 570 m altitude, and the terrain is rich with karst sinkholes. The stand represents the pure beech stand from seed with clumped tree formation. The single-layer stand has a uniform structure, full crown closure and medium quality (Figure 1, Figure 2B).

The permanent experimental plot was formed according to the experimental plot establishment methodology applied in the "Ecological- Economic Forest Type Valence" multidisciplinary project [23, 24], extended with the demands of the ICP forest workgroup about minimal size on which measuring and experimental taking can take place presented in horizontal plain.

FIGURE 1
Pure beech stand on permanent experimental plot "Medveđak"

The experimental plot is in rectangular shape with dimensions 100×100 m, and 60×60 m and 30×30 m subplots (Figure 2).

While placing the plot in 1998 every tree has been permanently tagged with a colour, which is, named with a number. Two mutually perpendicular

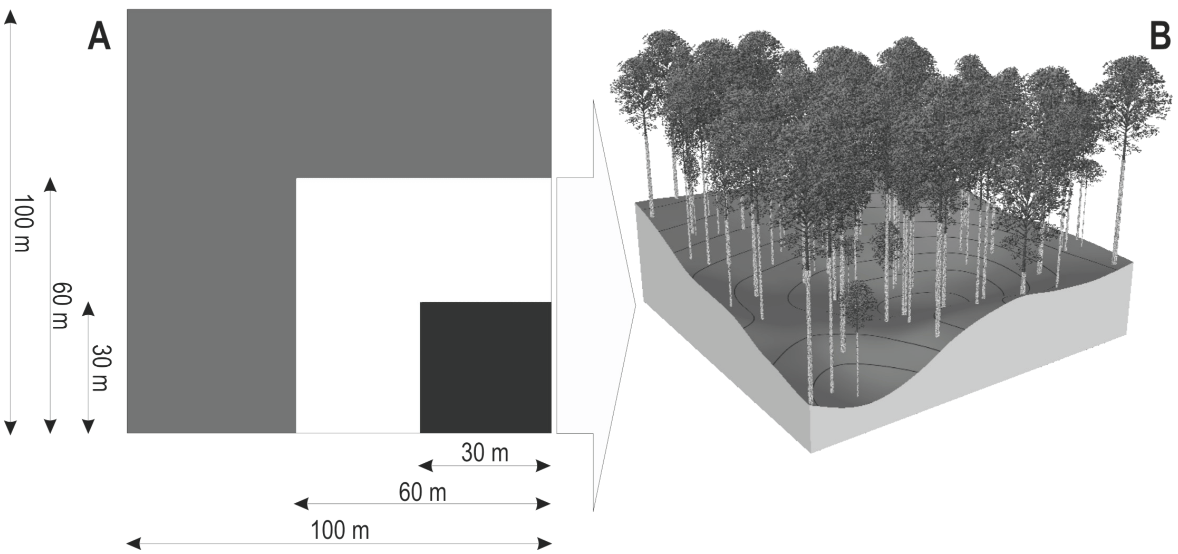

FIGURE 2
Shape and size of permanent experimental plot (A) and 3D visualization of stand on 60 x 60 m subplot in software EnVision (B)

diameters at breast height (dbh_1, dbh_2) were measured to all trees with diameter at breast height above 10 cm which gave the base for calculating the average diameter at breast height (dbh). The tree height (h) and stem height (h_d) were measured to every tree on the permanent experimental plot. Tree age was determined by counting the tree rings on three stumps in the diameter class of mean basal area tree and one stump per diameter classes above and below the diameter class of mean basal area tree. Stand age was then calculated as the arithmetic mean of those five tree ages. The tree crown damage assessment was made according to the method prescribed by ICP Forests. For the trees within the 60 x 60 m map of the crown projected areas was made, and the stand was visualized in the software package EnVision (USDA Forest Service) (Figure 2B). For the purpose of the stand visualization terrain was spatially modelled in ArcMap (ESRI) software using the terrain heights measured by LaserAce 300 measurement device.Tree crown damage assessment was repeated in 2003, and in June 2008 there was another measurement of the necessary stand elements (dbh_1, dbh_2, h) on the permanent experimental plot. Also, to every tree within the 60×60 m plot was given a position in the location. Azimuth was determined by a compass and the distance from the plot centre with a distance meter. This way one can get an insight in the spatial formation of trees on the subplot.

All field data of both measurements are registered in the Ecological Management Types of the Republic of Croatia data base [25]. Field data analysis, especially of the first and the second measurement, as well as registering the average diameter at breast height of every measured beech tree in a programme made by means of Excel 2000 professional programme package, produced a beech tree number distribution according to 5 cm thickness degrees. It also presents an overall distribution of tree numbers per hectare on the permanent experimental plot. By tree number distribution per hectare and a formula for basal area a distribution of beech basal area per hectare was obtained, that is, a distribution of the whole basal area per hectare. In order to obtain a volume distribution, i.e. beech volume per hectare, a tree volume tables were calculated for common beech on the experimental plot, both for the first and the second measurement.

The tables were constructed by parameters b_0 and b_1 of fitted height curves by the Mihajlov formula and a, b and c parameters for common beech from wood volume tables [26]. A tree volume as a diameter at breast height and tree height function is calculated by the Schumacher-Hall formula. Arithmetic mean($\bar{x}$), standard deviation (s), standard error ($s_{\bar{x}}$), variation coefficient (CV), and slantness coefficient ($ß_1$) and flatness coefficient ($ß_2$) as important biometrical indicators are calculated based on measured data for both measurements [24]. Obtained results were compared with data from growth-yield tables for common beech stands relevant to researched stand. In this case data from growth-yield tables present managed pure beech stands.

RESULTS AND DISCUSSION

According to the results of the tree analysis which were performed in 1998, the age of the mountain beech stand on the given permanent experimental plot in the foundation year is 147 years.

The Table 1 shows the total number of beech trees (N), basal area (G) and volume (V) per hectare on the experimental plot in 1998 and 2008.

Average diameter at breast height (dbh), tree height (h) and volume (v) in both measurements are shown in Table 2.

TABLE 1
Stand structure elements of first (1998) and second (2008) measurements

Measurement year	N	G	V
	N/ha	m^2/ha	m^3/ha
1998	301	43,11	656,41
2008	291	45,68	803,07

TABLE 2
Average values of diameter at breast height, basal aera and volume of beech trees of both measurements

Measurement year	dbh	h	g	v
	cm	m	m^2	m^3
1998	39,3	26,9	0,14	2,24
2008	41,1	31,7	0,16	2,47

Distribution of the total number of common beech trees per hectare arranged by 5 cm diameter degrees in the foundation year and in 2008 is shown in the Figure 3.

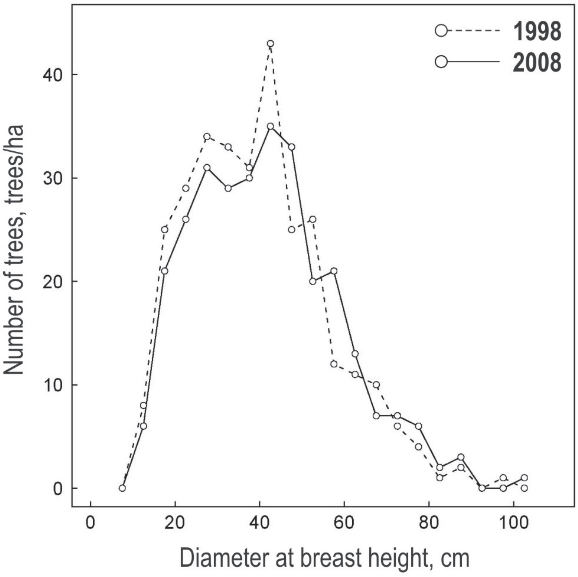

FIGURE 3
Diameter distributions of beech trees per hectare in both measurements

Stand height curves that represent stochastic dependence of the tree height by diameter at breast height (dbh) are fitted with Mihajlov formula and shown in the Figure 4. Parameters of fitted stand height curves for both measurements are shown in the Table 3.

TABLE 3
Stand structure elements for Common beech according to growth-yield tables [26]

Site quality	N	G	V
	N/ha	m^2/ha	m^3/ha
I	117	32,7	646
II	145	31,9	582
III	186	31,3	505
IV	223	29,6	413

Tree volume tables were calculated by b_0 and b_1 parameters of the fitted stand height curves with the Mihajlov formula and a, b and c parameters for

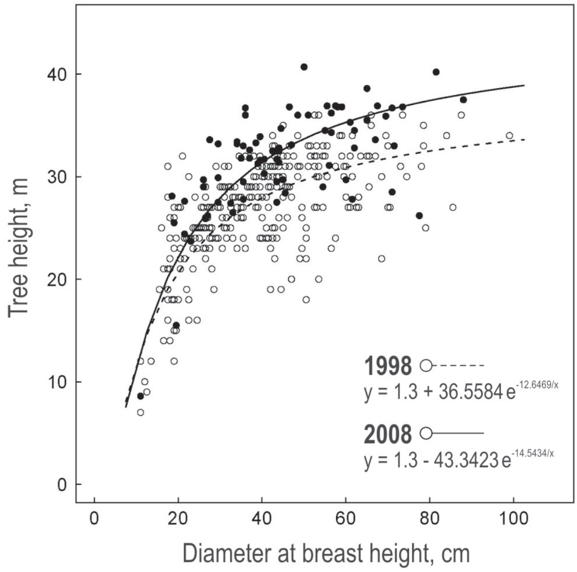

FIGURE 4
Stand height curves of common beech superimposed on measured tree heights in both measurements

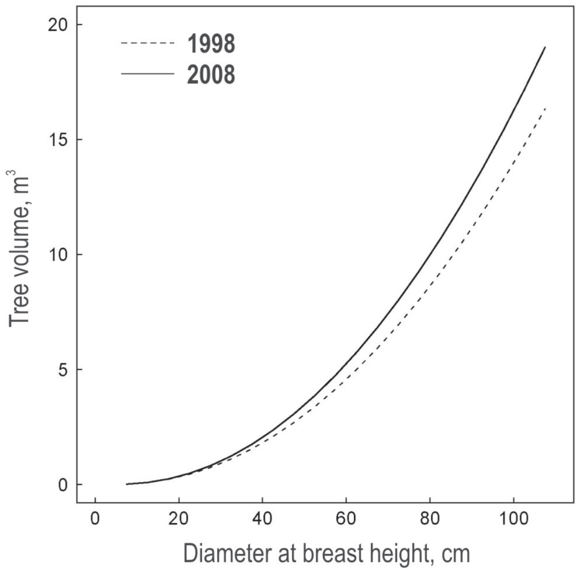

FIGURE 5
Tree volume tables in 1998 and 2008

Common beech according to Špiranec [26] were calculated by Schumacher-Hall formula and they are shown in the Figure 5.

Considering the stand age, a positive trend of diameter at breast height, tree height, basal area and tree volume development is expected as well as visible, both individually and summary. The tree

TABLE 5
Crown damage of a common beech on the monitored plot sample

Measurement year	Crown defoliation degree				Significance damage
	0-10 %	11-25 %	26-60 %	>60 %	(%)
1998	84,1	10,3	4,5	1,1	5,6
2003	67,0	15,9	6,8	10,3	17,1

number decrease is also both expected and logical in the given time. It results with also a logical positive shift of the observed elements stand height curves or tariff sequences. Therefore it can be said that diameter, height and volume increase is evident.

Comparing the values of the researched elements to the data from yield tables according to Špiranec [26] for a 157 year old beech with site quality from I to IV (Table 4), a significant deviation is visible. The differences in comparison of tree numbers, basal area and volume per hectare are significant, while the comparison differences of average diameter at breast height and medium stand tree height are smaller. At the same time the values of the diameter at breast height and the researched stand height are almost identical to the average values for the 159 year old beech on the IV site quality, according to Špiranec [26].

Observing the total volume (Table 1) as tree number function, diameter at breast height and tree height and its development as a time function, one can come to a conclusion that there is a large current annual volume increment (14,7 m^3/ha) as well as its increase percentage (2,23 %) considering the age of the researched stand.

Considering the fact that the role of the researched stand is not productive but protective, it is more interesting to observe the health condition and vitality. When the results obtained in this research are observed in that way, the conclusions are that in the period of the first as well as the second measurement, there are a too large number of trees and a large volume in the researched area. Therefore the obtained results, about the ground concealment with trees of 96% [8] and about the annual average 1 dead fallen tree and 3,6 dead trees (Figure 6) between two measurements are logical.

Comparing the initial status and the status after the second measurement based on the measured data, we get an insight about the participation of fallen and dead trees in reference to initial state. Decreasing in number of live trees and increased share of dead trees are most noticeable in the range of diameter degree from 17,5 cm to 42,5 cm, and these are trees that are beneath the canopy of dominant trees.

The confirmation of these data is visible also in crown damage analysis in the monitoring period from 1998 to 2003 (Table 5).

An increasing number of considerably damaged trees in a five year period, 5,6 % to 17,1% can be justified by a fact that those trees, to a higher extent, are under the crowns of the dominant trees [9]. Nevertheless the fact is surely concerning and alarming. Due to the competition among trees and without management activities and interventions, the trees die out in a natural process. In our research the case is the same, but it also emphasizes an undeniable fact that it significantly reduces vitality and health condition of the stand.

According to the results of stand structure development (shape of diameter distribution, number of trees, stand basal area and volume) and results obtained in other research at the same plot [9] (number, vitality and quality of beech young growth) it can be concluded that our stand is developing towards the optimum phase of the secondary virgin forest.

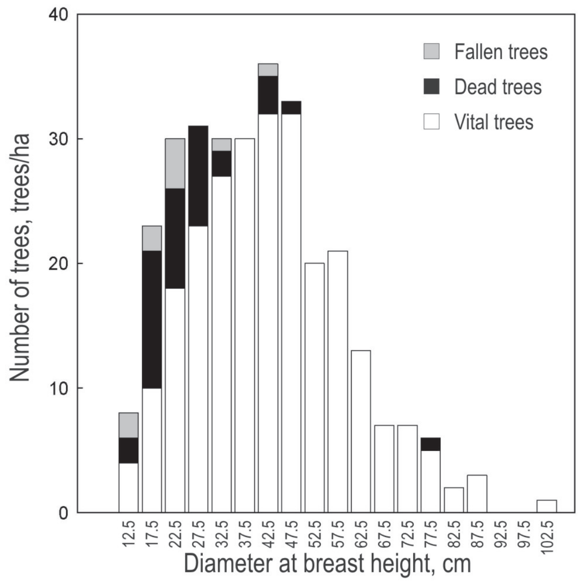

FIGURE 6
Number of dead and fallen trees in the total tree number between the two measurements

As already mentioned, Lukić and Kružić [19] also researched development of stand structural elements on permanent plot in pure beech stand in the forest reserve Medveđak. Results from first (1980) and second measurement (1988) showed no change of the unimodal character of the diameter distribution of beech trees. Furthermore, the number of trees decreased by 6,5% (29 trees), basal area was increased by 6,94% (3,16 m²/ha) and volume by 12,49% (60,62 m³/ha). Current annual volume increment of 7,58 m³/ha (1,56%) was found. Juriček [27] also found similar trends in the development of beech stand structural elements. From 1980 to 2004 the number of trees decreased by 25,89%, basal area was increased by 5,82 % and total volume by 31,96%. Current annual volume increment amounted to 9,08 m³/ha (Table 6).

Hren [15] conducted research in pure beech virgin forest in optimal phase in Ramino korito where he found even-aged structure in all researched stands. According to his research stand density varied from 371 to 524 trees per hectare, stand basal area was between 45,68 and 49,05 m²/ha, stand volume amounted from 486,91 to 654,89 m³/ha, and the Dbh of mean beech trees measured from 29,5 to 39,9 cm (Table 6).

Mešković [28] researched a stand structure of virgin beech forest "Mačen do" (BIH) in different development phases. Results for "early" and "late" optimum phases correspond well with the results obtained in our research (Table 6). Table 6 summarizes some of the published results from the research conducted in optimum phase of virgin beech forests in the SEE region, in the terms of stand density N, stand basal area G, stand volume V and stand current annual volume increment (i_V). For some of presented results their repeated measurements are also shown.

CONCLUSIONS

The research area is under a state and international protection. The development of the stand researched structure elements was observed as a time function in almost natural development conditions, with only small or none anthropogenic influence. According to the results of stand structure development (shape of diameter distribution, number of trees, stand basal area and volume) and results obtained in other research at the same plot [9] (number, vitality and quality of beech young growth) it can be concluded that our stand is developing towards the optimum phase of the secondary virgin forest.Comparing the obtained values of the researched structure stands elements to the data from yield tables for managed pure beech stands a significant deviation is visible. Since our researched stand is a special purpose forest whose function is primarily protective rather than productive, besides structural stands elements it is important to observe the health and vitality of stand as well. The

TABLE 6
Results of stand structure elements of research conducted in optimum phase of virgin forests

Reference	Research area	Measure-ment year	Develop-ment phase of virgin forest	Taxa-tion limit (>dbh)	N	G	V	i_V
				cm	trees/ha	m²/ha	m³/ha	m³/ha
[15]	Ramino korito	1972	Optimum	7,5	371 - 524	45,68 - 49,05	486,91 - 654,89	-
[19]	Medvjeđak_1	1990	Optimum	7,5	447	42,37	424,64	-
[19]	Medvjeđak_1	1998	Optimum	10	418	45,53	485,26	7,58
[27]	Medvjeđak_1	2004	Optimum	10	332	43,98	653,25	9,08
This research	Medvjeđak_2	1998	Optimum	10	301	43,11	656,41	-
This research	Medvjeđak_2	2008	Optimum	10	291	45,68	803,07	14,7
[28]	Mačen do	2003, 2004	Early optimum	5	546	43,60	635,67	9,08
[28]	Mačen do	2003, 2004	Late optimum	5	782	56,18	890,25	9,54

results observed in ten-year period show a decrease in the number of trees, increase the proportion of dead trees and increase proportion of significantly damaged trees which then indicate that vitality and health of the stand is significantly decreased.

Consequently we must ask ourselves: Should protected forests today be absolutely left to the natural process of growth, development and dying? There is surely an answer to that, and the task of the forest science especially, is to present it in the best interests of forest and people existence, and of the natural forest resource preservation with a help of future research results in that area. In the seeking of answers, continuous monitoring surely can help us. In this preliminary research monitoring was proved to be a good method for monitoring and analyzing the growth and development of special purpose forests. Since ten years is a brief period for research and draw conclusions about structural changes in the stand, especially because our observed stand is an old stand in which structural changes occur slowly, it is necessary to proceed with further continuous measurements.

Furthermore, research must be expanded with additional information and data from other permanent experimental plots which are also founded in other special purpose forests within project as well.

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