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Bundesforschungs- und Ausbildungszentrum
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Ziel: Das Centralblatt für das gesamte Forstwesen veröffentlicht wissenschaftliche Arbeiten aus den Bereichen Wald- und Holzwissen-schaften, Umwelt und Naturschutz, sowie der Waldökosystemforschung. Die Zeitschrift versteht sich als Bindeglied von Wissenschaftlern, Forstleuten und politischen Entscheidungsträgern. Daher sind wir auch gerne bereit, Überblicksbeiträge sowie Ergebnisse von Fallbeispielen sowie Sonderausgaben zu bestimmten aktuellen Themen zu veröffent-lichen. Englische Beiträge sind grundsätzlich erwünscht. Jeder Beitrag geht durch ein international übliches Begutachtungsverfahren.

Aims and scope: The Austrian Journal of Forest Science publishes scientific papers related to forest- and wood science, environmental science, natural protections as well as forest ecosystem research. An important scope of the journal is to bridge the gap between scientists, forest managers and policy decision makers. We are also interested in discussion papers, results of specific field studies and the publishing of special issues dealing with specific subjects. We are pleased to accept papers in both German and English. Every published article is peer-reviewed.

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Editorial

From May 9 to May 11 2016, the IUFRO unit 4.05.00 'Managerial economics and accounting' together with its sub-units 4.05.01 'Managerial, social and environmental accounting', 4.05.02 'Managerial economics' and 4.05.03 'Managerial economics and accounting in Latin America' held their annual conference entitled 'Advances and Challenges in Managerial Economics and Accounting' in Vienna, Austria. The event was hosted by the University of Natural Resources and Life Sciences, Vienna (BOKU) and brought together 41 participants from 17 countries. On behalf of the organizing committee and all the participants I would like to express once again our gratitude and appreciation to the members of the BOKU ForEc-Team Erhard Ungerböck, Philipp Toscani and especially Michaela Grötzer who ensured the smooth and convenient order of events. The scientific program comprised 7 sessions with a total of 29 oral and 2 poster presentations. A respective documentation is available at the conference webpage: *https://www.wiso.boku.ac.at/afo/tagungen-forst/iufro-symposium-2016/*

The program committee gratefully acknowledges the possibility to assemble a special issue of the Austrian Journal of Forest Science devoted to this event. Many thanks to the publisher as well as to chief editor Hubert Hasenauer! Thus, a substantial part of the topics presented and discussed at the conference can be communicated in more detail to a broader scientific audience. All of the manuscripts were peer-reviewed by two scientists, mostly members of the program committee. I am grateful to the authors and co-authors for their efforts as well as patience, to the reviewers for their input and comments and once again to Philipp Toscani for his invaluable assistance in the whole process.

The wide range of methods applied and topics addressed is typical for the great diversity which is maintained in this IUFRO unit. It fosters fruitful discussions and is appreciated for its inspiring character. Several of the contributions are located at the interface to the subject fields of other research units within division 4 ('Forest Assessment, Modelling and Management') but also located in divisions 3 ('Forest Operations Engineering and Management') and 9 ('Forest Policy and Economics') of IUFRO, thus highlighting the significance of problem-oriented, interdisciplinary research. Economic assessments in regard to timber production as well as the provision of non-wood goods and forest services are of great importance at company, regional, national but also global levels. Sound valuations have to tackle deficits in regard to data and knowledge as well as methodological challenges, in the financial and in the social sphere alike. The management of forests has to deal with a great diversity of settings, objectives, attitudes and perceptions. Future research in managerial economics and accounting seems especially promising in regard to the multifunctional use of forests and required adaptations in view of changing frame conditions. According to the heterogeneity of research issues a broad range of methods – quantitative as well as qualitative ones – have to be applied and refined. Thus, this special issue shall signify the final element of a successful conference and at the same time serve as stepping stone for future advances in science.

Walter Sekot
Guest Editor

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Comparison of the forest accounting system in Slovakia and IAS 41

Vergleich des forstlichen Buchführungssystems der Slowakei mit IAS 41

Blanka Giertliová*, Zuzana Dobšinská, Rastislav Šulek

Keywords: harmonization, accounting standards, IAS 41, forest enterprises

Schlüsselbegriffe: Harmonisierung, Buchführungsstandards, IAS41, Forstbetriebe

Summary

The harmonisation of financial accounting and reporting standards is seen as a means of facilitating the globalization of capital markets by enhancing investors' ability to make informed decisions regarding investment alternatives. By the comparison of the existing Slovak Republic accounting legislation with international accounting standards (IAS), a base for the assessment of the level of accounting harmonization process in Slovakia has been obtained. There are several companies that apply the International Financial Reporting Standards (IFRS), but none from the forest sector. Therefore, we focus on the information about biological assets presented in the fi-

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nancial statements of selected Slovak forest enterprises. The aim of this paper is to identify differences in the reporting of forest assets as part of biological assets in accordance with the Slovak national accounting system and international standards IAS/IFRS adjustments. The paper identifies the potential problems associated with the implementation of IAS 41 in the Slovak forest enterprises. The analysis of selected financial statements has shown the lack of information about biological assets, primarily the value of trees in a plantation forest. Therefore, the application of fair value in the valuation of biological assets seems to be a major barrier to the application of IAS 41 Agriculture in the practice of Slovak forest enterprises.

Zusammenfassung

Die Harmonisierung der Rechnungslegungs- und Berichtsstandards wird als Mittel zur Erleichterung der Globalisierung der Kapitalmärkte angesehen, indem die Anleger in die Lage versetzt werden, fundierte Entscheidungen über Investitionsalternativen zu treffen. Mit dem Vergleich der bestehenden Rechnungslegungsvorschriften der Slowakischen Republik mit internationalen Rechnungslegungsstandards (IFRS) wurde eine Grundlage für die Bewertung des Rechnungslegungsprozesses in der Slowakei geschaffen. Es gibt mehrere Unternehmen, die IFRS anwenden, aber keine aus dem Forstsektor. Daher konzentrieren wir uns auf die Informationen über biologische Vermögenswerte, die in den Jahresabschlüssen ausgewählter slowakischer Forstbetriebe dargestellt werden. Das Ziel dieser Arbeit ist es, Unterschiede in der Berichterstattung bezüglich der biologischen Vermögenswerte und der Waldproduktion nach dem slowakischen nationalen Buchführungssystem und internationalen Standards IAS/IFRS zu identifizieren. Der Beitrag identifiziert mögliche Probleme im Zusammenhang mit der Umsetzung von IAS 41 in den slowakischen Forstbetrieben. Die Analyse der ausgewählten Jahresabschlüsse zeigt, dass ein Mangel an Informationen über biologische Vermögenswerte, vor allem betreffend den Wert der Bäume in einem Wirtschaftswald, existiert. Daher scheint in der Praxis der slowakischen Forstbetriebe die Ermittlung des Zeitwertes bei der Bewertung von biologischen Vermögenswerten ein großes Hindernis für die Anwendung von IAS 41 zu sein.

1. Introduction

The harmonization of financial accounting and reporting standards is seen as a means of facilitating the globalization of capital markets by enhancing investors' ability to make informed decisions regarding investment alternatives. Any subsequent reduction in information asymmetry between preparers and users should be reflected in a lower cost of capital (Balman and Verrecchia, 1996). According to Horton et al (2013) more than 120 countries require or permit the use of International Financial

Reporting Standards (IFRS) by publicly listed companies on the basis of higher information quality and accounting comparability from IFRS application.

The content and form of external financial reports is regulated by accounting standards and, until recently, accounting standards have been the domain of national governments and accounting organizations within a particular country (Herbohn and Herbohn, 2006). The globalisation of capital markets commencing in the 1960ies and 1970ies however led to calls for the international financial reporting practices to be 'harmonised' (Henderson et al., 2013). In the 1990ies, the European Union began to realize the need for harmonization of accounting rules. However, it could neither use the existing European Directives (based on the large amount of permissible alternative accounting procedures), nor national regulations of other countries (e.g. US GAAP), since such a decision would limit EU institutions' actions in the case that these rules are contrary to their interests. The result was the decision that if the IASC was to achieve the declared EU objectives, the EU would consider the use of International Accounting Standards (IAS) for the preparation of financial statements in its Member States (Tumpach, 2006).

The legislative framework for the application of international accounting standards is a common regulation of the European Parliament and Council Regulation (EC) no.1606 / 2002 of 19 July 2002 on the application of international accounting standards. The regulation states that its purpose is to contribute to the cost-effective functioning of capital markets. Protecting investors and maintaining confidence in financial markets is also important.

Commission Regulation (EC) No. 1725/2003 of 29 September 2003, adopted certain international standards and interpretations on 14 September 2002 that were extant. In the following years, there have been several amendments to each accepted standard. For this reason, Commission Regulation (EC) No. 1126/2008, containing the text of all existing applicable accounting standards was enacted. Agriculture plays an essential role in the global economy but accounting for its activities has attracted less attention from researchers and accounting standard regulators until the International Accounting Standard (IAS) 41 – Agriculture was adopted (Herbohn and Herbohn, 2006). IAS 41 represents the starting point of a consistent transition from the purchase historic cost principle towards a fair value accounting (Lefter and Roman, 2007).

The Slovak Republic is a part of the ongoing globalization processes in the EU and worldwide. Its current economy is characterized as open with high foreign investments. Several major companies are using foreign capital, which makes the need for unification, and thus clarification of economic information as accounting outputs even more critical. The harmonization process of accounting standards in the Slovak Republic also concerns forest enterprises. There is the possibility to transfer from national to international accounting standards especially in the group of large forest enterprises. At present no studies exist that would analyse differences between the Slovak forest accounting system and IAS/IFRS, only studies aimed at the biological assets accounting in the Slovak Republic, but they focus only on the area of agriculture (e.g. Bohusova et al., 2011, Bednarova, 2012, Košovska et al., 2014). The aim of this paper is to outline the process of accounting legislation harmonization and the related use of international accounting standards in the Slovak Republic. It is focused on a specific area which is forestry. The paper approaches the process itself as well as the current harmonization level of Slovak accounting legislation in relation to the International Accounting Standards in general and then focuses on forestry, where the approach to the accounting for biological assets is analysed. The lack of research activities in the accounting of forestry in the Slovak republic, particularly in relation to the application of IAS/IFRS is the main reason, why the authors have selected that topic for research.

2. Material and Methods

Forests in Slovakia cover an area of 2170 thousand hectares, 40.9% of that is in state ownership (i.e., managed by state enterprises)[1] . The remainder is split between private holdings, municipalities, with relatively large areas owned by the church. Spatially, the 78% of Slovak forest belong to little-differentiated single storey stands. The European beech (Fagus sylvatica L.) is the most common forest tree species with 31.6% coverage. The next most common forest tree species are Norway spruce (Picea abies), oaks (Quercus spp.), pines (Pinus spp.) and silver fir (Abies alba) with the coverages of 25.5%, 10.7%, 7.0% and 4.1%, respectively.

State forestry administration is separated from state management organizations and performs administration and controls forest management. Slovakia has a long tradition of forestry and silviculture. Currently, there are several levels of forest management planning in the Slovak Republic. The most complex strategic national planning instrument is the National Forest Program SR at the political level. Lower level planning is represented by Forest Management Plans which are elaborated for forest management units (minimum forest area is 1000 hectares) for the period of 10 years[2]. Professional level of forest management is ensured by the Authorized Forest Manager who is a licensed individual guaranteeing expert treatment of forest property for the forest owner in accordance with the law (Sarvašová et al, 2014).

The research is based on the information obtained from the public sources, as from the Ministry of Finance of the Slovak Republic, Ministry of Agriculture and Rural development of the Slovak Republic, Statistical office of the Slovak Republic, and other public institutions and organizations.

To analyse the impact of Slovak legislation harmonization with IAS a comparative analysis of currently applied rules was used. The analysis was based on the documents that are presented in Table 1.

[1] Report on the status of forestry in the Slovak Republic of 2014 (Green report - 1st edn). Ministry of Agriculture and Rural Development of SR in cooperation with National Forest Centre Research Institute, Zvolen, Slovakia, pp.86

[2] All forest owners (users), regardless the area of forest land, are obliged to manage their forests according to a valid forest management plan.

Table 1: List of analysed acts and decrees

Tabelle 1: Liste der analysierten Gesetze und Verordnungen

Name	Short name (as hereafter referred to)	Short description
Act no. 431/2002 of the Coll. on accounting and its amendments[3]	Act on Accounting	General legal norm governing accounting - defines basic terms, states the obligations of accounting entities in accounting and presenting accounting information, defines accounting systems
Decree of the Ministry of Finance of the Slovak Republic No. 23054/2002-92 of 16 December 2002 and its amendments	Decree on Accounting Procedures for Entrepreneurs	lays down details of the accounting procedures and the framework for the chart of accounts for entrepreneurs maintaining accounts under the system of double entry bookkeeping
Decree of the Ministry of Finance of the Slovak Republic No. 4455/2003-92 and its amendments	Decree on Financial Statements	lays down details of the structure, description and content of items of individual financial statements and the extent of data contained in individual financial statements to be published by entrepreneurs maintaining accounts under the system of double entry bookkeeping
Act No. 595/2003 of the Coll. on Income tax and its amendments	Income Tax Act	regulates corporate income tax, define the provisions applicable to the determination of the tax base
Decree of the Ministry of Justice No. 492/2004 Coll. on Determination of General Property Value and its amendments	Decree on Determination of General Property Value	classifies particular methods of determination of a general property value (a property method, business method, combined method, liquidating method and a comparative method)
Commission Regulation (EC) No 1126/2008		adopts certain international accounting standards in accordance with Regulation (EC) No 1606/2002 of the European Parliament and of the Council, includes a consolidated text of all IAS/IFRS standards that EC had endorsed between 29 September 2003 and 15 October 2008.

Note to table 1:
[3] This Act has been amended 29 times, important amendments to its scope and importance are: Act no. 561/2004 of the Coll., Act no. 198/2007 of the Coll., Act no. 333/2014 of the Coll.

The second part of the paper is represented by the analysis of accounting methods applied for biological assets in Slovak forest enterprises. For the analysis accounting outputs of the most significant entities operating in forestry were used. The accounting outputs consisted of the financial statements (balance sheet, income statement and notes), annual reports and auditor's report for the time period from 2010 to 2015. The structure of analysed enterprises is presented in Table 2. The aim of the analysis was to evaluate applied methods of financial statements creation and their eventual changes in the reporting period. We focus on the identification of biological assets components that are forestland, forest stand, resp. wood stock in forest stand. The time frame for the analysis was selected to reflect main changes in Slovak legislation seeking to approximate the international standards.

Forest enterprises for the analysis were selected in order to present a representative selection set covering the different legal forms of enterprises, ownership structure and their main source of income that was forestry. The results of the analysis are presented in chapter 3.2.

The information obtained was further supplemented by personal interviews with selected employees responsible for accounting. In total 12 interviews were undertaken. The questions asked were:

• How do you determine the value of forestland in your financial statements?

• Do you update (revalue) the value of forestland? If yes, how often and based on which circumstances (e.g. change in land use, change in market prices, etc.).

• Do you keep records in your accounting about the biological assets value – standing forest stands?

• If yes, in which manner? How do you value this asset? Do you update (revalue) its value?

Information obtained from the interviews was complemented by the analysis of accounting reports and are presented in chapter 3.2.

The analysis focused on:

• Biological assets identification and recognition in the financial statements

• Biological assets measurement

• Identification of the main differences between the current state and IAS 41

Table 2 :Analysed forest enterprises

Tabelle 2: Untersuchte Forstbetriebe

Slovak name	English equivalent	Managed area of forest land in ha
LESY SR, š.p.	Forests of the Slovak republic, state enterprise	893 017
Vojenské lesy a majetky SR, š.p.	Military forests and assets, state enterprise	65 431
Mestské lesy Košice, a. s.	Municipal forest Košice, inc.	19 432
Mestské lesy Kremnica, s.r.o.	Municipal forest Kremnica, ltd.	9 702
GELNICKÉ LESY, s.r.o.	Gelnica Forests, ltd.	4 640
Lesný podnik mesta Zvolen, s. r. o.	Forest enterprise of the city Zvolen, ltd,	1 560
WH Danubius s.r.o.*	WH Danubius ltd.	3 000
Lesné hospodárstvo Inovec, s.r.o.	Forest Economy Inovec, ltd.	2 234
PRO POPULO Poprad, s.r.o.	PRO POPULO Poprad, ltd.	12 900
Vysokoškolský lesnícky podnik vo Zvolene	Forest Enterprise of the Technical University in Zvolen	9 724

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3. Results

3.1. Harmonization of Slovak accounting legislation

An important step in the approximation of Slovak legislation with EU law (the Fourth and Seventh Council Directive of the European Community), creating the conditions for the application of IAS/IFRS, was the adoption of Act on Accounting in 2002. The law contains for the first time definitions of basic terms used in accounting requirements based on IAS/IFRS, adjusted to meet the demands of accounting entities in Slovakia and suitable for the preparation of consolidated financial statements.

On 9 September 2004 the National Council adopted an amendment to the act on accounting which came into effect on the 1st January 2005. The Act introduced application of true and fair view principles - accounting entities are required to account for transactions so that the financial statements give a true and fair view of the entity's underlying substance and financial situation. Financial reporting is true if the content of the financial statements corresponds to reality and is in accordance with established accounting policies and methods. Financial reporting is fair if the applied accounting policies and methods lead to a fair presentation of the underlying substance in the financial statements. The accounting period is no more only calendar year but also a financial year. Financial year is defined as a period of 12 successive calendar months, not necessarily identical with the calendar year. The Act introduced the materiality concept for information in the financial statements - information in the financial statements must be useful to their user, is judged based on materiality, and must be understandable, comparable and reliable. Assets, liabilities, revenues and costs or expenses are defined similar to IAS. These basic terms were not defined before. Classification was based on a decision of the entity or in accordance with the present Decree on Accounting Procedures for Entrepreneurs. Notes have become an integral part of financial statements; their importance was reinforced. The act introduced for the first time that certain accounting entities, called "big accounting units", are obliged to compile individual financial statements in accordance with International Financial Reporting Standards. Big accounting units are those who meet at least two of following requirements in at least two consecutive accounting periods:

• The total amount of assets exceeded 165 969 594,40 €, where the amount of assets is present in the balance sheet in valuation not adjusted by items according to § 26 (3) of Act on Accounting,

• Net sales exceeded 165 969 594,40 €,

• Average recalculated number of employees in one accounting period exceeded 2 000.

Such individual financial statements had to be elaborated for the first time in the accounting period beginning on 1st January 2006.

Another important "harmonization" amendment to the Act on Accounting is Act no. 198/2007 of the Coll. Most of the provisions of the amendment came into force on 1st January 2008. In relation to the accounting entities obliged to prepare individual financial statements according to IAS/IFRS, there was only the extension to Slovak Railways. With this change in legislation the state enterprise 'Forests of the Slovak Republic' become the last large enterprise with state ownership that is not obliged to implement IAS/IFRS.

The harmonization process of Slovak accounting standards is not yet completed. The analysed Act on Accounting was since its first approval in 2002 amended a total of 29 times. From the last amendments from 2014, the accounting practice draws a distinction between entities in size classes as to the required level of information to be reported in the financial statements. New, simplified financial statements for the so-called micro entities (e.g. the balance sheet has 45 lines instead of 145) were introduced. One of the benefits is also extending the application of fair value which brought the Slovak accounting standards again closer to IAS/IFRS.

Despite the long term efforts of the Slovak Republic to move closer to international standards, some differences between the two accounting systems still exist. The main differences are presented in Table 3.

Table 3: Main differences between Slovak Accounting Standards and IAS/IFRS

Tabelle 3: Hauptunterschiede zwischen dem forstlichen Buchführungssystem der Slowakei und IAS/IFRS

Slovak Accounting Standards	IAS/IFRS
Legislation established accounting procedures and the content and form of financial statement	Not limited to a particular legal framework, they do not prescribe specific formats for financial statements
3 components of the financial statements (balance sheet, income statement, notes)	4 components of the financial statements (balance sheet, income statement, cash flow statement, statement of changes in equity)
Different reporting of income tax	
There is a growing emphasis on fair value, although not yet in such extent as in IFRS.	Focus on fair value measurements

3.2. Forest accounting in the Slovak Republic

According to the Slovak legislation, forest enterprises have to choose between Slovak accounting standards and IAS/IFRS.

Several IAS/IFRS standards apply for forestry (e.g., IAS 16 in the case of land related to forestry activity, IAS 38 for intangible assets, IAS 20 in the case of state subsidies). However, the dominant position is occupied by IAS 41 Agriculture. This standard determines the recognition of biological assets, agricultural produce at the point of harvest and agricultural government grants. Biological assets include living animals or plants such as sheep, trees in a plantation forests, dairy cattle, fruit trees, etc.. IAS 41 defines the agricultural production as the product obtained from an entity's biological asset during harvest; and the agricultural activity as the management by the entity of the biological transformation process of living animals or plants (biological assets) up to their sale as agricultural produce or subsequent biological assets. According to this international standard, biological asset or agricultural produce at the point of harvest shall be recognized when the entity controls the asset as a result of past events, it is probable that future economic benefits associated with the asset will flow to the entity and the fair value or cost of the asset can be measured reliably. As presented in Figure 1, the application of the standard depends on the type of activities carried out by the entity.

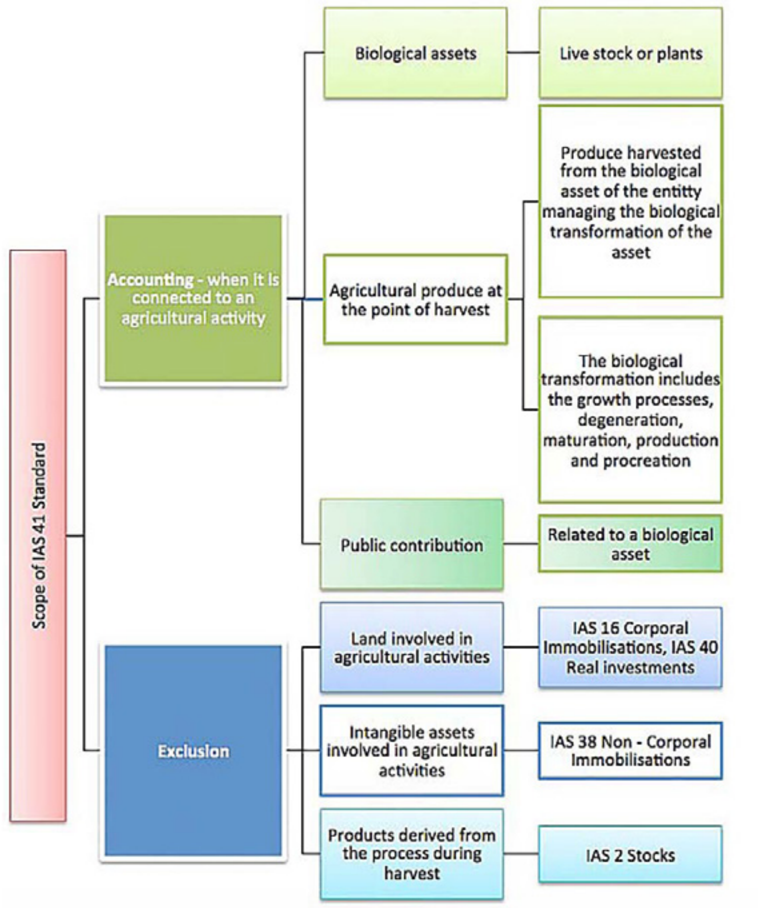

Figure 1: Scope of the IAS 41 standard (adapted from Mates et al., 2015)

Abbildung 1: Der Anwendungsbereich von IAS 41 (verändert nach Mates et al., 2015)

Standard IAS 41 Agriculture introduces fair value valuation of the biological assets in forest enterprises. According to this value, biological assets are valued at first recording and subsequently always at the date of financial statement elaboration. Fair value is reduced by the estimated costs of sale (selling costs)[4]. As a basis for fair value estimation the standard enables to use[5]:

• quoted price on active market – commodity and crop stock market (priority),

• last transaction price, if there have not been rapid economic changes,

• market prices of similar assets, for example for the trees planted in the forest and which are physically attached to land cannot be a separate market, but there may exist a market for the combined assets, that is, for the trees in the forest, raw land, and land improvements, as a package. The company may use information regarding the combined assets to determine fair value for standing timber, for example, to distinguish the value of land from the total forest property thus obtaining the true value of the standing timber. The entity has to find two identical properties with the same timber stock, infrastructure, location, etc.

• sectoral criteria,

• present value of expected net cash flow discounted at the current market rate – in the case no market price or value exists,

• cost price – in exceptional, specific cases when costs may approximate the fair value (for example when the impact of the biological transformation on price is not expected to be material, particularly when the tree crops are young).

The applied method of biological assets valuation subsequently affects the way the disclosure of the enterprises´ financial condition and changes in the notes. The Standard also states that the fair value of a biological assets (trees in a plantation forests) can change due to both physical changes and price changes in the market. Forestry is exposed to climatic, disease and other natural risks. If such an event occurs, it must be disclosed in financial statements, for example, an outbreak of a virulent disease, insect damage, storm, etc.

Slovak Accounting Standards do not yet contain the concept of biological assets. Within current assets, it is possible to identify two accounts that are associated with biological assets. It is the item of Property, Perennial crops with fertility period longer than three years and Livestock and draft animals.

The accounting entity accounts for the land to which it has ownership or, in the case of state lands, property rights[6]. This group includes all land, agriculture, forestry, and the other, regardless of the type and method of use. In relation to forestry an import-

[4] Selling costs can include commissions, fees, transfer tax and duties. They cannot include financial cost and income tax.

[5] See also IFRS 13 Fair Value Measurement

[6] This means that if the company manages lands leased from private owners or from another companies, the company does not record them in its balance sheet.

ant provision defines the obligation to include in the cost of land also the value of the purchased forest if bought for the purpose of forest management. Cost of purchased land planted with trees or bushes that are not perennial crops, is the price including the cost of planting.

The group of perennial crops with a fertility period longer than three years includes hop fields, vineyards and orchards. It excludes, however, for example stands of fast-growing trees cultivated for energy purposes (willow, poplar, pine, etc.) and forest stands. The value of forest stands is a part of the entity assets only if it has been included in the purchase price of the land. It is not possible to classify forest stands as perennial crop.

In the case of current assets, biological assets are mentioned only in connection with specific inventory items - animals. According to the Accounting Procedures for Entrepreneurs these are young animals, animals for fattening, flocks of hens, ducks and turkeys, fish, hives and the like. Included here can be bred herd of fallow deer, mouflon and deer when their usefulness in the breeding is less than four years.

For the valuation of biological assets three alternative values can be used:

- acquisition cost,
- conversion cost,
- fair value.

The results of analyses show that the majority of Slovak forest enterprises apply the existing accounting provisions of the Act of Accounting and Accounting Procedures for Entrepreneurs and they account only the value of forest land without taking into account the present value of trees in a plantation forest. In the accounting only the information on already harvested wood can be found (felled trees). Wood for sale is considered as stock – product because it is the subject of own production and is intended for sale outside the accounting entity. The increment of harvested wood is indicated as an increase in current assets in the balance sheet and at the same time an increase of revenues in the income statement. This approach in reporting harvested wood meets the requirements of IAS/IFRS. Standard IAS 41 defines biological assets only until the point of harvest. Felled trees are treated as agricultural produce therefore IAS 2 Inventories or another applicable standard is applied.

Table 4: Recognition and measurement of forest land

Tabelle 4: Berücksichtigung und Bemessung von Waldboden

English equivalent	Managed area of forest land in ha	The value of land in the balance sheet at 31.12.2015 in EUR	Measurement - used principles	Revaluation
Forests of the Slovak republic, state enterprise	893 017	523 041 412	Replacement cost	YES, per year, on the date of financial statements preparation
Military forests and assets, state enterprise	65 431	54 614 513	Acquisition cost	NO
Municipal forest Košice, inc.	19 432	81 126	Acquisition cost	NO
Municipal forest Kremnica, ltd.	9 702	44 764	Acquisition cost	NO
Gelnica Forests, ltd.	4 640	28 479	Acquisition cost	NO
Forest enterprise of the city Zvolen, ltd.	1 560	0	-*	-*
WH Danubius ltd.	3 000	5 238 056	Acquisition cost	NO
Forest Economy Inovec, ltd.	2 234	0	-*	-*
PRO POPULO Poprad, ltd.	12 900	37 803	Acquisition cost	NO
Forest Enterprise of the Technical University in Zvolen	9 724	0	-**	-**

* This enterprise manages forest lands owned by the city. Therefore, according to the Slovak accounting principles, the value of forest lands is not listed in its financial statements.

** This is a special-purpose facility at the Technical University of Zvolen, the value of forest land is presented in the financial statements of the Technical University.

Based on the analysis of forest land value reporting in the financial statements, selected enterprises can be divided into three groups:

1. enterprises reporting forest land value in their balance sheet, the value is updated during time - Forests of the Slovak republic, state enterprise

2. enterprises reporting forest land value in their balance sheet but in historical prices - Military forests and assets, state enterprise, Municipal forest Košice, inc., Municipal forest Kremnica, ltd., Gelnica Forests, ltd., WH Danubius ltd., PRO POPULO Poprad, ltd.

3. enterprises not reporting forest land value in their balance sheet - Forest enterprise of the city Zvolen, ltd., Forest Economy Inovec, ltd., Forest Enterprise of the Technical University in Zvolen

Among the Forests of the Slovak republic, state enterprise accounting practices are closest to the provisions of IAS/IFRS. However, for the valuation of forests stands not fair value is used but only replacement cost. Replacement cost is the price that an entity would pay to replace an existing asset at current market prices with a similar asset. The enterprise made consistent valuation of forest land using replacement cost for the first time in 2010, following an annual revaluation at the balance sheet date. Valuation is made in accordance with the Decree on Determination of General Property Value. Differences that arise from the revaluation will be reflected into the basic (stock) capital base.

The value of the property determined in the Decree on Determination of General Property Value cannot be identified with fair value. It is based on the construction of calculating the forest land value. The calculation includes the following factors:

• species composition - the target tree species

• property value – is the production capacity of forest land

• basic value – stated in the Decree for each species and property value separately in EUR/ha

• location factor – forwarding distance, removal distance

• coefficient of location differentiation - reflects the factors as forest category, level of environmental protection, population density and forest cover of the region.

The value of forest land set in the Decree on Determination of General Property Value does not satisfy real market prices. According to data of the Slovak Static Office in 2015 the cost of forest land on the market ranged from 0.30 to 1.80 EUR per m² (3 000-18 000 per ha). Based on the existing rules, the sale price of forest land encompasses the value of standing trees. This approach is contrary to the requirements of IAS that require the separation of biological assets from bare land. Additionally, there are practical difficulties in valuing biological assets separately from related assets such as the land on which they are located.

Another deviation from the requirements of IAS to valuation of fair value is resulting from the use of the methodology for establishing the general value of forest land under the Decree on Determination of General Property Value. Multiple input variables are the result of a subjective assessment of a certified expert, problematic is also the use of tabulated values in the annex to the decree that remained unchanged since 2008.

The situation is further complicated in meeting the IAS 41 requirements for the biological assets reporting. In our analysis we focused on one part of the property defined as trees in a plantation forest. The analysis of the accounting procedures in selected enterprises showed that apart from the enterprise Forests of SR, none of the entities stated in its financial statements the value of forests. For the entity LESY SR, the value of forests is since 2010 listed on the off-balance accounts. Off-balance sheet monitor evidence which is not accounted in the books, but which is important for the assessment of the entity property situation in terms of economic resources at its disposal (Hajduchova et al., 2014). The value of forests is then not transmitted to the information provided in the balance sheet, it becomes just a part of the notes. The determined value is updated annually on the basis of valuation experts at the National Forest Centre in Zvolen. The value of forest stands and its development from 2010 is shown in Table 5.

The valuation of the analysed biological assets is based on the general value of forest stands established under the guideline set out in the Decree 492/2004 of the Coll. establishing a general value of assets. The measurement reflects the actual characteristics of the stand, as provided by the existing forest management plans: stand age and the planned rotation, actual tree species, the actual standing timber stock, crop density. Mentioned input parameters are supplemented by others as tabulated basic forest stand value (schedules are annexed to the Act), forest stand damage (starting from the level of assimilation organs damage on which basis percentage of damage to standing timber is estimated) and positioning and location differentiation factor (assessment procedure is the same as when determining the general value of land). The advantage of this calculation is that a considerable part of the required inputs can be obtained from existing forest management plans.

As stated in the interview, LESY SR, s.e. strictly keeps the procedures established by the Decree on Determination of General Property Value, and is using historical prices set in 2004 in valuation. The change in the reported value of biological assets do not reflect the price development of raw wood in Slovakia. The enterprise in determining the value of standing trees fails to reflect the fair value, as evidenced from the development of prices of the main timber assortments in Slovakia (Table 6).

Table 5: Indicators of the of biological assets value reported by the Forests of the Slovak republic, state enterprise

Tabelle 5: Indikatoren für den biologischen Vermögenswert; Werte entstammen den Berichten der slowakischen Staatsforstbetriebe.

Year	2009	2010	2011	2012	2013	2014	2015
Managed land in ha	943 2722	938 617	930 249	921 051	904 745	897 883	893 017
The share of managed area on the stand soil in Slovakia	49%	48%	48%	47%	47%	46%	46%
Value of forest stands in EUR		3 490 006 758	3 699 916 599	3 826 497 827	3 842 197 899	3 906 496 350	3 953 635 538
Value in forest land in EUR	1 187 973 816	519 113 517	521 845 358	523 826 634	521 336 665	521 541 375	523 041 412
Wood stock in m^3	223 555 464	224 329 463	224 190 009	221 973 291	222 567 270	220 879 218	n

Note. n – Data not available

Table 6: Annual change in selected indicators of biological assets

Tabelle 6: Jährliche Änderungen ausgewählter Indikatoren für das biologische Vermögen

	2011/2010	2012/2011	2013/2012	2014/2013	2015/2014
Change in the stand value	1,06	1,03	1,00	1,02	1,01
Change of the average wood price*	1,18	1,05	1,04	0,99	1,02
Change in managed area	1,00	0,99	1,00	0,99	-
Change in value for m^3 trees in a plantation forest	1,06	1,04	1,00	1,02	-
Change in value per ha	1,07	1,04	1,02	1,02	-

* *Source: Statistical Office of the Slovak republic (http://www.statistics.sk/pls/elisw/casovy_Rad.procDlg)*

4. Discussion

The Slovak accounting standards are converging to a number of issues with IFRS referential. There is a certain number of companies which apply the IFRS, but none of them is a forest enterprise. In connection with the application of international accounting standards IAS/IFRS in terms of forest management, the most important is IAS 41 Agriculture. The most significant change the standard provides is the application of fair value in the valuation of so called biological assets. Fair value valuation seems to be a major barrier to the application of IAS 41 Agriculture in practice of Slovak forest enterprises. In the Slovak accounting system, no attention has been paid to the problems associated with accounting for and the valuing of biological assets.

IAS/IFRS could be presumably applied by the biggest forest enterprise in Slovakia, which is the Forests of the Slovak Republic, state enterprise. The state forest enterprise is the biggest forest land management company, in 2014 they managed 44,59% of the total forest cover in Slovakia and their share on the wood market was 50,8%.

At present, the accounting legislation stipulated in the Act on Accounting applies most of the important procedures defined by IAS/IFRS. Compared to the currently applied procedure of the company´s assets disclosure, the change is that the value of forests is taken into account as the biological asset of the company. Applicable accounting legislation only requires the valuation of forest land as a part of the fixed assets. The valuation of forest stands / the growing stock for accounting purposes is not performed. The stocks of wood are recognized in the balance sheet only after logging and only during the storage period.

When applying the provisions of IAS/IFRS standards at forest enterprises, the following major problems can be identified in Slovakia: Forest land owned by the state cannot be sold and cannot be a subject of hedging. The guarantee of future economic benefits is therefore limited because this asset cannot be exchanged for other property, it cannot be accepted by creditors for obligation settlement, and it cannot be split between the company´s owners. Due to the limited market with forest land in Slovakia, determining its real market value is problematic.

The final value of forests stands obtained by different methods varies significantly, causing disturbed objective valuation of the enterprise assets as a whole. The best alternative seems to be using the cost prices for young forest stands (approx. until the growth phase coppice) and for older stands the most precise methods is the present value of expected net cash flow. Due to the turbulent environment of the timber market, market valuation of these biological assets can be recommended only for stands ready for logging. There are also some computer – supported valuation procedures based on the single-tree growth simulator, Sibyla, which have been tested for forest insurance purposes (see e.g. Holecy and Hanewinkel, 2004, Brunette et al., 2015).

Valuation procedures are still not consistent even in other countries. Grege-Staltmane (2010) identified a number of differences in estimating of the fair value among international forestry companies. They interpret the IAS 41 differently. The most common method among forest companies for determining fair value according to IAS 41 is the discounted cash flow approach.

Reporting the value of forestland and forest stands in protective forests and special purpose forests can become a problem, too. The main management goal in these forests is not timber production but ensuring the continuous provision of the protective function. Their total share on the forest land was 28,5% in 2014, which represents a notable area of forests.

There is an increasing prevalence of hurricanes, windbreaks, tornadoes, forest fires and other catastrophes affecting timber markets. Despite the results of some studies (see for example. Alvarez-Diaz et al., 2015) that confirm the impact of damaged timber on timber price, it is necessary to take into account the increasing volume of the incidental felling. Commercial timber production is prone to various risks, those affecting the growth of trees or the timber markets being the most obvious ones. According to Mutenthaler and Sekot (2016) the long production periods (which may well exceed a century) implies great uncertainty in regard to future demand patterns but also in terms of changing site conditions as well as the economic and political framework.

The application of the requirements of IAS 41 demands a lot of extra work and is associated with additional cost. The same conclusions were reached also by Feleaga et al. (2012), Burnside and Schiller (2005) or Elad and Herbohn (2011).

In general, it can be stated that the application of IAS standard 41 in Slovakia will confront forest enterprises with increased demands for compiling financial statements. At the same time, it will improve the overall view of this type of accounting entities. As Forst (2014) states, Slovakia can be integrated into IFRS integrated group, which have greatly expanded the use of IFRS beyond the limited mandate of the IAS Regulation.

5. Conclusions

The process of harmonization simplifies accounting procedures for a wide range of accounting entities. The harmonization of accounting becomes a tool which can achieve cross-country comparability of financial statements in transnational terms. With the accession of the Slovak Republic to the European Union, the country assumed a number of commitments related to the implementation of European law. One of them is the gradual harmonization of accounting. This is carried out by various amendments to the Act on Accounting, which brought national accounting standards closer to international accounting standards IAS/IFRS. However, the problem remains in the access to the accounting system, which can be characterized as government driven and tax dominated. The high value of the forests of the Slovak forest companies indicate that IAS 41 is a potentially important issue for reporting entities with biological forestry assets, but the implementation of the standards incorporates a number of problems. Tools for evaluation of forest stands are available, it is necessary to evaluate their usability and consistency with IAS/IFRS requirements. Based on the personal interviews, we can say that the forest entities are not yet interested in applying the provisions of IAS 41. Therefore, a wider application among Slovak forest enterprises will be problematic; it will require a change in the overall perception of this type of accounting entities.

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Specifics of Forest Enterprises' Performance Measurement

Besonderheiten der Leistungsmessung bei Forstbetrieben

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Keywords: Performance, Non Wood Forest Products, Return on Equity, Profitability

Schlüsselbegriffe: Performance, Nichtholzprodukte, Eigenkapitalrentabilität, Profitabilität

Summary

The paper deals with determining forest enterprises' performance in Slovakia. The authors draw attention to the general methods used for performance analysis based on the analysis of the enterprise's profitability. The paper contains goal settings and methods for performance analysis and highlights the specific application of these methods in forest enterprises as well as difficulties in obtaining input data. The results show that the highest performance of forest enterprises was noted in the years of 2011 and 2014. The more detailed analysis of performance – based on the relation between the analytically determined input and the material output of the transformation process (Zalai, 2013) – confirmed that the increased performance was triggered by in-

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tensified timber harvesting. Recommendations and conclusions for the performance analysis of forest enterprises as well as the evaluation of the performance of forestry in Slovakia are presented in the last part.

Zusammenfassung

Der Artikel befasst sich mit der Leistungsmessung slowakischer Forstbetriebe. In diesem Artikel werden allgemeine Methoden zur Leistungsmessung herangezogen welche auf der Analyse der betrieblichen Profitabilität aufbauen. Der Beitrag beschreibt Zielsetzungen und Methoden der Leistungsmessung und geht auf die spezifische Anwendung in Forstbetrieben ein. Auf die Herausforderung bei der Beschaffung von Inputdaten wird separat eingegangen. Die Ergebnisse zeigen, dass die Forstbetriebe die höchste Performanz in den Jahren 2011 und 2014 erreicht haben. Eine detaillierte Analyse der Ergebnisse - aufbauend auf dem Zusammenhang zwischen analytisch definiertem Input und dem materiellen Output des Transformationsprozesses (Zalai, 2013) - hat gezeigt, dass diese Höchstwerte auf eine Intensivierung des Holzeinschlages zurückzuführen sind. Der letzte Teil enthält Empfehlungen und Schlussfolgerungen bezüglich der Leistungsanalyse von Forstbetrieben sowie eine Evaluierung der Leistung slowakischer Forstbetriebe.

1. Introduction

The aim of every business entity, including forest enterprises, is to succeed in the current highly competitive environment and, at the same time, to make a profit. However, in addition to this aim, forest enterprises have to meet economic goals and also other objectives, such as providing ecosystem services that affect the processes and economic results of the businesses of forest enterprises.

Main goal of the paper is to draw attention to the results of evaluation of the forest enterprises success in Slovakia by means of performance analysis. In the paper, the general methodologies are used for the performance analysis and, moreover, authors point out specifics of forest production and management of forestry assets and their impact on the performance of forest enterprises. As reported earlier (Neumaierová & Neumaier, 2002), the value of the company is determined by its performance. So if we want to increase the value of the company, it is necessary to improve its performance. Company performance criteria are the result of:

• time value of money as money that we have today is of different value than money received in the future, or present revenues have higher value than expected revenues,

• risks of investing as a safe investment is more valuable than the risky one,

• expectations of investors as maximization of the wealth of owners implies maximization of the net present value of the company.

According to the above mentioned, there were several methodological procedures elaborated for evaluating company performance, the theoretical foundations dating back to the 1980-ies and originating in the USA. Their founders were professors of American business schools (Brealey & Myers, 1992; Copeland, Koller & Murrin, 1991).

However, in case of forest enterprises, we are facing problems of performance measurement that arise from the specifics related to the management of forest land. Therefore, in this paper, the indicators that eliminate weaknesses of classical approaches are suggested for general use.

The Slovak Republic (SR) covers a rather small area but the proportion of forest is relatively high compared to that of other European countries. In 2013, the area of forest land was 1,942 thousand hectares, or 41 % of the total land area. Slovak forests are characterised by high levels of diversity, with both coniferous (39.3 %) and broadleaved species (60.7 %) abundant. Forest land on the territory of the SR is owned by the state (app. 40 % of forest area) and non-state entities (app. 60 % of all forests). The categories of non-state forests include those under private, community, church, agricultural cooperative and municipal ownership. An area of 54 % of forest land is managed by the 4 state organizations, the largest one is the state enterprise Forests of the Slovak Republic, Banská Bystrica (Ambrušová et al, 2015). The contribution of forestry to the GDP in SR is below 1 %. The domestic roundwood production was 9.417 mil. m^3 in 2014. This volume represents the actual felling and is relatively stable from a long-term perspective, although the share of accidental felling is quite high (up to 70%) (Parobek et al, 2014).

2. Material and Methods

Performance is a rather broad term – in general, it defines the characteristics of how the examined subject provides certain activity, based on the similarities with the reference way of providing such activity. The interpretation of the performance characteristics results from the ability to compare the examined phenomenon with the reference one according to the given criteria scales (Wagner, 2009).

According to the definition of the European Foundation for Quality Management, performance is perceived as the level of results obtained by the individuals, groups, organizations and their processes (Nenadál, 2001). Using performance, the picture of an enterprise is presented from the financial as well as non-financial point of view and, moreover, performance may serve as a tool for the competitiveness assessment and, in a broader context, for the assessment of its vitality and further development.

A large segment of forestry research literature (Drolet & LeBel, 2010; Posavec, Zelic, Fliszar, Beljan, 2011; Šišák, Riedl, Dudik, 2016) has contributed to the advancement of knowledge from the perspective of effectiveness and efficiency by describing performance in a technical and statistical manner through the development of various analytical models that can be applied to forest harvesting, production-oriented dashboards, productivity surveys or by studying the impact of external economic conditions on operating costs.

The traditional way of performance measuring is based on the evaluation of the selected financial indicators of profitability and productivity, used in particular in following analyses:

- income and revenue analysis,

- profitability analysis,

- profit margin analysis,

- economic value added analysis.

Based on the assumption that turnovers are indicators of financial performance, then these should be analysed from different points of view, especially as follows:

- revenues from main activities, namely revenues from own products, services and goods,

- revenues from the sale of fixed assets and inventory,

- in-house performances,

- financial income

- extraordinary income.

All of these items help to increase total revenues and thus also to increase performance. They need to be assessed separately as the corporate management should be interested primarily to increase revenues from the main activity. If the growth of revenue is triggered by an increased share of revenues from the sale of fixed assets and inventory, such divestments may indicate financial problems. Also growth of in-house services is undesirable as it depletes and binds financial resources necessary for the development of the company. The growth of financial income, which is not associated with the main activity of the company, points out that the financial resources of the company are used for savings and not used to expand the production. Long-term growth of extraordinary income is another indication of things going off course. Apart from revenues it is necessary to analyse also the costs, because if they grow at a faster rate than revenues, business performance will be declining.

Data for the analysis of sales, costs and profit is provided by the income statement, which is not available for all forest enterprises. Therefore, in order to analyse revenues, focus will be placed on the comparison of the proportion of revenues originating from the sale of timber on the total revenues. The research sample consisted of all forest enterprises and thus, aggregated data of revenues, costs and profit of all forest enterprises in Slovakia as provided by the Green Reports on Forestry from the years of 2011 to 2015 (cf. References).

When analysing the income and revenues, it is also necessary to consider the impact of legislative requirements, which will limit the results of forest production as a result of prescribed forest management plans. According to the SR Forest Act, all forest owners (or users) have to perform forest management by authorized forest managers according to the valid forest management plans that limit e.g. the volume of timber harvesting. Thus, increased revenues, in addition to growth in production, can be brought about mainly by increased prices of outputs. However, here we face trade barriers resulting from the structure of timber demand.

The effect of ecosystem services is significantly present in terms of a reduced possibility to decrease costs of forest management. Forest enterprises have to provide satisfactory levels of such services. At least in certain cases, this leads to increased costs of management, including the costs of communication of these issues (Lichý, 2013). These specific issues are analysed by a number of authors who deal with the evaluation of ecosystem services (Croitoru, 2007; Trenčiansky, 2011, Šišák & Stýblo, 2013), the analysis of profitability and impact of economic cycles to the economic viability and sustainable development of forest management (Krečmer, 1994; Kupčák, 2014; Tutka, 2013).

The analysis of profitability is based on the analysis of profit generation from either own or total assets (Brealey & Myers, 1992; Hajdúchová, 2000). In order to measure performance using the methods of profitability analysis, obtaining input data is rather difficult because a lot of non-state forest enterprises use only a system of single entry bookkeeping. When using such a system, only accounts payable are listed in the financial statements and the amount of equity can be calculated as the difference between total assets and account payable, only. Still, the determination of the assets' value is problematic even in the case of double entry bookkeeping – the reason is the fact that the forest enterprises are not able to effectively use their whole forest property, e.g. due to the restricted forest management in protective and special-purpose forest stands where timber harvesting is limited in favour of certain ecosystem services. Consequently, decreased timber sales lead to decreased performance of forest enterprises.

Performance assessment based on the determination of enterprise value relies on the assumption that the faster the total value of property grows, the higher the performance of the enterprise is (Brealey & Myers, 1992). There are several methods available to determine the enterprise value – the most important ones are the following:

- property methods – based on the bookkeeping (or substantial) value of the enterprise,

- flow methods – based on the analysis of cash (or revenue) flows,

- combined methods – based on the analysis of profit and economic value added.

The scope of this paper does not allow to deal with these generally known methods comprehensively. Thus, only some specifics related to their application in forest enterprises are mentioned.

The bookkeeping method needs internal analysis in order to evaluate assets according to the so-called fair value. Considering incorporeal property, it is necessary to include also the value of ecosystem services (Šišák, Riedl, Dudik, 2016). Moreover, in order to determine the value of financial property, it is necessary to discount (or compound) it for actual time value. Considering this methodology, other problems are associated with the market evaluation of forest land and forest stands.

The method of net present value is based on the assumption that the enterprise value shall be higher than the value invested to the enterprise establishment. The enterprise value shall be calculated based on the discounted financial flows according to the following formulas (Neumaierová & Neumaier, 2002):

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_o$$

where:
C_t = net cash inflow during the period t
C_o = total initial investment costs
r = discount rate, and
t = number of time periods

$$H = \frac{CF}{r_e}$$

where:
H = Enterprise value for the owner
CF = represents financial flows to the owner and
r_e = alternative cost of capital.

The problem is how to determine the alternative cost of capital – for such purposes the following approximation is used:

- the value of forest interest rate in the interval of <1,5; 2,5 > (Kolenka, 2006)

- the interest rate of state bonds,

- the interest rate of state bonds reduced by the inflation and increased by the risk of losses due to the decreased stand density,

- costs of equity, i.e. return on equity.

The combined method is based on the calculation of the economic value added (EVA) according to the following formula (Brealey & Myers, 1992):

$$EVA = NP - E * r_e$$

where:
NP = net profit after taxation,
E = equity
r_e = the alternative cost of capital.

EVA determines the value of an enterprise from the long-term point of view. Similarly, as in the case of calculation of profitability, there is also the problem of obtaining information on the value of equity here. All before-mentioned methods can be used for performance analysis in the case of enterprises using double-entry bookkeeping (Balážová, Luptáková, 2016). However, it is not possible in the case of performance analysis of forestry in total, due to problems described above.

Disadvantages of these approaches might be partially compensated by the analytical approaches of performance assessment. They are based on the bilateral relations between the analytically defined input and material output of the transformation process. Such indicators are as follows (Zalai, 2013):

- indicators of productivity and efficiency based on the ratio of Output/Input

- indicators of intensity based on the ratio of Input /Output

In the case of the analysis of the group of forest enterprises, the following indicators have been modified:

1. Indicators of productivity and efficiency:

$$Logging\ efficiency = \frac{Sales\ (EUR)}{Volume\ of\ felling\ (m3)}$$

$$Assets\ efficiency = \frac{Sales\ (EUR)}{Forest\ crop\ land\ (ha)}$$

$$Inventories\ efficiency = \frac{Sales\ (EUR)}{Growing\ stocks\ (m3)}$$

2. Indicators of intensity:

$$Resource\ intensity = \frac{Growing\ stocks\ (m3)}{Sales\ (EUR)}$$

$$Logging\ intensity = \frac{Volume\ of\ felling\ (m3)}{Sales\ (EUR)}$$

3. Results

The performance analysis based on the flow indicators shows that the performance increased until 2011, then it decreased until 2013 and then, in 2014, again increased, however not as much as in 2011. The profit is highest in 2014 (51.62 mil. EUR) – it indicates that, in 2014, the increase of revenues was higher than the increase of costs as is clearly illustrated in the Fig. 1.

Table 1: Flow indicators of performance of the Slovak forest enterprises (mil. Eur)

Tabelle 1: Leistungskennzahlen der slowakischen Forstbetriebe (mill. EUR)

Indicator	2014	2013	2012	2011	2010
Sales	532.88	470.91	494.44	544.24	478.82
Timber sales revenue	430.18	384.73	391.84	433.42	376.88
Costs	481.26	439.38	454.28	495.84	460.71
Profit	51.62	31.60	39.60	48.40	18.11

Source: own calculation according to the Green reports on Forestry 2012 – 2015 data

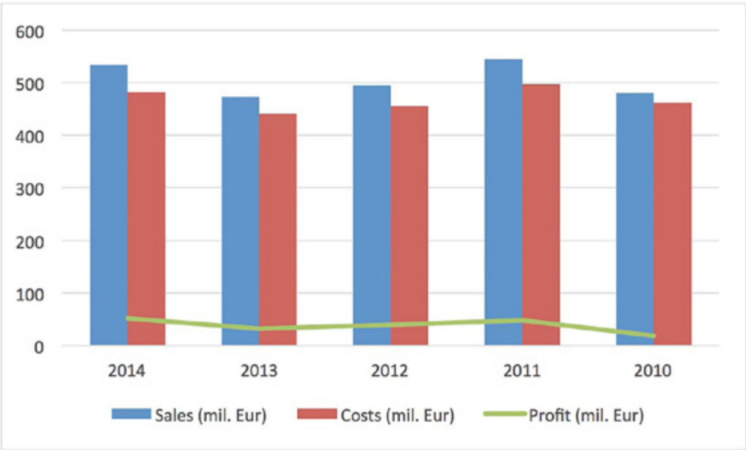

Figure 1: Development of sales, costs and profit

Abbildung 1: Entwicklung von Verkaufserlösen, Kosten und Gewinn

It is positive that the forest enterprises were profitable in all of the analysed years. As stated before, except of the total sales, it is necessary to monitor also the share of timber sales on total sales and thus, the sale of timber assortments as a result of the main activity of forest enterprises (cf. Fig. 2).

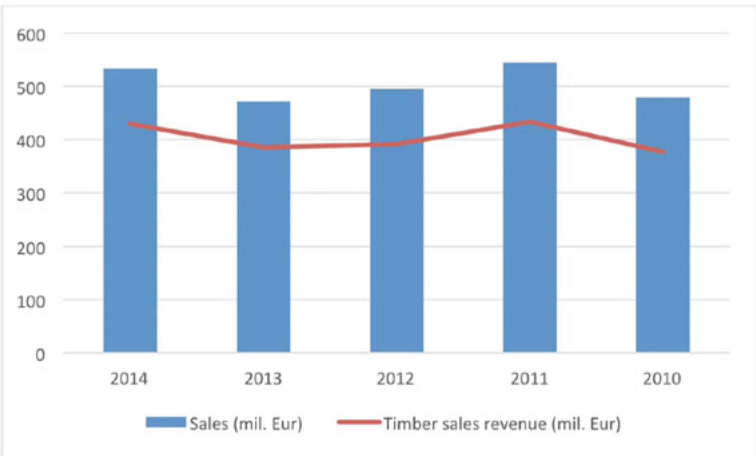

Figure 2: Share of timber sales on total sales

Abbildung 2: Anteil der Holzverkaufserlöse an den gesamten Verkaufserlösen

Based on the Fig. 2, one may state that the development of total sales was rather volatile. Total sales include, except of timber sales, also sales of seedlings, plants, game, etc. Still, the fact that the share of timber sales on total sales is almost constant shall be viewed as the positive fact, with the lowest value of 79 % in 2010 and the highest value of 82 % in 2013. It means that mainly the sales originating from the main activity of forest enterprises determine their performance.

The development of sales and profit was also affected by the fact the levied taxes in forest enterprises, including value added tax, were almost constant – they were lowest in 2010 (49.07 mil. €) and highest in 2011 (56.17 mil. €), even if the profit was highest in 2014. Despite the amount of levied taxes, the support of forest enterprises form public sources is decreasing. Thus, the economic results are negatively affected. Also, the volatility of subsidies is especially high and exceeds the one of other analysed financial indicators. The subsidies provided for forest enterprises were highest in 2011 (109.79 mil. €) and lowest in 2013 (34.775 mil. €). The development of subsidies and taxes is shown in Figure 3.

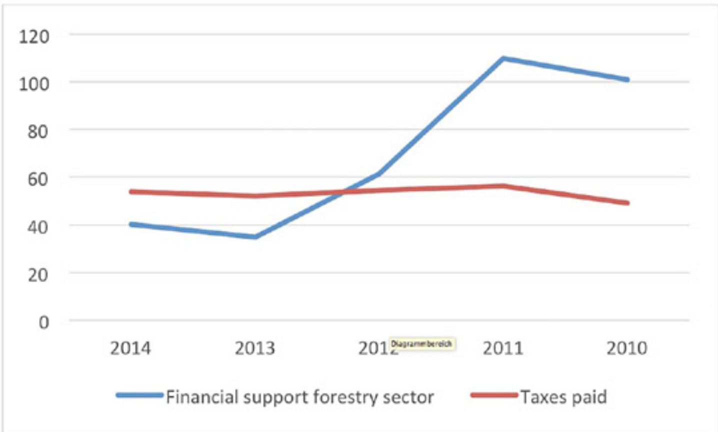

Figure 3: Comparison of levied taxes and obtained subsidies

Abbildung 3: Vergleich der entrichteten Steuern und erhaltenen Förderungen

The impact of external and internal factors on the forest enterprises' performance was analysed by analytical approaches of performance evaluation – the results are shown in Tab. 3 and 4. In order to abstract from the inflation rate, the sales were calculated using real prices according to the discount rates presented in Tab. 2. The impact of inflation on the sales is presented in Fig. 4. While the sales presented in current prices were higher in 2011, the sales recalculated according to the inflation rate (and thus the enterprise performance) was highest in 2014.

Table 2: Inflation rates and discount rates on the Slovak Republic in the period 2010 to 2014

Tabelle 2: Inflationsrate und Diskontierungsrate der Slowakischen Republik in den Perioden 2010 bis 2014

Indicator	2014	2013	2012	2011	2010
Inflation rate (%)	1	1.4	3.6	3.9	0.7
Discount rate	1	0.9725772	0.8993334	0.8580998	0.965723

Source: Own calculation according to the Statistical Office of the Slovak Republic

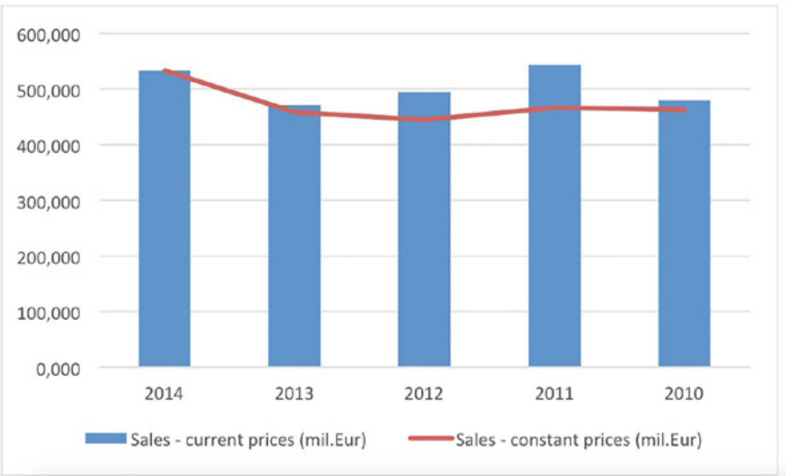

Figure 4: Development of sales in current prices and constant prices

Abbildung 4: Nominale und reale Entwicklung der Verkaufserlöse

Table 3: Final values of indicators of productivity and performance

Tabelle 3: Werte der Indikatoren für Produktivität und Leistung

Indicator	2014	2013	2012	2011	2010
Growing stock (mil. m^3)	476.6	475.45	472.18	466.07	461.95
Volume of felling (mil. m^3)	9.42	7.84	8.23	9.46741	9.8597
Forest crop land (ha)	1 941 990	1 941 520	1 940 300	1 940 110	1 938 900
Area of commercial forests (ha)	1 389 500	1 382 800	1 371 290	1 365 890	1 370 200
Sales – current prices (mil. Eur)	532.880	470.910	494.440	544.240	478.820
Sales – constant prices (mil. Eur)	532.880	457.996	444.666	467.012	462.408
Timber sale revenue (mil. Eur)	430.180	384.730	391.840	433.420	376.880
Timber sale revenue – constant prices (mil. Eur)	430.180	374.180	352.395	371.918	363.962
Indicators of productivity and efficiency based on timber sales revenue – real prices					
Logging efficiency ($Eur*m^{-3}$)	56.569	58.418	54.030	49.328	46.899
Assets efficiency (based on forest crop land) ($Eur*ha^{-1}$)	0.00027	0.00024	0.00023	0.00024	0.00024
Inventories efficiency ($Eur*m^{-3}$)	1.118	0.963	0.942	1.002	1.001
Indicators of intensity based on timber sales revenue – current (nominal) prices					
Resource intensity (m^3*Eur^{-1})	0.894	1.038	1.062	0.998	0.999
Logging intensity (m^3*Eur^{-1})	0.018	0.017	0.019	0.020	0.021

Source: Own calculation according to the Green Reports on Forestry (2016, 2015, 2014, 2013, 2012)

For assessing the impact of changes in output on selected inputs, the ratios comparing the performance of the two immediately following periods as well as the absolute differences between these variables were used. The resulting values define the input level changes induced by output changes – these changes may be presented in a relative as well as an absolute way. The obtained results have been assigned to one of two groups:

- intensive development – output growth is not caused by any increase in inputs, in some cases inputs decrease,

- extensive development – output growth is caused by increased inputs (the only factor of output growth is the amount of input).

The relation between the increase of performance analysed according to the sales in constant prices and the indicators of efficiency and management intensity is shown in Figure 5.

Figure 5: Comparison of sales indices and indices of efficiency and intensity indicators

Abbildung 5: Vergleich von Erlösindizes sowie Indizes von Effizienz und Intensität

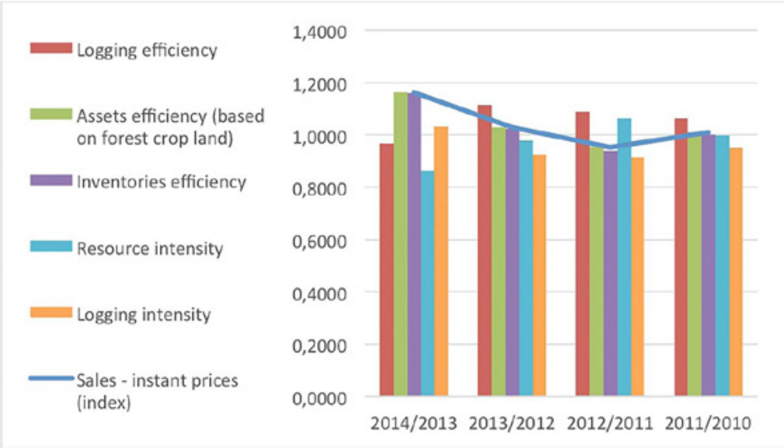

Table 4: Differences of indicators

Tabelle 4: Differenzen zwischen den Indikatorwerten aufeinanderfolgender Perioden

Indicator	2014/2013	2013/2012	2012/2011	2011/2010
Sales – constant prices (index)	1.1635	1.0300	0.9522	1.0100
Sales – constant prices (mil. Eur)	74.8837	13.3299	-22.3458	4.6047
Volume of felling (index)	1.2015	0.9526	0.8693	0.9602
Volume of felling (mil.m3)	1.5800	-0.3900	-1.2374	-0.3923
Logging efficiency	0.9684	1.1146	1.0900	1.0642
Forest crop land (index)	1.0002	1.0006	1.0001	1.0006
Forest crop land (ha)	470.0	1220.0	190.0	1210.0
Assets efficiency (based on forest crop land)	1.1632	1.0293	0.9521	1.0093
Area of commercial forests (index)	1.0048	1.0084	1.0040	0.9969
Area of commercial forests (ha)	6700.0	11510.0	5400.0	-4310.0
Inventories efficiency	1.1607	1.0229	0.9398	1.0010
Growing stock (index)	1.0024	1.0069	1.0131	1.0089
Growing stock (mil.m3)	1.1500	3.2700	6.1100	4.1200
Resource intensity	0.8616	0.9776	1.0640	0.9990
Logging intensity	1.0327	0.9249	0.9130	0.9507

Based on the results of the analyses it is obvious that the forest enterprises' performance was highest in 2011 – it was higher than in 2010 by 1 %. Then, in 2012, the performance decreased by 4.8 % and in 2013 again increased by 3 %. The most intensive increase of performance was observed in 2014 – by 16.35 % in comparison with the previous year. It is positive that the increase of performance in 2011 and 2013 was triggered by the increased efficiency of logging activities and only partially by the increased efficiency of stocks and forestland area. Thus, it is obvious that the performance increase was rather intensive.

On the other hand, the performance increase in 2014 was rather extensive as the increase of sales by 16.35 % was due to the increase of timber felling by 20.15 % - the intensity of logging activities increased by 3.27 % and its efficiency decreased by 5.16 %. There was also an insignificant increase of forest land area by 0.2 % and an increase of commercial forests' area by 4.48 % spotted in 2014. The efficiency of stocks increased by 16.07 % and their intensity decreased by 13.84 %.

4. Discussion

The performance of forest enterprises is affected by a number of factors as follows:

- enterprises, except of activities generating sales, fulfil also functions that do not generate any sales and, thus, they shall be financed by the state (e.g. production of oxygen),

- enterprises carry costs associated with the fulfilment of ecosystem services that are commercially used by other entities (e.g. water production, soil protection),

- enterprises carry costs that do not generate revenues due to the provision of sustainable forest management (e.g. silvicultural activities in protection forests),

- the enterprises' assets and liabilities include such sources that enterprises use for fulfilment of functions that do not generate any sales (e.g. forest roads),

- the value of the enterprises' assets and liabilities is based on the historical value that is in contradiction with the real actual market value.

The methodological approaches for performance evaluation proposed in this paper are considered suitable for all forest enterprises. However, in order to obtain real results, it is necessary to provide sound accounting data so that it is possible to analyse assets, liabilities and revenues separately for their use in production and non-production forestry activities.

Based on the presented analyses, results show that, despite the recent problems caused by the risk of climate change and consequent wind throws resulting in increased material intensity and costliness (Brunette at all., 2015), forest enterprises reached intensive increase – this fact shall be perceived as a positive signal for a future where a further increase of the importance of ecosystem services is expected. Long-term profit shall be viewed as an objective criterion of the enterprise market value if the costs associated with the fulfilment of ecosystem services are compensated by appropriate subsidies.

The presented results describe the measurement of business performance adapted to the conditions of forest enterprises. Based on the results, it can be concluded that the growth in performance of forest enterprises was ensured mostly by extensive means, which was reflected in growth of the forest land area and of the growing stocks. In 2011 however, an intensive growth in revenues was recorded as a result of a lower level of harvesting as well as of a decreased area of commercial forests.

Based on the analysis, the following risk factors influencing growth in performance of forest enterprises in Slovakia were identified:

- reduction in volume of the planned harvesting – putting pressure on raw wood price level,

- increased share of random harvesting associated with lower yields per unit of wood and the raised cost of harvesting and silvicultural activities,

- decreasing area of commercial forests,

- reduction of funds from public means.

Performance analysis not only provides insight into the past, it is also a strong management tool supporting the setting of future goals and it also helps to identify the tools to achieve them.

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Using a latent class model to segment citizens of Ljubljana (Slovenia) according to their preferences over the recreation setting in the Golovec urban forest

Segmentierung der Einwohner von Lubljana (Slowenien) entsprechend ihrer Einstellung zum Erholungsangebot des Golovec Stadtwaldes unter Anwendung eines latenten Klassenmodells

Anže Japelj*, Donald G. Hodges, Andrej Verlič, Luka Juvančič

Keywords: choice experiment, recreation setting, urban forest, preferences, willingness-to-pay

Schlüsselbegriffe: choice Experiment, Erholungsfunktion, Stadtwald, Präferenzen, Zahlungsbereitschaft

Summary

The paper reports on an economic valuation study using a choice experiment to assess people's preferences over a set of attributes, which describe the recreational setting of the Golovec urban forest (within the city of Ljubljana). The research goal was to identify heterogeneity of preferences for outstanding trees, forest openings, waymarks and information boards, and paved walking trails. This was achieved by employing a

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two-class latent class model on response data of 263 residents, where they could express preferences over hypothetical changes of the attributes. Marginal value (willingness-to-pay) was also estimated. Respondents in class 1 express positive preferences for having more outstanding trees and negative for extending the overall length of paved trails. Those in class 2 are in favour of having more forest openings, and having waymarks and information boards maintained. Respondents' class-membership is also affected by their age, settlement type, how often they visit forests and the purpose of their visits.

Zusammenfassung

Dieser Artikel beschreibt eine ökonomische Bewertungsstudie welche mittels eines choice Experimentes die Präferenzen der Einwohner von Lubljana in Bezug auf Attribute, welche den Erholungswert des Stadtwaldes Golovec charakterisieren, erhebt. Das Ziel der Untersuchung war die Vielfalt von Präferenzen betreffend bemerkenswerter Bäume, Lichtungen, Beschilderung, Informationstafeln als auch befestigter Spazierwege zu identifizieren. Dies erfolgte unter Verwendung eines Zwei-Klassen-Modells von latenten Klassen und Antworten von 263 Bewohnern welche ihre Präferenzen für hypothetische Änderungen der Attribute zum Ausdruck bringen konnten. Auch die marginale Zahlungsbereitschaft wurde geschätzt. Die Befragten in Klasse 1 drücken positive Präferenzen für mehr bemerkenswerte Bäume und negative Präferenzen zur Verlängerung von befestigten Spazierwegen aus. Diejenigen der Klasse 2 präferieren mehr Lichtungen im Wald und die Wartung von Schildern und Informationstafeln. Die Zugehörigkeit zu Klassen ist auch von den Merkmalen: Alter, Siedlungstyp in dem sie leben sowie Häufigkeit und Zwecke von Waldbesuchen abhängig.

1. Introduction

Due to the growing urban population worldwide (according to the UN (2015) their share will increase from 73% in 2011 to 82% in 2025), reductions in quality of life indicators such as congestion (Tacoli et al., 2015), pressure on the water resource (UN-HABITAT, 2012), and air and noise pollution (Whitford et al., 2001) are likely to continue. Some of these drawbacks can be mitigated to some extent by the presence of vital areas of green infrastructure within and in proximity to urban areas (Tzoulas et al., 2007; Kessel et al., 2009; Nilsson et al., 2011; Francis et al., 2012). In addition, green infrastructure offers benefits also to individual users, with one being particularly important – outdoor recreation opportunities (Konijnendijk et al., 2005). People have a biological need to be in touch with the natural environment (Kellert and Wilson, 1993) and will thus visit green areas if given a chance to do so (Hitchings, 2013). Therefore, sufficiently abundant and evenly distributed green infrastructure is a key for improved quality of life in and near the cities. In Europe, the importance of green infrastructure has been recently acknowledged by the adoption of the Green Infrastructure Strategy

(European Commission, 2013) and Resolution on Green Infrastructure of the European Parliament (European Parliament, 2013).

Increasing urbanisation brings many challenges for effectively planning and managing green infrastructure. It begins with increasing scarcity (in absolute, or at least in relative terms) of publicly available green areas. Furthermore, different groups of users are competing for the same resources which, in the absence of effective management, may result in conflict, not to mention the asymmetries (and thus inherent conflicts) between the management goals of (private) owners and (public) consumers of ecosystem services. Challenges are particularly visible in the case of urban forests, which are among the most close-to-nature types of green infrastructure. They provide society with numerous ecosystem services such as nature-like scenery, mitigation of the heat-island effect, filtration of solid air particles, opportunities for high-quality outdoor recreation, and stormwater mitigation. They also increase social interaction and decrease crime rates (for overview see Haase et al., 2014 and Davis et al., 2012). A broader range of benefits usually implies increased variety of users and potentially more frequent conflicts. In the case of urban forests, it is important to consider their multifunctionality when attempting to strike a balance between private owners' interests and the needs expressed by the general public within a certain temporal and spatial framework (Vandermeulen et al., 2011). This is very true in the case of recreation in urban forests, which may potentially impede forestry works, cause damage to trees and forest soils, impair forest wildlife and thus affect negatively the range and quality of ecosystem services in urban forests. Additionally, recreational habits differ by expectations (Eriksson and Nordlund, 2013; Tyrväinen, 2001), ethnicity (Gentin, 2011), social status (Germann-Chiari and Seeland, 2004) and other socio-demographic characteristics (Jim and Shan, 2013), resulting the the possibility of different user groups. Since the benefits that evolve from people having the right to enter private forests for recreation often have characteristics of public goods, landowners do not have a market stimulus to provide socially desired levels of those benefits. In line with economic theory, the bodies empowered by the public to represent their interests (e.g. the government, city council, municipality), are expected to intervene and provide incentives to assure socially desired levels of accessibility and quality of recreation in urban forests.

The variety of recreation-related needs must be addressed within the management of urban forest to avoid, or at least to mitigate, conflicts among forest owners (managers) and different groups of users (e.g. cyclists, joggers and wildlife watchers). In fact, such conflicts often emerge due to the lack of information on different forest recreational uses. Infrastructure which is unsuitable for the needed variety of activities can cause discontent among forest visitors, for example, making them leave trails and move into undeveloped forest areas. This can cause damage to forests and trigger frustration among forest owners. This is the case for the Golovec urban forest in Ljubljana – the capital of Slovenia and a rapidly growing (both in population and economic terms) city (SORS, 2014). Private forest ownership prevails in Golovec, however it is an important recreation area for the citizens (Osanič, 2002). Since Act on forests (Zakon o gozdovih,

2015) states that access to forests for recreational purposes in Slovenia is an everyman's right regardless of forest ownership, managing different expectations – forest owners' vs. other users' – is key for assuring forests' multifuncionality. Thus, the goal of this investigation was to identify the preferences of Ljubljana's citizens towards changes of the Golovec urban forest recreation setting. The setting was defined with a set of attributes, which presumably affect its recreational benefits. Such attributes can be related to the quality of recreational opportunities (Clark and Stankey, 1979) and represent a recreational setting of an urban forest. Additionally, we have also addressed the issue of heterogeneity of citizens' preferences.

We use an economic valuation approach as one of the possible ways to assess preferences. It assignes a monetary value to changes in the attributes and those values are referred to as preferences. The value is expressed as the willingness-to-pay (WTP) for the changes in the quantity/quality of individual attributes and this information helps decision makers identify priorities, which are a key element in urban forest management planning. Either positive or negative WTP estimates indicate, likewise, positive or negative preferences for implementing the suggested changes in the attributes. Since we were interested in preferences for individual attributes, a choice experiment (CE) was applied, as it allows for the estimation a WTP for each of the considered attributes. The attributes in our research covered both the characteristics of infrastructure (paved trails, waymarks and information boards) and characteristics of the forest stand (outstanding trees and forest openings). Consequently, it addressed a wider range of thematic and management-related aspects than its predecessors, focusing specifically on recreation in urban forests and utilizing CE such as Arnberger et al. (2010) and Nordh et al. (2011). Both dealt with only one type of attribute group (infrastructure or forest characteristics). Although Koo et al. (2013) covered both forest and infrastructure-related attributes, the research did not include a monetary attribute which would allow for the monetisation of changes in the attributes. Thus, the working approach of this study attempts to complement previous work.

We used a latent-class analytical approach, which enabled us to segment people's preferences into groups, which is in line with the issue highlighted above – heterogeneity of preferences and existence of different interest groups. Since CE is a survey-based approach, we constructed a questionnaire for the CE, and administered it to a sample of 263 Ljubljana's citizens to explore their preferences for changes in the selected recreation-related urban forest attributes. Within the assessment of CE data, we tried to link the heterogeneity of preferences with socio-demographic characteristics and recreation habits.

The study area of urban forest area of Golovec is located in the eastern part of Ljubljana (46.032262° N, 14.554796° E). It is mostly (>75%) privately-owned and is an important venue for outdoor recreation for a significant part of the 237,517 citizens (SORS 2014) of Ljubljana (Osanič, 2002). Within its 675 ha of close-to-nature area of mixed forest, it offers 14 km of paved trails, 2 educational trails with information boards, 1 site with basic outdoor-fitness equipment and a grid of waymarks to follow specific routes. There is no entrance fee, with funds for maintaining the infrastructure being provided by the city. The area is among 20 areas declared as forests with special purpose by Ljubljana municipal decree no. 48 (Decree, 2015).

2. Material and methods

2.1. Designing the study

The CE technique is grounded in Lancaster's consumer theory (Lancaster, 1966) and linked to the random utility model (RUM), which is derived from Luce (1959) and McFadden (1973) (Bateman et al., 2002; Hanley et al., 2001). Goods, which are being assessed by means of a CE are described as bundles of attributes. By combining varying levels of the attributes, different bundles (i.e. alternatives) can be designed. CE is a survey-based approach where each respondent is faced with a set of different alternatives organized in choice sets. Each choice set contains one alternative presenting the current state (business-as-usual; BAU) of the assessed good (in our case recreational setting of the urban forest of Golovec), and other alternatives with hypothetical states, where the attributes of the good differ from the current state. Each alternative is also assigned with a cost attribute, indicating the amount of money needed for implementing the hypothetical states. The aim of a cost attribute within the survey is to assess the marginal values for changes in the attribute levels. Respondents select among alternatives within a choice set, and by selecting a preferred alternative, they implicitly make a trade-off among the hypothetical changes of the attributes and costs attached to each alternative (Hensher et al., 2005). According to RUM, one always chooses the alternative which indicates the maximum sum of utilities of changes of the attributes. The utility U derived from a good is modelled as a function (equation 1) (i.e. indirect utility function) of two sets of components: 1) a deterministic component V, which depends on observable attributes of the good, and 2) a random component ε representing the error term, which comprises of all non-observable features that affect the choices of the respondents, but are not observable by the researcher:

$$U_{ij} = V_{ij} + \varepsilon_{ij} = \beta_i x_{ij} + \varepsilon_{ij} \quad (1)$$

β is a vector of parameters, in our case indicating preferences for changes of the attributes (viz. "taste" parameters), x is a vector of attributes, in our case attributes of the Golovec urban forest, and ε is assumed to be of a type 1 extreme distribution (Boxall and Adamowicz, 2002). Subscript i denotes an individual respondent and j stands for an alternative being observed.

The attributes for our study of the Golovec urban forest were selected through a pre-survey in which 108 respondents from the general public assessed attributes, which they commonly associated with the quality of forest recreation. Respondents ranked each of the 12 forest-related and 5 infrastructure-related attributes according to the magnitude of the effect on recreation. The attributes were presented with images and short text descriptions. The four highest-ranking attributes were selected for the CE (Table 1). This was done to assure a higher reliability of the survey as those attributes, which respondents could most easily relate to, were selected to be used in the main survey. Moreover, the number was restricted to four as more attributes would require a more complex experimental design and a larger sample size. BAU levels of the attributes were defined by a field inventory in the area of the Golovec urban forest. This was followed by a two-step Delphi process, in which professionals from forestry, spatial planning, decision makers and representatives of forest owners defined possible alternative levels of the attributes. Those levels could be achieved with additional management measures.

Table 1: Attributes (and their levels) used in the choice experiment

Tabelle 1: Attribute (und deren Ausprägungen), die im choice Experiment verwendet wurden

	CURRENT STATE	ALTERNATIVE STATES
Forest openings	[% of forest openings in the overall forest area in a 20 m wide strip on either side of a walking trail]	
	0.5 %	**2.0 %, 3.5 %**
Outstanding trees	[% of outstanding trees among all trees in a 20 m wide strip on either side of a walking trail]	
	6 %	**12 %, 18 %**
Waymarks and information boards	[maintenance of information boards and waymarks along the walking trails]	
	Unmaintained	**Maintained information boards; maintained waymarks**
Paved walking trails	[length of maintained paved walking trails in kilometres]	
	14 km	**21 km, 28 km**
Payment	[annual personal monetary contribution to a special fund in EUR]	
	0 EUR	**2, 4, 6, 8, 10, 12 EUR**

Paved walking trails are those which are hardened with a layer of gravel or sand so that they are safe to use even in wet conditions. Forest openings are patches with no trees, overgrown mostly with grasses or shrubs. They are located within the forest and are caused either by tree-fall or small-scale felling. Waymarks are located beside the walking trails and mark different routes so that visitors are aware of where they are going. Information boards offer visitors information on historical sites and cultural features within the forest or forest-educational trails. Outstanding trees are those which are noticeable for their size or shape of crown, or appear old due to cavities in the trunk. The monetary attribute was designed as the yearly personal contribution from all citizens of at least 18 years of age into a special fund. This would be used by the City to invest in improvements in the recreation setting. The levels of the monetary attribute were also defined through the Delphi process.

2.2. Structure of the questionnaire

The introductory part of the questionnaire consisted of a set of 'warm-up' questions so that the respondent had a chance to get familiar with the concept of attributes and their levels describing an urban forest recreational setting. Respondents were asked about their preferred recreational activities, how often they noticed the attributes in the forest, how important the attributes were for their recreational experience, and what were their desired levels of the attributes.

The central part of the questionnaire contained the CE, which consisted of 18 choice sets, where each set included three alternatives. Alternatives were constructed so that the attributes and their possible levels from the Table 1 were combined by employing a sequential orthogonal fractional factorial design (ChoiceMetrics, 2012). This process generated 54 different alternatives, which were used to populate the choice sets. One of the three alternatives in a choice set always presented the BAU state, whereas the other two indicated alternative hypothetical states of the recreational setting with changes in attribute levels. Changes always suggested improvements; increases in quantitative attributes (forest openings, outstanding trees, paved walking trails) and a shift from "unmaintained" to "maintained" for the waymarks and information boards. The BAU alternative included a zero-cost as there are no additional funds needed to maintain the current levels of the attributes. The alternatives always included a non-zero payment. An example of a choice set is given in the Annex 1. Choice sets were grouped into two blocks to minimize the cognitive burden, so that each respondent was presented with 9 instead of 18 sets, and asked to sequentially select their preferred option from each one. Grouping into blocks retained the orthogonality of the design (ChoiceMetrics, 2012).

Following the CE were three debriefing questions, two of which were designed to indicate biased answers within the CE and one to detect protests (see Bateman et al., 2002). In addition, questions on attitudes regarding the city's investment policy related to the recreational setting of urban forests were included. The concluding part of the questionnaire covered socio-demographics of our respondents.

The questionnaire was designed as a computer-assisted survey and was administered to a sample of 263 respondents of age 18 or older. Respondents were randomly selected from a panel of a major market research company, preselected by their residence in Ljubljana, and stratified according to gender and age ratios so to be representative of Ljubljana's population (Table 2).

Table 2: Gender ratio and mean age for the sample and the population of the City of Ljubljana and z-test of the differences

Tabelle 2: Geschlechterverhältnis und Durchschnittsalter für die Stichprobe und die Bevölkerung der Stadt Ljubljana und z-Test der Unterschiede

	Sample	Population average[a]	*z*-score
Gender (% of women)	53.9	52.7	0.32
Age (mean)	48.6	47.9	0.51

[a](SORS, 2014) for people of 18 or more years of age

The survey was conducted in July and August of 2013 in a mixed mode of web-based and face-to-face interviews. More than half (59%) of the respondents completed the survey via web, whereas the rest (41%) were questioned in person at their homes.

2.3. Analysing the response data

The protests and biased answers were identified and removed from the response set. This resulted in 178 valid responses, which were, under the RUM assumption of probability of individual choices, analysed with a latent-class logit model (LCLM). This model was used because it assumes that the sample of respondents consists of a finite set of C classes for which an individual's membership is latent or unobserved by the researcher. Each of the classes is assigned by a unique set of preferences – in our case preferences for changes of the attributes of forest recreation setting, which are indicated by β parameters from the utility function (equation 1). This was in line with the objective of the research to assess the existence of different groups of recreational users of the Golovec urban forest. The probabilistic function (equation 2) explaining the assignment of each individual i into each class c is based on socio-demographic characteristics, perceptions, and attitudes z_i, and represents one of the two components into which the deterministic portion of the utility function (equation 1) is divided. The membership likelihood function is formulated as a multinomial logit model and provides unconditional class membership probabilities:

$$\pi_{ic} = \frac{e^{\theta'_c z_i}}{\sum_{m=1}^{C} e^{\theta'_m z_i}} \quad (2)$$

where θ'_c are specific class-related coefficients (Boxall and Adamowicz, 2002). Thus, equation 2 enables the assignment of individuals into different classes (viz. groups).

Respondent choices of alternatives are explained by a second component (equation 3) of the deterministic part of the utility function:

$$\pi_{ij} = Prob\{V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik}; j \neq k, \forall k \in I\} \quad (3)$$

Choice probabilities are (according to RUM) probabilities for individuals to pick an alternative, which yields the highest level of utility from a set of j=1,…,I known and mutually exclusive offerings in a given choice situation (Ben-Akiva and Lerman, 1985). The probabilities are conditioned on class-membership and if it is realistical to assume that the choices are independent over the set of choice situations (i.e. *iid* assumption holds), conditional choice probability can be modelled with:

$$\pi_{ij|c} = \frac{e^{\beta'_c x_{ij}}}{\sum_{k=1}^{I} e^{\beta'_c x_{ik}}} \quad (4)$$

where x_{ij} is the vector of attributes associated with each alternative and β'_c is the vector of estimated coefficients. The conditional probability that individual i chooses alternative j is:

$$\pi_{ij} = \sum_{c=1}^{C} \pi_{ic}\, \pi_{ij|c} \quad (5)$$

Equation 5 explains the probability of individuals selecting different alternatives, however this probability is conditioned on one's class membership. In this way, LCLM enables assessment of preferences, which are different for each class of individuals.

The overall estimation goal is to find parameter values that best explain a respondent's choice of alternatives, which means to obtain π_{ic} and $\pi_{ij|c}$ that maximize the log likelihood function:

$$\ln L = \sum_{i=1}^{N} ln\left[\sum_{c=1}^{C} \pi_{ic} \left(\prod_{j=1}^{I} (\pi_{ij|c})^{y_{ij}}\right)\right] \quad (6)$$

where y_{ij} equals one when individual i chooses the alternative j and zero otherwise (Hensher et al. 2015).

Grounded on the Bayes theorem, posteriori conditional class-membership probabilities can be written as (Boxall and Adamowicz, 2002):

$$\pi_{ic}'^{*} = \frac{\pi_{ic}\prod_{j=1}^{I}(\pi_{ij|c})^{y_{ij}}}{\sum_{c=1}^{C}\pi_{ic}\left(\prod_{j=1}^{I}(\pi_{ij|c})^{y_{ij}}\right)} \quad (7)$$

With this and by using the previously calculated $\pi_{ij|c}$ and π_{ic}, a new set of individual-specific (posteriori) estimates of probabilities $\pi'_{ic}{}^{*}$ is obtained. Those probabilities indicate individual *i* being in class *c* and are conditioned upon individual's choices of alternatives. With this new information, the individual-specific posterior estimates of the parameters can be derived:

$$\beta_i' = \sum_{c=1}^{C}\pi_{ic}'^{*}\beta_c' \quad (8)$$

where β'_c are class-specific parameters of the utility function. The parameters indicate the preferences of individuals towards changes of forest attributes. A utility function is estimated specifically for each class, as preferences differ among classes. The attribute-related β_i''s are estimated iteratively by varying the number of classes, *c* in the model. The optimal number of classes can be defined upon model fit criteria such as BIC (Bayesian Information Criterion) as well as other indications, such as the expected sign of the coefficients and distribution of the respondents among classes (Swait, 2007).

Conditional class-membership probabilities can also be used to define the monetary marginal values of changes in attribute levels, which are exhibited by WTP. Class-specific estimates of WTP are (Boxall and Adamowicz, 2002; Greene and Hensher, 2003):

$$WTP_{i|c} = -\frac{1}{\beta'_{payment,c}}\left[ln\left(\sum_{k=1}^{I}\exp\left(\beta_c' x_k^0\right)\right) - \ln\left(\sum_{k=1}^{I}\exp\left(\beta_c' x_k^1\right)\right)\right] \quad (9)$$

where x_k^0 denotes the status quo value of the attribute and x_k^1 refers to its alternative value. β_c is the *c*-class specific coefficient for the attributes, and $\beta_{(payment,c)}$ is the payment coefficient for class *c*.

The data were analysed with Nlogit (2012) software. Variables used in the estimation of the indirect utility function (Table 1), such as outstanding trees, forest openings, paved walking trails and payment, were assumed to have linear effects and were design coded, whereas waymarks and information boards were treated as categorical variables and were recoded as one dummy variable per each level.

3. Results

A two-class model was used for analysing the response data. This was done despite the fact that BIC information criteria suggested four-class model to be the best. In line with (Boxal and Adamowicz, 2002; Scarpa and Thiene, 2005), we applied two additional criteria for the determination of the number of classes: the plausibility of results and size of classes. Both four- and three-class models were inspected. Large standard errors of β estimates appeared in one class for both models, indicating an unstable model. The model with five classes was characterized by insignificant differences among some of the classes and, moreover, one of the classes was very small, holding less than 2% of respondents.

Table 3: Test results for different number of classes of the latent class model

Tabelle 3: Testergebnisse für eine unterschiedliche Anzahl von Klassen des latenten Klassenmodells

Number of classes	Number of observations (N)	Number of parameters (P)	Log-likelihood (LL)	BIC[a]
Model with no covariates				
1	1602	7	-1600.18	3252.0
2		15	-1034.00	2178.7
3		23	-935.69	2041.1
4		31	-900.94	2030.6
5		39	-900.94	2089.7

[a] $BIC = (-2 * LL) + (\ln(N) * P)$

The model with variables representing attributes of the recreational setting was estimated initially. Then additional variables such as socio-demographic characteristics and recreation habits were gradually introduced into the model and estimated (estimates of the membership function parameters) with the attributes (estimates of the utility function parameters).

Six such additional variables (including the constant term) were statistically significant, meaning that they affected class membership (Table 4). Both sets of parameter estimates are reported in Table 5. Parameters of those were normalized to zero for class 2, so that class 1 can be interpreted relative to class 2 (i.e. reference class).

Table 4: Description of additional variables of the LCLM for CE for the Golovec urban forest

Tabelle 4: Beschreibung der zusätzlichen Variablen des LCLM für das CE für den Stadtwald Golovec

VARIABLE	DESCRIPTION	STATISTICS						
		Mean	**Standard deviation**	**Minimum**	**Maximum**			
Age	Continuous variable: respondent's age	48.60	19.25	18	93			
		Relative frequencies						
Settlement type	Dummy variable: respondent's settlement type	Rural	Urban					
		0.31	0.69					
Frequency of visiting a forest	Discrete variable: respondent's visitation rate	never	> once per 6 months	once per six months	once per month	once per week	2- to 3-times per week	each day
		0.08	0.04	0.20	0.29	0.18	0.16	0.05
Walking a dog	Discrete variable: how often does one visit a forest to walk the dog	never	almost never	occasionally	frequently			
		0.47	0.22	0.06	0.25			
Picking forest fruits	Dummy variable: how often does one visit a forest to pick berries, chestnuts, mushrooms, etc.	never OR almost never	occasionally OR frequently					
		0.44	0.56					

The model's adjusted-ρ^2 was 0.43, which is equivalent to R^2 of 0.8 for linear models (Domencich and McFadden, 1975). According to Louviere et al. (2000) values of adjusted-ρ^2 between 0.2 and 0.4 indicate a very good model fit. According to the calculated class membership probabilities, the respondents were distributed between both classes very evenly, with 49% belonging to class 1 and 51% to class 2

Table 5: Estimation results of the LCLM for CE for the Golovec urban forest

Tabelle 5: Schätzergebnisse der LCLM für das CE für den Stadtwald Golovec

Attributes	**Estimates of the utility function parameters**	
	Class 1 [share of respondents: 49%]	Class 2 [share of respondents: 51%]
	$\hat{\beta}$	$\hat{\beta}$
Outstanding trees	0.17*	-0.00
Forest openings	1.07	0.55**
Forest openings ^{2}	-0.29	-0.12**
Waymarks	-0.45	0.32*
Information boards	-0.16	0.40***
Paved trails	-0.15*	0.01
Yearly payment	-0.85***	-0.14***
Constant term	0.30	2.00***
Additional variables	**Estimates of the membership function parameters**	
	Class 1	Class 2: reference class
	θ'	
Constant term	1.28	
Age	0.04**	
Settlement type (0-rural;1-city)	-1.00*	
Frequency of visiting a forest	-0.29**	
Walking a dog (1-frequently;2-occasionally;3-almost never;4-never)	-0.31*	
Picking forest fruits (1-frequently OR occasionally;0-almost never OR never)	-0.68*	
Model diagnostics		
logL	-1007.15	
No. of observations	1602	
pseudo-R^2	0.43	
* significance level: 0.10; ** sig. level: 0.05; *** sig. level: 0.01		

Note: ^{2} square of the variable.

The estimates of the utility function parameter $\hat{\beta}$ indicated that respondents in class 1 were positively sensitive to increases in the abundance of outstanding trees and had negative preferences to increases in the length of paved walking/cycling trails. They also expressed a negative attitude towards higher yearly payments, which is in line with the hypothetical market situation, in which respondents are asked to trade-off between the payments and changes of the attributes. Non-significant parameter estimates for other attributes indicate that their changes do not affect the recreational setting of the urban forest of Golovec as perceived by class 2 respondents.

Respondents in class 2 expressed positive preferences for more forest openings, however only up to a point. In addition to the linear parameter, the square of the variable also proved to be significant. Its negative sign and values of both coefficients suggests that utility of increasing the area of forest openings in the study area is better explained with a quadratic function with a maximum at 2.3%, suggesting that the optimal abundance of forest openings is not the 3.5% (the highest suggested value as in the choice cards), but somewhat lower. Respondents from this class also expressed positive preferences for maintaining waymarks and information boards as opposed for no maintenance. As those from class 1, class 2 members expressed negative preferences for higher yearly payments. However, respondents from class 2 expressed exactly the opposite preferences for outstanding trees and paved trails. In fact, those from class 2 were insensitive to alterations in both attributes as those in class 1 were not. Moreover, respondents from class 2 also expressed a positive attitude towards alterations from the current state in general, which is indicated by a positive and statistically significant constant term.

Estimates of the membership function parameters θ' in class 1 indicate that older respondents were more likely to be in this class than in class 2. Furthermore, those who live in the city and those who visit the forest more frequently are less likely to be in class 1 compared to class 2. Respondents who visit the forest more often to pick blueberries, mushrooms, chestnuts and other forest fruits are also less likely to be in class 1 than in class 2. Conversely, those who visited the forest more often to walk the dog were more likely to be in class 1 than in class 2.

The WTP for changes in the attributes were calculated using the utility function parameter estimates. WTP values are given in Table 6 for each of the two classes and indicate a monetary value which an individual from the sample would be willing to contribute for either a quantitative increase or a qualitative shift in the attribute level.

Table 6: Willingness to pay [EUR person^{-1} year $^{-1}$] for the changes of forest and infrastructure attributes

Tabelle 6: Zahlungsbereitschaft [EUR Person^{-1} Jahr $^{-1}$] für die Veränderungen der Wald- und Infrastrukturattribute

Attributes	Class 1 *(»change rejecters«)* [share of respondents: 49%]	Class 2 (*»change supporters«*) [share of respondents: 51%]
	Mean willingness to pay [confidence intervals]	
Outstanding trees	0.20** [0.01; 0.38]	-0.00 [-0.17; 0.16]
Forest openings	0.16–1.15	1.76–4.43**
Waymarks	-0.56 [-1.97; 0.86]	2.32** [0.13; 4.51]
Information boards	-0.19 [-1.79; 1.40]	2.93*** [0.96; 4.91]
Paved trails	-0.17* [-0.35; 0.00]	0.07 [-0.06; 0.21]

Note: * significance level: 0.10; ** sig. level: 0.05; *** sig. level: 0.01. The confidence intervals (and consequently the sig. levels) of the WTP estimates were calculated with the Delta method (Hole, 2007).

In the case of forest openings (class 2), utility was not assumed to be linear with respect to changes in the openings' area. Thus the marginal values (WTPs) are not equal for all equidistant changes in the area (Figure 1). A complete range of WTPs is reported.

First, WTP steadily increases for each additional percent of the forest openings (1.76 EUR person^{-1} year $^{-1}$ for increase from the current 0.5% to 1.5%), reaches its maximum of 4.43 EUR person^{-1} year $^{-1}$ for the increase from the current 0.5% up to 2.3%, and gradually drops to 3.00 EUR person^{-1} year $^{-1}$ for the increase from the current 0.5% to a maximum of 3.5%. WTP for forest openings was not significantly different from 0 for those in class 1.

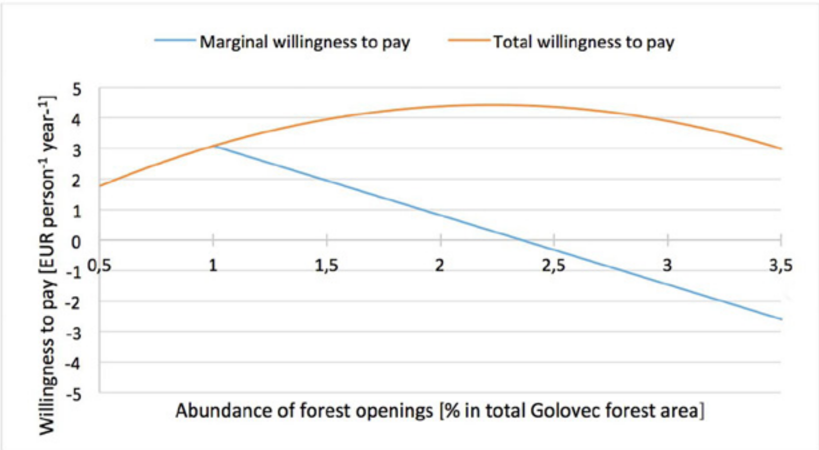

Figure 1: Distribution of willingness to pay for the changes in the abundance of forest openings for class 2 and the distribution of corresponding marginal values

Abbildung 1: Verteilung der Zahlungsbereitschaft für Veränderungen betreffend die Häufigkeit von Lichtungen für die Klasse 2 und die Verteilung der entsprechenden Grenzwerte

Respondents in class 1 expressed a WTP of 0.20 EUR for each 1% increase in outstanding trees and a WTP of -0.17 EUR for each additional kilometre of paved trails. WTP for both attributes were not significantly different from zero for those in class 2. On the other hand, respondents in class 2 expressed positive and significant WTPs of 2.32 EUR and 2.93 EUR for assuring maintenance of waymarks and information boards, respectively. Those in class 1 did not express a significant WTP for these attributes.

4. Discussion

Almost half (49%) of the respondents (those in class 1) expressed positive preferences (WTP of 0.20 EUR) for having more outstanding trees, which is in line with previous research (Gundersen and Frivold, 2008; Edwards et al., 2010) that revealed the quality of recreation improves with increasing abundance of older trees. Moreover, in their CE, Termansen et al. (2008) indicated positive preferences for having more trees older than 60 years. Our results also indicate that positive attitudes towards outstanding trees matches with lower forest visitation rates, which could mean that those visiting forest less frequently focus more on observing trees with unique habits, markedly larger dimensions, or appearing very old. Frequent Golovec forest visitors do not notice them as often and they do not find them as important for their recreational experience.

The presence of forest openings was inadequately covered by other forest recreation-related studies, except Hanley and Ruffell (1993), who addressed forest openings in a very general way, and studies by Edwards et al. (2010), Gundersen and Frivold (2008), and Holmes and Boyle (2003), who all assessed the effect of clearcuts on recreation. Forest openings was the only attribute of a recreational setting, covered in our research for which we showed that the utility can be modelled with a quadratic-shaped utility function. We established that there is a saturation point in the abundance of openings and it is very near the midpoint of the suggested range. However, this was not true for all respondents, as those in class 1 were insensitive to the increase in presence of forest openings.

Previous research indicated that those who visit forests for recreation more often seem to appreciate maintenance more than others. In more detail, Hanley et al. (1998) and Bernat and Roschewitz (2008) report that more active forest visitors support improvements in recreational opportunities more than less frequent vistors. Similarly, Christie et al. (2007) concluded that improvements increase forest visitation. This is very much in line with our results as we showed that maintenance of waymarks and information boards is more appreciated by frequent visitors (those in class 2) than by those who visit Golovec less often (class 1). WTP for maintenance of waymarks and information boards seem to be very close (2.32 and 2.93 EUR), suggesting that both aspects are similarly important.

Paved trails was the only attribute in our study, in regard to which respondents expressed negative preferences. Those in class 1 indicated that they would want to be compensated with 0.17 EUR for each additional kilometre of paved trails constructed in Golovec forest. This might be linked to a fact that those who visit forest often to walk their dogs do not appreciate more trails, because it might attract more other visitors. More congestion might deteriorate their recreation experience. The issue of congestion was highlighted by other research as well. Arnberger et al. (2010), Manning (2007), Nordh et al. (2011) and Sayan et al. (2013) all empasize the negative effect of congestion on the quality of recreation in forests.

All respondents (both classes) expressed a disinclination towards higher yearly payments. This actually supports the credibility of our research as it indicates that respondents were embedded into the hypothetical market environment, and that they made consistent trade-offs among payments and changes of the attributes, both being captured in the alternatives. Our research results are thus not burdened by the "strategic" bias, which is one of the most common consequences because of the hypothetical nature of CE (Bateman et al. 2002).

Some studies also tested personal income as one of the covariates, which might affect preferences. We did the same, and similarly to Tyrväinen and Väänänen (1998), and Koo et al. (2013), we found that income was not a significant predictor when it comes to recreational setting of an urban forest. Ottitsch and Krott (2005) suggest that this might be due to the fact that people consider recreation in forests as a freely available public good, where purchase power does not preclude users.

We have also related respondent age with preferences and found out that those who were older were less supportive to increasing the length of paved trails. A part of explanation might be that older respondents are less prone to investments into forest, which was, to some degree, shown by Tyrväinen and Väänänen (1998), who established that elderly were less likely to pay for preventing forest to be converted into land for urbanization.

5. Conclusions

This study clearly illustrates heterogeneous citizens' preferences for recreational settings of a popular urban forest area. We employed CE data and a LCLM as an empirical modelling tool to show that the citizens of Ljubljana can be categorized into two groups (viz. classes) according to how they valued changes in the recreation setting attributes within the Golovec urban forest. We have clearly demonstrated that each class can be assigned a unique set of preferences which differentiates them.

Additionally, we have shown that those preferences can be linked to socio-demographic characteristics. Age and the type of settlement in which the respondent lives is significantly related to their preferences. Furthermore, recreation habits also affect preferences. Those that proved to be significant predictors were the frequency of visits to the forest, frequency of walking a dog as a reason to visit a forest, and frequency of picking forest fruits as a reason to visit a forest.

The results of our investigation can serve as important information for urban forest management. Specifically, managers of such areas, or other recreational areas, must understand the type of use and motivations of the various user groups. As our results and others have demonstrated, citizens possess a wide range of interests and expectations. We showed that many appreciate outstanding trees, although this depends on the frequency of their visits. Furthermore, having more openings and maintained waymarks and information boards may increase the quality of recreational experience of those who visit forests more often. On the other hand, investing in paved trails may not prove rational since the majority of respondents disapprove their extension. Zoning the forest according to the citizens' preferences may rationalize management costs and increase the quality of the recreation experience. Fully understanding these divergent needs is crtitical to managing such a resource and satisfying all groups of citizens. While a CE may not be necessary for management decisions, some assessment of people's preferences and their differences will allow managers to provide those experinces and characteristics most popular to the various groups of people.

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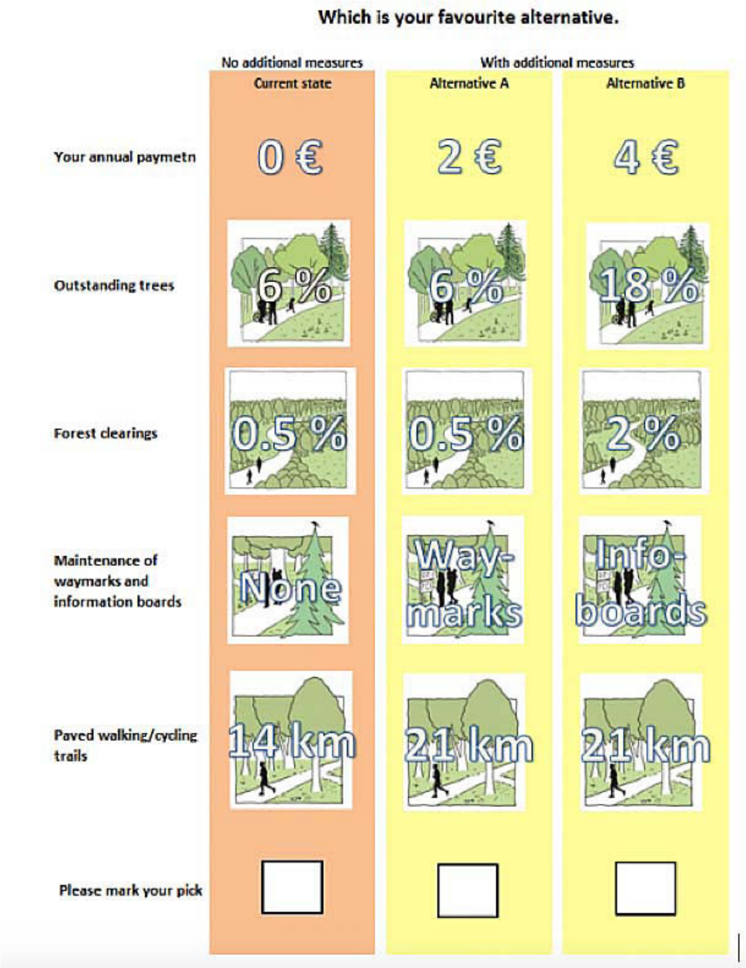

Annex 1: A presentation of a typical choice set that was presented to a respondent during the survey

Anhang 1: Eine Darstellung eines typischen Auswahlsatzes, der einem Befragten während der Befragung vorgelegt wurde

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Value Chain Analysis and Socio Economic Aspects of Non-Wood Forest Products in Central Serbia

Wertschöpfungskettenanalyse und sozio-ökonomische Aspekte von Nicht-Holz Produkten in Zentralserbien

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Keywords: value chain analysis, non-wood forest products, socio-economy, trends, market, Serbia

Schlüsselbegriffe: Wertschöpfungskettenanalyse, Nicht-Holz Produkte, Sozio-Ökonomie, Trends, Markt, Serbien

Summary

The value chain represents a detailed outline of the process that a product or service passes from raw materials, production and distribution to the consumer. The analysis of this process is the core of this research that examines the development opportunities of a sample of small and medium-sized enterprises (SMEs) based on the sustainable use of non-wood forest products (NWFPs) in a specific area of Central Serbia. The research focuses in particular on the dynamics of purchasing and marketing on NWFPs, both in terms of quantities and market value. The subjects of the research are:

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purchased and sold quantities in analyzed companies, as well as the prices of these products in the market. The research included 55 companies engaged in purchasing, processing and sale of NWFPs. The response rate in the research was 87.3%. In this paper, the following NWFPs are considered: mushrooms, medicinal and aromatic plants and forest fruits. All interviews, which were conducted, contained qualitative and quantitative questions and a section of socio-economic questions. The data are divided into those related to the purchase of raw materials, the sale of final NWFPs on the domestic market, and to NWFPs export. The aim of the research (in terms of the analyzed companies) were: income / outcomes, processing facilities, supply, export destination, price (purchase and sale) and distribution channels. The primary use of parametric statistics through regression analysis was to determine the average annual growth rates (AAGR) (in the purchase, sale on the domestic market and exports). The most of the SMEs in NWFPs sector of Central Serbia are situated in rural areas (app. 67.4%) and 63.5% are small and micro enterprises. All of them are privately owned. Most of the SMEs in Central Serbia are engaged in mushrooms and forest fruits business (83.3%). SMEs in NWFPs were only working at 52.5% of capacity. Regarding the quantity of NWFPs that are processed and placed on the domestic and foreign markets in Serbia, fungi were the greatest product in the period examined (1993-2014). In Central Serbia export orientation of NWFPs is higher by 2.57 times, compared to sales on the domestic market. The most common value chain is: supplier-processor-wholesaler-retailers-consumers.

Zusammenfassung

Die Wertschöpfungskette beschreibt die Abfolge von Prozessen, welche ein Service oder Produkt vom Rohmaterial über die Produktion und den Vertrieb bis hin zum Endkonsumenten durchläuft. Ziel dieses Artikels ist es, für die analysierten Betriebe in der Statistikregion Zentralserbien die Kauf- und Verkaufsdynamik sowie den Wert von Nicht-Holz Produkten (NHPs) zu ermitteln. Zweck dieser Studie ist es, die Entwicklungsmöglichkeiten einer nachhaltigen Nutzung von NHP für kleine und mittlere Betriebe (KMU) in ausgewählten Gebieten von Zentralserbien zu untersuchen. Gegenstand der Analyse sind die Einkaufs- und Verkaufsquoten sowie die erzielten Marktpreise in den Untersuchungsbetrieben. Die Studie umfasst 55 Betriebe, die sich mit dem Einkauf, der Verarbeitung oder dem Verkauf von NHPs beschäftigen. Die Rücklaufquote betrug 87,3%. Dieser Artikel betrachtet folgende NHPs: Pilze, Waldfrüchte sowie Heil- und Gewürzpflanzen. Alle durchgeführten Interviews umfassten sowohl qualitative als auch quantitative Fragen sowie einen Abschnitt zu sozio-ökonomischen Aspekten. Die erhobenen Daten werden untergliedert nach dem Einkauf von Rohmaterial, dem Verkauf von veredelten NHPs am heimischen Markt sowie dem NHP Export. Der Schwerpunkt der Studie liegt auf dem Einkommen/Betriebsergebnis, den Verarbeitungstechnolo-

gien, dem Vertrieb, den Exportländern, den Einkaufs- und Verkaufspreisen sowie den Verteilerkanälen der 55 analysierten Betriebe. Der parametrische Statistikansatz der Regressionsanalyse dient dazu, die durchschnittlichen Jahreszuwachsraten (DJZWR) im Einkauf und im Verkauf auf den heimischen Märkten und im Export von NHPs zu bestimmen. Die meisten der KMUs im NHP Sektor befinden sich in ländlichen Gebieten von Zentralserbien (ca. 67,4%) und davon sind 63,5% Klein- oder Mikrobetriebe. Alle Betriebe sind Privatunternehmen. Die meisten dieser KMUs aus Zentralserbien handeln mit Pilzen oder Waldfrüchten (83,3%). Allerdings schöpfen diese KMUs des NHP Sektors nur 52,5% ihrer Kapazität aus. Im Analysezeitraum 1993 – 2014 waren Pilze die dominanten Produkte, sowohl in Bezug auf die verarbeitete Menge als auch gemessen am Inlandsabsatz sowie am Exportvolumen. In Zentralserbien werden 2,57 Mal so viel NHPs exportiert als auf den heimischen Märkten verkauft. Dabei ist die Kette: Lieferant-Verarbeiter-Großhandel-Einzelhändler-Konsumenten vorherrschend.

1. Introduction

The constant development of forestry has led to an expansion of the traditional framework in which forestry now has the potential for creating a symbiosis with other disciplines, such as economics, sociology, ecology, and statistics. Non-wood forest products (NWFPs) (Arnold, 1995) have increased in importance through the expansion of organic production and are now an integral part of modern concepts of bioeconomy (Jordan et al., 2007; Birch and Tyfield, 2013) and sustainable development (Hopwood et al., 2005). The study finds that value chains as part of the bioeconomy (Kaplinsky, 2000; Gereffi and Fernandez-Stark, 2011), are evolving and vary depending on the actor, but display similarities such as the emphasis on economic output (Donaldson et al., 2006) and a broad, cross-sectoral focus. Various aspects of the bioeconomy have been increasingly explored (McCormick and Kautto N., 2013). One of those important for forestry, is NWFPs, because the trade of commercially important NWFPs is estimated at 11 billion US$·year-1 (Iqbal, 1993; Broad et al., 2003) in the world. The collection, and in some cases the sale, of NWFPs provides one of the most widely accessible livelihood opportunities available to poor rural people in the regions of Africa. Percentage contribution to household income of NWFPs to rural households in Africa varies between 15.0-28.4% (Shackleton and Gumbo, 2010). The value of the commercial trade in NWFPs to regional and national economies can be substantial, although general data are extremely scarce or unreliable.

A significant part of the rural labor force in Serbia (45-50% of the employed rural population) work in agriculture, while agriculture comprises more than 20% of total employment in the Republic of Serbia (Vukmirović and Smith Govoni, 2008). There are app. 6500 people employed in the forestry sector of Serbia. According to the National Program of Rural Development, the main reasons for the high dependence on agriculture are reduced employment opportunities and low investment activity, especially in rural areas (Keča et al., 2015).

The total forest area in Serbia is 2.25 million hectares or 29% of the territory, and thus Serbia is ranked as medium wooded land. The total growing stock amounts to 363 million m^3, while the annual increment is 9 million m^3. NWFPs are very attractive for rural population as an additional source of income (Pepke, 2010; Keča et al., 2013). Countries of South-Eastern Europe are a very attractive area for collecting NWFPs and have a significant role in international trade (Kathe et al., 2003). The current situation in terms of reducing world poverty is a key factor in achieving the double goals of increasing the value of forest resources, by saving wood as a raw material in the forest, and improving the financial condition of the working age population (Gaulli and Hauser, 2011). The increasing global demand for mushrooms has enabled the companies from Serbia, in accordance with their capabilities, to concentrate more and more on the export of final products from mushrooms (Keča et al., 2014). Serbia is known for a rich spectrum and a wide distribution of mushrooms, the country being located in a moderate zone with rich deciduous and coniferous forests. Large number of plant species, diverse soil types and climatic conditions are appropriate for growing a range of commercially important species of mushrooms such as: *Boletus edulis, Chantherellus cibarius, Craterellus cornucopioddes, Lactarius deliciosus, Marasmius oreades, Tuber aestivum* and *Tuber magnatum*. Thousands of families are engaged in collecting NWFPs in Serbia with a total of 120,000–150,000 individuals according to some estimates. In 2007, Serbia exported a little over USD 10 million worth of fresh (chilled) forest mushrooms to the EU 25. In second place was the export of dried forest mushrooms, at about USD 8.5 million, followed by preserved forest mushrooms at USD 3.6 million (Keča et al., 2014, 2015). Forests of Central Serbia are ecosystems containing a large number of medicinal plants of outstanding properties, valued on the market and frequently used by pharmaceutical and cosmetic industries (Keča et al., 2012). Due to the variety of plant species and convenient natural characteristics, the area of Central Serbia is identified as highly suitable for the development of an NWFPs based sector and organic production (Marčeta and Keča, 2014). More intensive use of NWFPs opens a number of possibilities for development of micro, small and medium entrepreneurships, which can foster economic development in rural areas (Marshall et al., 2006; Vuletić et al., 2009) in Western Balkan. Many studies all around the world deal with the concept of NWFPs under different aspects. The bulk of studies lies in the fields of socio-economics and conservation issues and dates back to the 1990-ies (since Earth Summit in Rio de Janeiro, 1992) (Janse and Ottitsch, 2005; Marčeta and Keča, 2014). In addition, first definitions of NWFPs date from this period (Chamberlain et al., 1998).

2. Material and methods

This paper focuses on the use of value chain analysis (VCA) in buyer–supplier relationships (Dekker, 2003) in regard to NWFPs. In the management accounting literature VCA is regarded as a core analytical tool of strategic management accounting (SMA) (Shank and Govindarajan, 1993; Porter, 2008). The concept of the value chain has risen to the fore in recent years to reflect major changes in market conditions (Mitchell et al., 2009).

The VC of NWFPs in Serbia is a "supply driven chain" (Kaplinsky and Morris, 2001; Benton and Maloni, 2005) that is characterised by a horizontally based structure driven by local firms and companies (Sweeney, 2010; Keča et al., 2014) which are dependent mainly on private capital. The phrase "internal supply chain" (Bowersox et al., 2002) is used to describe work aimed at breaking down the barriers between functions within organizations. Most businesses – certainly manufacturing-based business, as NWFPs business – can be described in terms of the five key supply chain activities: buy; make; store; move; and sell. This is what is referred to as the internal (or micro or intra-firm) supply chain (Fawcett and Magnan, 2002). Every product is delivered to the final consumer (the only source of 'real' money in the chain) through a series of often-complex movements between companies, which constitute the complete value chain. In other words, the supply chain is increasingly viewed as a single process, with the various links (i.e. companies) in the chain needing to function in as seamless a manner as possible (Sweeney, 2010). To understand the implications of promoting NWFPs commercialization, it is necessary to understand who and what is involved in the production-to-consumption system (Belcher et al. 1998) or VCA. Intention of VCA is to describe the full range of activities that are required to bring a product or service from conception (Kaplinsky and Morris, 2001).

There were 149 registered and legal small and medium sized enterprises (SMEs) dealing with NWFPs in Serbia in 2014 (Ministry of Agriculture and Environmental Protection, Internal document, 2014). The majority of them (63) are situated in the statistical region of Central Serbia. A statistically valid, representative sample of 55 enterprises, of which 15 were medium sized enterprises, was selected from Central Serbia (Commission Recommendation 2003/361/EC, 2003, Ayyagari et al., 2007). The remaining 40 enterprises were small or micro sized enterprises (staff of 10 to 50). All of the companies are privately owned. The primary criteria for inclusion of enterprises were: 1. SMEs according to Law on Accounting and Auditing of Republic of Serbia (2010), database of Business Registers Agency, 2. more than 10 permanent workers, 3. average annual placement of over 100 t of NWFPs and placement on domestic and/or foreign markets, 4. they are engaged in buying, processing and selling/placement of NWFPs. The response rate was 87,3%; in that way the research has the census research (Pinsonneault and Kraemer, 1993; Bryman and Bell, 2011). In this paper the following NWFPs are considered: mushrooms, medicinal and aromatic plants and forest fruits. The interviews were structured to address standard questions and prior to each interview, the interviewees (owners or general managers of SMEs) were given a full explanation of the purpose of the questioning (Gachter, 2004, Dul and Hak 2008). Face to face interviews were conducted with the leading companies in the field; in other cases, questionnaires (57 questions) were mailed (open- and close-ended questions). All interviews, which were conducted, contained qualitative and quantitative questions and a part of socio-economic questions (Kothari, 2004). The data are divided into those related to the purchase of raw materials, the sale of final NWFPs on the domestic market, and to NWFPs export. The questionnaire used in the survey-included questions on quantities purchased and placed NWFPs, as well as price of these products and distribution channels.

The aim of the study was to analyze VCs and business relations among the companies engaged in purchasing, processing, and selling NWFPs in Central Serbia (refers to territory of Serbia without of Vojvodina and Kosovo and Metohija). The objectives of the research (in terms of the analyzed companies) were: income / outcomes, processing facilities, supply, export destination, price (purchase and sale) and distribution channels. Parametric statistics in terms of regression analysis was used to determine the average annual growth rates (AAGR) as regards purchase, sale on the domestic market and exports (Altman et al., 2005). Analyses of the results, including t-tests, F-tests, correlations and regression models, were carried out using SPSS 12 (SPSS Inc., Chicago, Illinois). The primary method used is modeling, followed with the statistical methods including trend, regression and correlation analysis. To verify the obtained regression models trend correlation coefficient (R), t – statistics derived estimates of parameters and F – statistics (to assess the significance of the correlation coefficient) were used. For all tests statistical significance was $\alpha = 0.05$.

3. Results and discussion

In the aftermath of the global financial crisis of 2008–2009, there has been an increased interest in the role of small and medium enterprises in job creation and economic growth in the world (Ardic et al., 2011). SMEs in Central Serbia are characrerised by heterogeneous structure with underused capacities and lack of financial support, as well as insufficient information of owners of SMEs in funding possibilities and expansion into new markets (Keča and Bogojević, 2013). The most of the SMEs in NWFPs sector of Central Serbia are situated in rural areas (app. 67,4%) and 63,5% are small and micro enterprises. All of them are privately owned. The majority of the workers are seasonal workers so that the number of engaged labor force varies according to seasons. The NWFPs were found in forest ecosystems and meadows, harvested seasonally, and all of them are wild (Keča et al., 2013). Average number of the workers are 97 workers/year/forest area of Central Serbia in NWFPs sector. The most of them are male, average age of 38. The numbers of pickers in Serbia varies with season, but it is estimated by authors that approximately 1 000 to 3 000 people are involved (Keča et al., 2013). The most of SMEs are engaged in mushrooms and forest fruits business (83.3%) in Central Serbia. External factors negatively influencing business were unfair competition, undeveloped market and lack of favorable loans and subsidies. The majority of the SMEs in Central Serbia (77%) trade in the domestic and international market and the factors that affect negatively on their businesses are: unfair competition among entrepreneurs in supplying the raw NWFPs, taking the technology innovation, poorly developed markets and the lack of favorable loans and subsidies. Development of NWFPs, therefore, has potential in developing countries, when labor is cheap and in ample supply (Iqbal, 1993). However, SMEs in NWFPs were only working at 52.5% of capacity in Central Serbia, which is insufficient compared to the potential.

Regarding the quantity of NWFPs that are processed and placed on the domestic and foreign markets in Serbia (Fig. 1) fungi were the greatest product in the period examined (1993-2014). Fluctuations in annual processed volumes and placements are evident regarding other products, which are affected by several factors including (un)favorable natural factors, and political and economic conditions in the country. In addition, The NWFPs trade in Central Serbia is characterized by fluctuations in supplies. Secondary processing and finalization of the product are relatively higher in larger companies that are mostly export-oriented, while smaller companies are reduced to primary processing, largely due to the lack of adequate equipment (Keča et al., 2015), as well as unfair competition that prevails in the market (79.1% of respondents). In addition, external negative influencing factors are undeveloped market and sometimes-unfavorable climate conditions (17.3% of respondents).

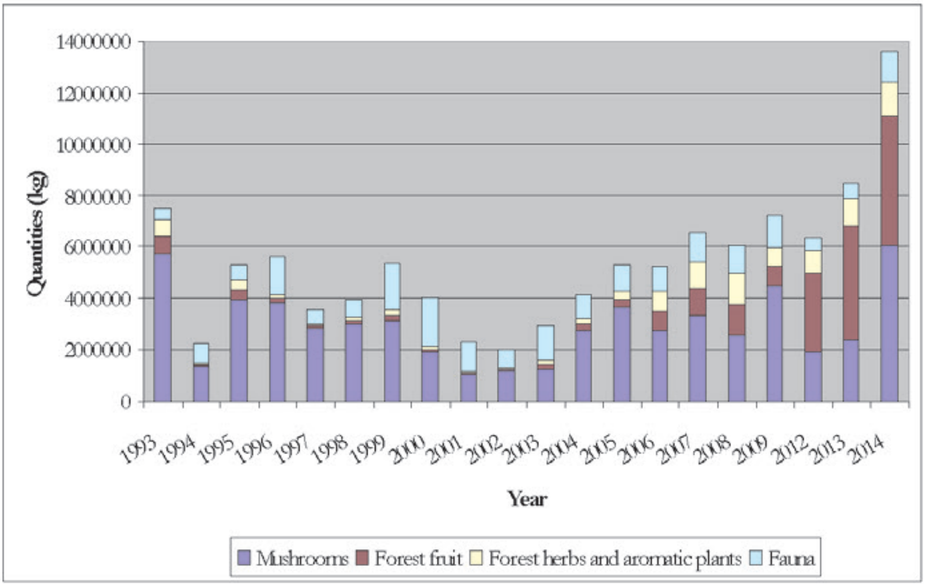
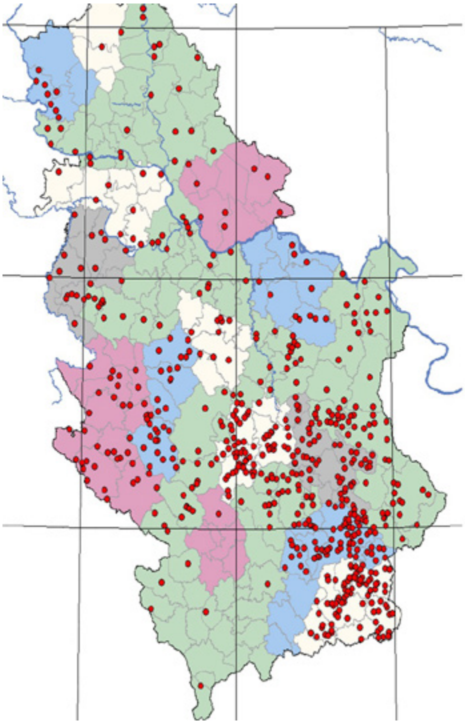


Figure 1: The quantities of processed and placed NWFPs in the market in the period (1993-2014).
Abbildung 1: Mengen verarbeiteter und am Markt abgesetzter NHP in der Periode 1993-2014.

The quantities of purchased raw NWFPs in Central Serbia at 284 purchase stations are unified and based on the total level expressed through a linear trend with strong correlations, significant parameters, and an AAGR of -10.6% (see Table 1). Products covered by the purchase are: herbs, forest berries, honey and mushrooms.



Map 1: The main purchase stations of NWFPs in Serbia

Karte 1: Die hauptsächlichen Einkaufsstationen für NHP in Serbien

It is important to mention that mushroom pickers in Serbia sell products to the "purchase stations", which are usually located near the SME's (92.5%) (Map 1) (Keča et al., 2013) or directly sell the products to the firms, which organised several truck collecting lines and immediately pay in cash for product (Keča and Marčeta, 2014). The results show that overall across Central Serbia a picker can pick 20-50 kg of different NWFPs, 43.1 kg berries and 21.5 kg mushrooms per ha.

Table 1: Elements of regression analysis of purchase of NWFPs

Tabelle 1: Elemente der Regressionsanalyse für den Einkauf von NHP

Parameter		***t***	***R***	***F***	Y= -260,15x + 525400	
a	525399,77	3,00	0,748	8,944		
b	-260,15	-2,99			**AAGR *(%)***	**-10,6**

Placement of NWFPs (in tons) on the domestic market also exhibited a negative trend, with an AAGR of -16.0%, and a linear trend, with strong correlation (see Tab 2).

Table 2: Elements of regression analysis of placement of NWFPs

Tabelle 2: Elemente der Regressionsanalyse für den Verkauf von NHP

Parameter		***t***	***R***	***F***	Y= -67,509x + 136122	
a	136121,55	3,94	0,829	15,475		
b	-67,50	-3,93			**AAGR *(%)***	**-16,0**

Export of NWFPs (in tons) was also negative, with AAGR of -14.1%, a linear trend, strong correlations and significant parameters (see Table 3). Comparing to other parts of Serbia, it can be concluded that the highest growth rates of mushrooms are: for dry Boletus in Belgrade statistical region and dry Chanterelles in Šumadija and Western Serbia (Keča et al., 2014).

Table 3: Elements of regression analysis of export of NWFPs

Tabelle 3: Elemente der Regressionsanalyse für den Export von NHP

Parameter		***t***	***R***	***F***	Y= -254,7x + 513829	
a	513828,68	3,475	0,794	11,980		
b	-254,69	-3,461			**AAGR *(%)***	**-14,1**

In summary, the AAGRs decreased for purchases, placements and export of NWFPs from Central Serbia (Fig. 2). Conversely, some products demonstrated a very high market potential (in purchase: Pleurotus osteatus, Cornus mas; in placement on domestic market: Forest honey, Forest fruits, Rosae pseudofructus; in export: vinegar of Malus communis, Rubus ideaus). However, some new NWFPs are also being identified and commercially developed. On the other hand, it is necessary to strengthen strategy of the products such as: Rubus ideaus, Cahtharellus cibarius, Rosae pseudofructus (in purchase), Boletus edulis, Cantharellus cibarius, Rubus ideaus (in placement), dry, brined and frozen Boletus edulis, fresh Cantharellus cibarius (in export).

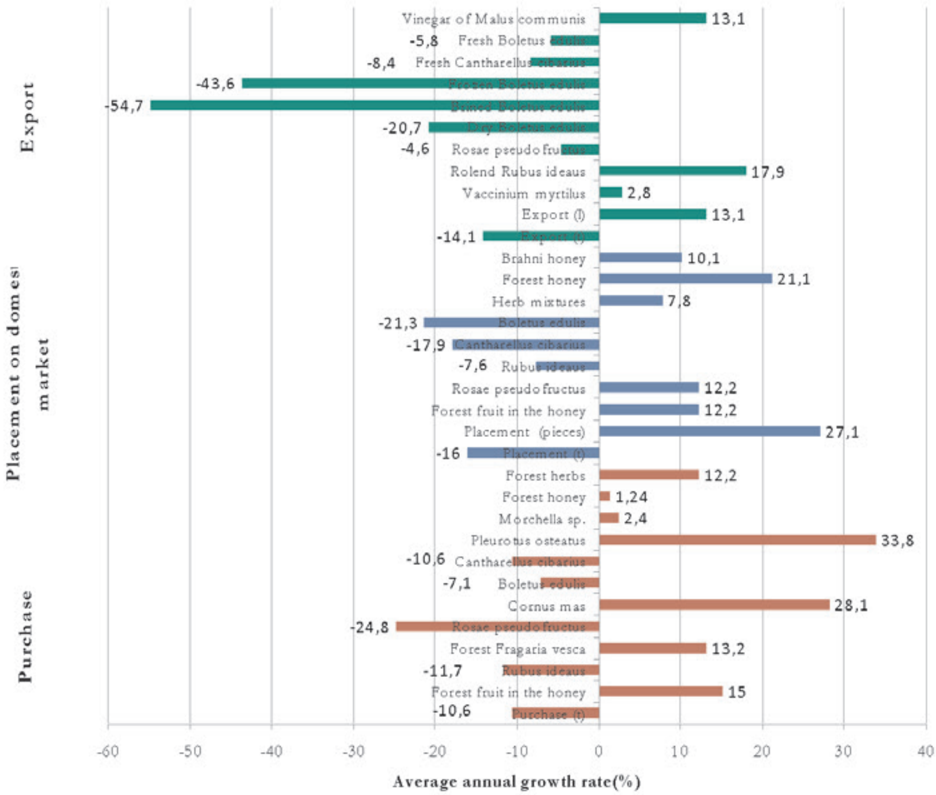


Figure 2: AAGR in purchase, placement and export of NWFPs from Central Serbia

Abbildung 2: DJZR von Einkauf, Verkauf und Export von NHP aus Zentralserbien

This study analysed products, companies, and structural elements of VCAs (Fig. 3), using a production-to-consumption system approach (Belcher and Schreckenberg, 2007), which was focused on the range of activities and transfers involved in the production, transport, distribution and promotion of particular commodities.

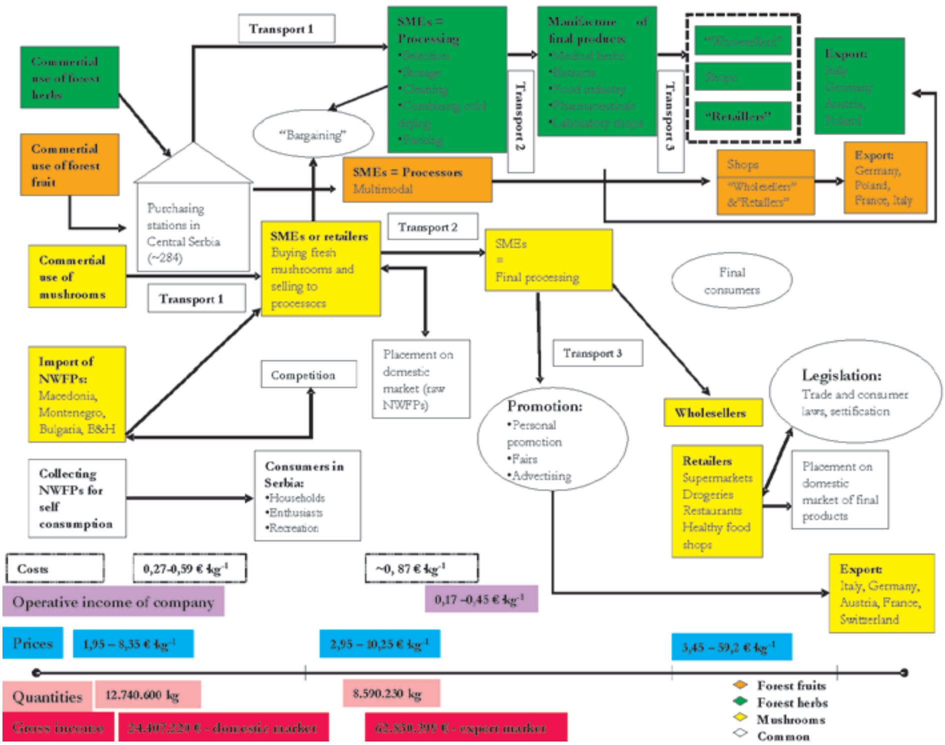


Figure 3: Value chain of NWFPs from Central Serbia

Abbildung 3: Wertschöpfungskette von NHP aus Zentralserbien

The value chain for the analyzed group of products (Fig. 3) (mushrooms, forest fruits, forest herbs) was broken down into individual activities, such as collection, processing, storage, transport, marketing, etc. It can be observed that some amounts of raw NWFPs are imported from neighboring countries (FYR of Macedonia, B&H, Montenegro, Croatia, Bulgaria, etc.). In addition, an amount of approximately 15% of berries and mushrooms are collected for self-consumption in Central Serbia. It has been observed very often, especially in Southern and Eastern Serbia, a number of pickers who collected amount of NWFPs placed by the so-called "local dumping prices" and thus present a problem to pickers with permission. Implementation of Act about control of using and trade of wild flora and fauna in Serbia (Official Gazette of Republic of Serbia 09/10, 2010) protect and maintain wild fund of flora and fauna, including NWFPs. Permits and quotas are determined by the number of collected NWFPs last year and production needs of producers or entrepreneurs (issued by the Institute for Nature Protection) (Keča et al., 2013). It can be observed that the different processing activities are represented dependent of the group of the product. For forest herbs, the most significant phases are, so called secondary processing: selection, storage, cleaning, combining cold drying, and packing. In mushrooms processing dependent on final products the phases are: freezing, brining, drying, packing, etc. Final products are placed in the most cases (92.7%) through wholesalers and just 7.3% by retailers (supermarkets, drug stores, healthy food shops, restaurants, etc.). Dependent on the product, export destinations are: Germany, Italy, Austria, France, Switzerland, Poland, Western Balkan countries.

Gross income from placement on domestic market of final NWFPs is app. 24.4 mil. € and by exports approximate income is of 62.8 mil. €. It can be concluded that in Central Serbia export orientation of NWFPs is higher by 2.57 times compared to sales on the domestic market.

Prices of raw NWFPs are 0.27-0.59 €/kg, final products placed on domestic market are in a range 2.95-10.25 €/kg, and export products prices are in a range 3.45-59.20 €/kg. Top five products that have achieved the highest revenue in the domestic market are: Forest raspberry jam, sweet and jam, blueberries, and bee and honey products. Products that have earned the most revenue sales on foreign markets from the Central Serbia are: chanterelles, herbs, boletus, jam, marmalade and sweet and dry boletus.

Price is variable depending on the balance of supply and demand through the year, but also on: the purchase prices of NWFPs, costs of raw materials, followed by the cost of cleaning, processing, packaging and transportation of products, as well as the costs of promotion and the time of year when NTWPs are harvested (Keča et al., 2015). According to the database of the Institute for Nature Conservation was established price list of wild flora, fauna and fungi that can be collected each year. The highest fluctuations are present in mushrooms and the lowest in wild fruit in 2015. The most expensive raw materials are: *Tuber magnatum, Gentiana sp., Vaccinium sp*., while the cheapest are: *Craterelluss cornucopioides, Betula pendula* and *Crategus sp*. Almost all enterprises indicated that the price at which they sold was decided on a "cost plus" (Duvemo et al., 2014) basis.

The most common channel is the supplier-processor-wholesaler-retailers-consumers, particularly in the case of mushrooms and honey products in Central Serbia (Fig. 3), where it is obvious 3 types of transport (Purchase station -> Processors -> Wholesalers). Approximately 68.5% of the interviewed entrepreneurs had their own transport to facilitate rapid distribution to final consumers. For successful business in the NWFPs it is crucial that enterprises have quality physical distribution (stock management, warehousing, transport, and stock control) (Lambert et al., 1998).

This "system" of VCA of NWFPs is sensitive to numerous factors such as the nature and characteristics of a product, the markets into which they are sold, demand and supply factors (Barnes, 2002; Keča et al., 2013), risks and uncertainties, and how to cope with the possibility of over harvesting.

Wood processing industry of Serbia is export oriented and it is continually recording profit from export of app. 502 mil. €, comparing to NWFPs business of 62.8 mil. € in Central Serbia. There is app. 2 170 SMEs mostly privately owned in wood processing industry and furniture, and in NWFPs sector 146.

Table 4: Enterprises and employees in the forestry sector of Serbia

Tabelle 4: Unternehmen und Beschäftigte im Forst- und Holzsektor in Serbien

Active enterprises	**Number of enterprises**	**Number of employees**
Forestry	121	5 331
Wood processing and wood products	1 508	8 653
Furniture	662	13 226
NWFPs SMEs	146	n.a.

Source: Chamber of commerce of Republic of Serbia (2015)

Contribution of export of wood processing industry to Serbian economy is 5.7% and NWFPs is 0.7%. In future, it should use Serbian favourable geographical position and good transport communication with surrounding markets to promote and market NWFPs with higher degree of finalization. Tradition in the production of NWFPS and good quality-price relationships for products are also the strengths of products from Central Serbia.

The paper has examined the role of entrepreneurship in NWFPs commercialisation through the lens of value chains in Serbia. As such, VCA is a way of understanding markets and marketing of commodities (Kaplinsky and Morris, 2001). This analysis of NWFPs commercialisation has shown that entrepreneurship and promotion strategies (Porter, 2008) are important for the development of innovative marketing schemes.

4. Conclusions

All of the analysed processing companies in Central Serbia are privately owned. On average they used their production capacities only at a level of app. 52.5%. The main products in Central Serbia are fungi and forest fruit in purchase. In placement on domestic market these are honey and forest fruit and in export forest fruit and final products of them. Linear regression model of trend of growth of final production on domestic and foreign market shows negative average annual growth, with high correlation coefficients. The export markets are mainly countries of the EU. There is a broad range of trade-related instruments that impact on the trade in NWFPs. Trade liberalization appears to benefit NWFPs-export, as well as some sort of certification and labeling schemes. Also the suggestions are: providing a guaranteed minimum price to producers, improving social and working conditions of producers and the provision of financial incentives to all the actors in the value chain related to NWFPs.

Almost all enterprises benefit a pricing strategy using the “cost plus” method and purchase and placement prices in markets vary, dependent on supply and demand during the year and climate conditions. Gross income from placement on domestic market of final NWFPs is app. 24.4 mil. € and by exports approximate income is of 62. 8 mil. €. from Central Serbia. In the future, it is necessary to increase the level of finalization of products, improve the efficiency of organizational activities, working on financial subsidies of state to SMEs in this sector and simplify licensing procedures for business in NWFPs. These results can be used as a basis for further research on VCA of SMEs and possibilities of improvement of entrepreneurship in NWFPs sector. In the future, serious attention should be paid to ensure a stable supply base, while planning development of NWFPs in Central Serbia.

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Forestry measures in the European Rural Development programs 2014-2020: planning expenditure and priorities in the EU Member States

Maßnahmen der Forstwirtschaft im Rahmen des Europäischen Programms zur Entwicklung des ländlichen Raumes 2014-2020: Planung von Fördersummen und Prioritäten in den EU-Mitgliedsstaaten

Sonia Marongiu*, Filippo Chiozzotto, Luca Cesaro

Keywords: rural policy, evaluation, forestry measures, rural development

Schlüsselbegriffe: Politik des ländlichen Raumes, Evaluation, forstliche Maßnahmen, ländliche Erntwicklung

Summary

The European Treaty on the functioning of EU makes no reference to specific provisions for a common European forest policy but, during the time, some policies and in particular the rural development policies have had a great impact on the governance of the EU Member States. Forest policy is considered as an fundamental part of the EU rural development policy and the European Agricultural Fund for Rural Development (EAFRD) contributing to the implementation of rural development programmes in each Member State can be considered as the main source of funding for forestry

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measures. The new Rural Development Regulation (EU) 1305/2013 for the programming period 2014-2020 provides specific intervention based not only to the primary production function of forests and its contribution to the economic advancement of rural areas, but also to the new demands arising on forests. In particular a greater emphasis is given to the role of forests in maintaining and creating ecological and amenity services, in increasing biodiversity and in fighting against the climate change. The paper focuses on the forestry measures provided by the Reg. (EU) 1305/2013 (Measure 8 and Measure 15) giving an overview of the decisions taken by each Member State in terms of planned expenditures, priorities and focus area on the basis of the Rural Development Programmes (RDPs) approved in December 2015.The work gives a general description of Measures and sub-measures describing how they are classified in the general framework of Reg. (EU) 1305/2013, how the EU Member States have allocated the programmed expenditure between the two measures and what are the most important targets at EU level in terms of priorities and focus areas. The same analysis on the single sub-measures, is made for the Italian case on the basis of the information gathered from the 21 RDPs.

Zusammenfassung

Der Vertrag über die Zusammenarbeit innerhalb der EU enthält keine spezifischen Bestimmungen bezüglich einer gemeinsamen europäischen Forstpolitik. Trotzdem hatten einzelne Strategien, im speziellen die Strategie zur Entwicklung des ländlichen Raumes, im Laufe der Zeit starken Einfluss auf die Entwicklung einzelner EU Mitgliedsstaaten. Die Forstpolitik wird als fundamentaler Bestandteil der EU-Politik zur Entwicklung des ländlichen Raums und des Europäischen Landwirtschaftsfonds für die Entwicklung des ländlichen Raums (ELER) gesehen die zur Umsetzung ländlicher Entwicklungsprogramme in den Mitgliedsstaaten beitragen und ihrerseits wiederum die Hauptfinanzierungsmöglichkeit für forstliche Maßnahmen darstellen. Die Vorgaben der neuen Vorschriften für die Entwicklung des ländlichen Raumes (EU) 1305/2013 für die Periode 2014-2020 beziehen sich nicht nur auf die Produktionsfunktion von Wäldern und ihren wirtschaftlichen Beitrag für den ländlichen Raum sondern thematisieren auch neuartige Ansprüche an Wälder. Im Detail wird Wäldern eine Bedeutung beim Erhalt und der Schaffung ökologischer und spiritueller Leistungen, beim Erhöhen der Biodiversität sowie im Kampf gegen die Auswirkungen des Klimawandels beigemessen. Dieser Beitrag betrachtet die forstlichen Maßnahmen der Verordnung (EU) 1305/2013 (Maßnahme 8 und Maßnahme 15) und gibt einen Überblick über die Entscheidungen der Mitgliedsstaaten im Sinne von geplanten Ausgaben, Prioritäten und Zielgebieten auf Basis des Programmes zur Entwicklung des ländlichen Raumes (RDP) welches im Dezember 2015 beschlossen wurde. Die Arbeit beschreibt wie Maßnahmenpakete und Einzelmaßnahmen im Gesamtkontext der Verordnung (EU) 1305/2015 zu sehen sind, wie die EU Mitgliedsstaaten die Aufteilung der Förderungen

zwischen den Programmen durchgeführt haben sowie die wichtigsten Ziele auf EU Ebene in Bezug auf Prioritäten und Zielgebiete. Die selbe Untersuchung auf Ebene der Einzelmaßnahmen wird für die Regionen Italiens auf Grundlage der im Rahmen von 21 RDPs gesammelten Daten durchgeführt.

1. Introduction

Even if the European Treaty on the functioning of EU makes no reference to specific provisions for a common European forest policy, in the last decades forests have been included in a broad array of EU policies and initiatives arising from different sectors, giving an important contribution to the implementation of sustainable forest management and helping Member States in taking their decisions on forests. In particular environmental policies (i.e. Natura 2000) and rural development policies have had a great influence on forest policies in the EU Member States (Edwards and Kleinschmit, 2013).

The formulation of forest policies is a competence of the single Member States that define their specific framework, their national and regional laws and regulations, their medium-long planning according to non-binding governance agreements such as the National Forest Programmes or the EU Forest Strategy. This last document has been issued in 1998 with the aim to establish a framework for forest-related actions to support sustainable forest management and the multifunctional role of forests. The same guiding principles are the basis of the new EU Forest Strategy (EU Commission, 2013) that, in addition, refers to the resources efficiency, which can be evaluated to the extent that all the realized interventions optimize the contribution of forests and forest sector to rural development, growth and job creation.

In this respect, forest policy is considered as an integral part of the EU rural development policy (European Commission, 1997) and the European Agricultural Fund for Rural Development (EAFRD) supporting the implementation of rural development programmes in each Member State is the main source of funding for forestry intervention. The changed role of forests in rural areas is the core of the new Rural Development Regulation (EU) 1305/2013 for the programming period 2014-2020 that provides specific intervention based not only on the contribution of the productive function of forests to the economic advancement of rural areas, but also on the new demands arising for other environmental services. In particular a greater emphasis is given to the role of forests in maintaining and creating ecological and amenity services, in increasing biodiversity and in fighting against climate change. With respect to the latter, forests are considered in a holistic approach aiming to contribute to the fulfilment of the basic principles of the EU Forest Strategy and having regard to the international and national commitments and to what has been defined in the Ministerial Conferences on the Protection of Forests in Europe. Comparing to 2007-2013 RD programming period, the greater overall focus upon farm and forestry sectors support and environmental management and investment expected for 2014-2020, is notable (DG for Internal Policies, 2016).

The paper focuses in particular on the forestry measures provided by the Reg. (EU) 1305/2013, giving an overview of the decisions taken by each Member State in terms of planned expenditures, priorities and focus area.

Different from the past, the Member States have drawn their RDPs addressing specific common EU priorities: knowledge and innovation; viability and competitiveness of agriculture and sustainable forest management; food chain organization, animal welfare and risk management; ecosystems related to agriculture and forestry; resource efficiency, low carbon and climate-resilient economy; social inclusion and poverty reduction. Every priority is broken down into specific focus areas (FA) and the Member States quantify their targets against the FA, setting out which measures will be used to achieve these targets and how much of funding will be allocated in each measure. Information about planned expenditure and resource allocation for the next programming period has been gathered on the basis of approved RD Plans (118 on total, in December 2015) which contents are summarized in the official factsheet issued by the European Commission. A first level of analysis is made at EU level while the Italian case is described more specifically, even in terms of comparison with the previous programming period (planned expenditure, modulation, final expenditure and financial execution).

The analysis is based mainly on two measures: Measure 8 concerning investments in forest area development and improvement of the viability of forests and Measure 15 concerning forest-environmental and climate services and forest conservation.

A general description of both measures and sub-measures is given in the second chapter that describes how they are classified inside the general framework of Reg. (EU) 1305/2013 and what are the most important changes introduced in the new regulation. Almost all the interventions realized in the last programming period have been repeated in the new rural development policy, though reorganized in a more structured way in order to permit integrated projects with a higher value added. Some interventions have been merged while others have been proposed as they stand.

The third chapter describes how the Member States have allocated the financial resources between Measures 8 and 15 in terms of priorities and focus areas. This preliminary analysis, based on the approved RDPs (December 2015), permits to have a first idea about the most important targets for each Member State in terms of forestry policy orientation inside the RD plans. The six new strategic priorities for RD are different from the previous three goals applying for the 2007-2013 period (farm and forestry competitiveness, environmental management, economic diversification and quality of life), in particular because they add climate change, adaptation and mitigation, knowledge and innovation. Specific analyses describe the general patterns of allocation to priorities in the 2014-2020 period, showing a predominance of spending on environmental protection and enhancing competitiveness in farms and forestry (DG for Internal Policies, 2016). This work is an additional contribution specifically devoted to forestry measures that can give an initial overview about the planning of forestry intervention in the EU Member States, their choices and their approaches.

A similar analysis is made looking at the Italian case, described in the fourth chapter. In Italy RD policy is managed at a regional level, in 21 different RDPs and policy schemes. The chapter describes the distribution of resources among the Italian regions, priorities and FAs together with a brief ex-post analysis regarding the level of expenditures at the end of the last programming period. Every region has allocated the budget for forestry measures according to the territorial needs and to specific priorities. The comparison between the future allocation and the expenditures resulting in the last programming period shows a general decrease of resources for forestry measures but a conservative approach in the application of intervention. All data have been collected by the Italian Rural Network, involved in the monitoring and evaluation framework of RD policies. This is the first step for the future monitoring activities, complicated by the 21 different RDPs which render the application of a homogeneous and coordinated forest policy at national level difficult.

2. Forestry measures in the Rural Development Programming period 2014-2020

In 1957, in the European Treaty of Rome on the functioning of EU, forest products (with the exception of cork) were excluded from the annex 1, that is the list of products for which the Common Agricultural Policy (CAP) has been defined and implemented. Consequently, forest policy remained a competency of Member States on the basis of the subsidiarity principles. Currently, there is not an EU common forest policy but a significant body of forest-focused and forest-related policies. One of them is the Rural Development (RD) policy, funded by the European Agricultural Fund for Rural Development (EAFRD), that includes specific interventions for forests and forest management. During the time, the importance of forestry inside the rural development policies strengthened and today it is considered as an integral part, contributing to the achievement of some important environmental, social and economic targets and delivering multiple services to society. For the next programming period 2014-2020, almost 100 billion of euros and further 61 billion of euros of public funding in the Member States will be allocated to fund RD policy. The policy is implemented through 118 different Rural Development Plans (RDPs), with 20 single national programmes and 8 Member States opting to have two or more regional programmes.

Different from the last programming period 2007-2013, EU Member States and Regions have defined their programmes on the basis of six EU priorities (broken down in different focus areas), indicated in the art.5 of Reg. (EU) 1305/2013:

1. fostering knowledge transfer and innovation in agriculture, forestry and rural areas;

2. enhancing the viability and competitiveness of all types of agriculture, and promoting innovative farm technologies and sustainable forest management;

3. promoting food chain organization, animal welfare and risk management in agriculture;

4. restoring, preserving and enhancing ecosystems related to agriculture and forestry;

5. promoting resource efficiency and supporting the shift towards a low-carbon and climate-resilient economy in the agriculture, food and forestry sectors;

6. promoting social inclusion, poverty reduction and economic development in rural areas.

Forests are mentioned explicitly in three of the priorities. The promotion of the sustainable management of forests is included in priority 2. The protection of ecosystem dependent of forestry is included in priority 4, while the role of forest in moving towards a low carbon economy, sequestering carbon and enhancing the production of renewable energy is included in priority 5.

During the last programming period 2007-2013, a variety of measures covered different types of support for forestry investment and management. In order to simplify the implementation of forestry intervention and to allow the realisation of integrated projects having a higher added value, all the measures have been grouped into one single measure, that is Measure 8, under the article 21 of Reg. (EU) 1305/2013. The investments improving the resilience and environmental value of forest ecosystems, included in Measure 15, are eligible under the article 34 of Reg.1305/2013. Forestry interventions under Natura 2000 or other interventions affecting the forestry sector are provided by other measures and are not considered in this work.

Measure 8 concerns the investments in forest area development and improvement of the viability of forests (art.21-26 of Reg. (EU) 1305/2013). The measure includes several sub-measures:

- 8.1: afforestation and creation of woodland (art.22)

- 8.2: establishment of agroforestry systems (art.23)

- 8.3 and 8.4: prevention and restoration of damage to forests from forest fires, natural disaster and catastrophic events, including pest and diseases outbreaks and climate related threats (art.24)

- 8.5: investments improving the resilience and environmental value as well as the mitigation potential of forest ecosystems (art.25)

- 8.6: investments in forestry technologies and in the processing, the mobilising and the marketing of forest products (art.26)

The new regulation introduces new elements. As concerns sub-measure 8.1, the two interventions of afforestation of agricultural and non-agricultural land, are grouped in one intervention in order to simplify the procedure for the payment calculation (no need to check if the land is agricultural or not or if the beneficiary is a farmer or not). Afforested areas may benefit simultaneously from the direct payments under the first pillar of CAP. Moreover plantation of short rotation coppice is not supported. In sub-measure 8.2, not only the cost of establishment of agroforestry systems is included but also the maintenance costs.

Important elements are introduced in sub-measures 8.3 and 8.4 and, in particular, the measures of prevention against pest and diseases, natural disasters, catastrophic events and climate change related events (as drought and desertification, as defined in the WTO Annex 2 on disasters).

Measure 15 supports forest-environmental and climate services and forest conservation (art.34 Reg. (UE) 1305/2013).The measure responds to the needs of promoting the sustainable management and improvement of forests and woodland, including the maintenance and improvement of biodiversity, water and soil resources and combating climate change. It responds also to the need to conserve the forest genetic resources (novelty compared to the past), including activities such as development of different varieties of forest species in order to adapt to specific local conditions and to make forests more vital and resilient to pests and diseases and able to provide the expected level of ecosystem services.

3. Allocation of planned resources for Measure 8 and 15 in the European Member States

In the next programming period EU Member States will allocate 4.6% of the overall RD budget for M8 (about 7,070 millions €) and 0.3% for M15 (about 365 millions €). The distribution of the budget among them is shown in Table 1 together with a comparison of the planned expenditures with the total forested area (FOWL, forests and other wooded land).

Table 1: Planned expenditure for Measure 8 and 15 in EU Member States (Rural Development Programmes 2014-2020)
Tabelle 1: Geplante Ausgaben für Maßnahmen 8 und 15 in den EU Mitgliedsstaaten (Programm für die ländliche Entwicklung 2014-2020)

	Planned expenditure M8 (,000 €)	Planned expenditure M15 (,000 €)	Total planned expenditure (,000 €)	% planned exp. on total (EU M8+15)	Total FOWL (,000 ha)	Total planned expenditure/FOWL (€/ha)
Austria	127,050	7,000	134,050	1.8	4,022	33.3
Belgium	18,067	0	18,067	0.2	719	25.1
Bulgaria	63,527	8,750	72,277	1.0	3,845	18.8
Croatia	91,064	0	91,064	1.2	2,491	36.6
Cyprus	6,500	0	6,500	0.1	386	16.8
Czech Republic	78,078	7,821	85,900	1.2	2,667	32.2
Denmark	47,151	21,372	68,523	0.9	658	104.2
Estonia	10,000	0	10,000	0.1	2,456	4.1
Finland	0	0	0	0.0	23,019	0.0
France	35,3236	1,017	354,252	4.8	17,579	20.2
Germany	280,495	8,487	288,982	3.9	11,419	25.3
Greece	339,544	0	339,544	4.6	6,546	51.9
Hungary	209,413	51,691	261,104	3.5	2,190	119.2
Ireland	0	0	0	0.0	801	0.0
Italy	1,402,612	51,642	1,454,254	19.6	11,110	130.9
Latvia	36,864	0	36,864	0.5	3,468	10.6
Lithuania	122,384	1,274	123,658	1.7	2,284	54.1
Luxembourg	0	0	0	0.0	88	0.0
Malta	3,500	0	3,500	0.0	0	0.0
Poland	300,997	0	300,997	4.0	9,435	31.9
Portugal	570,335	5,599	575,934	7.7	4,907	117.4
Romania	124,513	117,804	242,317	3.3	6,951	34.9
Slovakia	137,684	4,950	142,634	1.9	1,940	73.5
Slovenia	59,481	0	59,481	0.8	1,271	46.8
Spain	2,057,274	24,337	2,081,611	28.0	27,627	75.3
Sweden	11,889	0	11,889	0.2	30,505	0.4
Netherlands	0	53,147	53,147	0.7	376	141.3
United Kingdom	619,275	0	619,275	8.3	3,164	195.7
EU	7,070,932	364,891	7,435,822	100.0	181,925	40.9

Source: EU Country Factsheets

The relative importance of the budget planned for forestry measures in the EU Member States (budget for forestry measures/total RDP budget) is highly variable. The biggest share of funds is allocated in Spain (28.0%) and Italy (19.6%), which together represent almost half the total expenditure planned at European level for the selected forestry measures, followed by the United Kingdom (8.3%) and Portugal (7.7%). Conversely, the smallest allocation can be found in Cyprus and Malta, the latter being the only EU Member State without forest land. Finland, Ireland and Luxembourg will not finance forestry interventions through their Rural Development Programmes.

Looking at each single measure, it can be seen that the majority of Member States have focused their expenditure plans mostly on Measure 8, with the exception of Romania which has divided the funds almost equally between the two measures. Other countries such as Netherlands, Italy and Hungary, have allocated a significant amount of resources on forest-environmental and climate schemes, while eleven Member States did not activate Measure 15 at all.

In the last column of Table 1an index shows the planned expenditure per hectare of forested area. On average in the European Union, the planned expenditure per hectare of forest and other wooded land is 40.9 €. Nonetheless, this value deeply varies among the Member States. The highest rate can be found in the United Kingdom: 195.7 €/ha to finance forestry interventions under the sole Measure 8, as Measure 15 has not been implemented. Then there is the Netherlands, which curiously adopted an opposite approach: in facts, the Dutch Managing Authority decided to allocate 141.3 €/ha but only for the intervention under Measure 15 of forest-environmental and climate services and forest conservation. These two countries are followed by Italy (130.9 €/ha), Hungary (119.2 €/ha), Portugal (117.4 €/ha) and Denmark (104.2 €/ha).

Figure 1 shows the ratio between the planned expenditure for forestry measures (M8 and M15) and the total budget 2014-2020 for RD policies (left side of the vertical axis) and the relative importance of forested land on the Utilized Agricultural Area (UAA, right side of the vertical axis) in each EU Member State. A ratio equal to 1 means that the extension of forested area is equal to the agricultural area; the ratio higher than 1 evidences the relative higher extension of forested land.

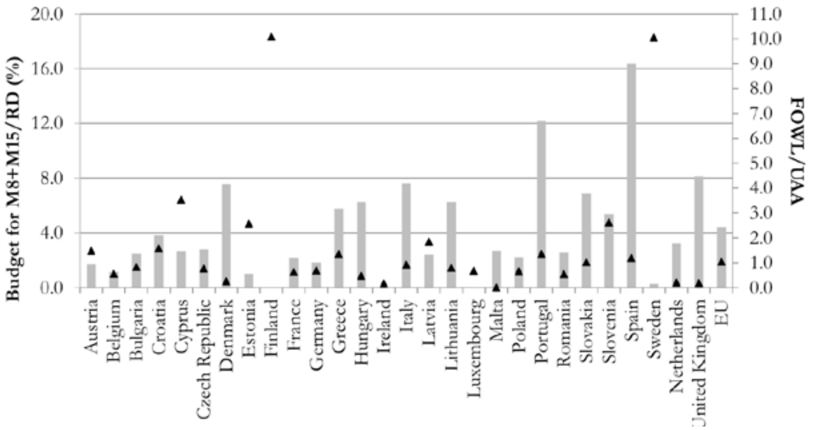


Figure 1: Relevance of forestry measures on total RDP budget and of forestry land on utilized agricultural area (UAA) in the EU Member States

Abbildung 1: Anteil der forstwirtschaftlichen Maßnahmen am Gesamtbudget des RDP und Verhältnis Waldfläche (FOWL) zu bewirtschafteter landwirtschaftlicher Fläche (UAA) in den EU Mitgliedsstaaten

The amount of financial resources dedicated to forestry measures in the countries where the stock of forest resources is relatively high, appears to be very low. The extreme case is represented by Finland, which has not applied for forestry measures under the RD policies, although its territory is 75.7% covered by forests and its forested area is 10 time larger than the agricultural one. This approach appears as a continuity with the previous programming period 2007-2013 when the same political decision was taken, with the exception of the afforestation of agricultural land (M221), implemented only to fulfil commitments made in the programming period 1995–1999 (AGRIGRID project, 2008). Almost the same situation can be found in Sweden, where the territory is 74.9% covered by forests but the planned expenditure for forestry measures is 0.3% of total Swedish Rural Development funds. In Cyprus, Estonia and Slovenia, the forest area is more than the double of the agricultural land but only in Estonia, the budget planned for forestry measures is relatively low (4.1 €/ha of FOWL). Nevertheless, it does not mean that these countries have not any forestry financing scheme: Finland has its own National Forest Strategy (newly adopted in February 2015), as well as an Act on the Financing of Sustainable Forestry through which about 75 million € are annually paid to private forest owners as incentives for forest improvement and biodiversity enhancement (Granholm, 2010). As regards Sweden, the National Forest Programme provides some national subsidies for measures in forestry in order to enhance the sector's environmental value.

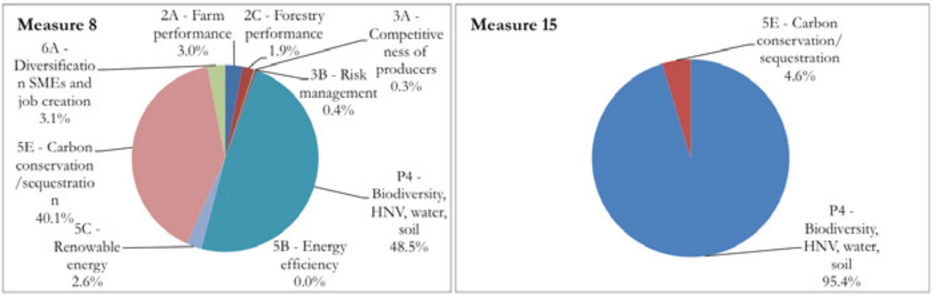
A rather different approach is the one adopted by Ireland. In fact, despite not having implemented any forestry measure in its RDP, the Irish Forest Service drafted a 100% State aid funding Forestry Programme, which is in accordance with Reg. (EU) 1305/2013 and the EU Guidelines for Strategic Programming for the period 2014–2020. The budget planned for measures falling within articles 22-27 and 34 of the Reg. (EU) 1305/2013 amounts to 220.5 million €. This means an expenditure of 275.2 € per hectare of forested area, the highest level among the 28 EU Member States (Forest Service, Dept. of Agriculture, Food and Marine of Ireland, 2015).

On the opposite side there are some Member States where the relative importance of forested area is quite low, but the planned expenditure for forestry measures seems to be very high. This is the case of Spain, where the ratio between FOWL and UAA is 1.2, but the percentage of financial resources destined to forestry measures is 16.4% of the total (the highest percentage in EU). Spain has always devoted significant parts of its RD budget to forestry measures: the rate was 16.7% in the programming period 2000-2006 (European Commission, 2003) and 14.3% in 2007-2013 (DG Agriculture and Rural Development, 2010). A special Focus Area F (Improved forestry use) was developed and utilized only by Spain, which allocates 0.4% of its Priority 5 spending to this. The FA has been added by Asturias where forestry related measures (in particular 8.1 and 8.6) are the ones with the highest allocations due to the large forestry area in this region (DG Internal Policies, 2016). A similar situation can be found in other Member States, for instance Portugal, Italy and Denmark, where the amount of resources for forestry measures is relatively high (12.2%, 7.8%, 7.6% respectively) while the stock of forest resources is low.

Even if it is not easy to point out a general trend in these policy decisions, there seems to be a different behaviour between the Mediterranean and the Northern countries, even though with some exceptions. The first ones, where the forest land is relatively low if compared to the agricultural area, tend to allocate a relevant part of their RD budget to forestry measures. On the contrary the continental countries, with high forest coverage and maybe a more deep-rooted tradition on forestry, target their funds on other rural development fields.

It is interesting to see how the resources planned to finance M8 and M15 are distributed among the priorities and focus areas at EU level (Figure 2). In total, EU Member States have addressed their forestry policies to reach the aim of the strategic Priority 4 (51% for ecosystem management) and Priority 5 (37.4% for low-carbon and climate resilience) in 2014-2020. The general pattern shows a predominance of spending on environmental protection while there is not the enhancing of competitiveness in forestry sector (low percentage of resources devoted for FA2A, FA2C, FA3A). As concerns Measure 8, 40.1% of the budget will be destined to reach the aim of FA5E regarding carbon conservation and sequestration; 27.6% for FA4B water management; 20.9% for FA4A biodiversity, HNV and landscapes. With regard to Measure 15, 75.1% of the budget is planned for FA4C (soil management) and 18.6% for FA4A.

Specific analysis resulting from the comparison between the planned expenditure under RDPs 2014-2020 and the expenditure realized under RDPs 2007-2013 (DG Internal policies, 2016), highlights a significant reduction of investment in forests (-42.0% for Measure 8, with 24 Member States decreasing their quota). As in the past, Measure 15 about forest conservation exhibits very low levels of spending and also in this case, a relevant number of Member States (21) have decreased the planned expenditures for these interventions.



Source: EU Country Factsheets

Figure 2: Allocation of planned resources in the EU Member States for Measure 8 and Measure 15 among focus area in 2014-2020

Abbildung 2: Verteilung geplanter Ressourcen in den EU Mitgliedsstaaten für die Maßnahmen 8 und 15 in den Zielgebieten von 2014-2020

4. Allocation of financial resources for forestry Measures 8 and 15 in Italy

Like in other EU Member States, the European Agricultural Fund for Rural Development (EAFRD) is the most important source for forestry policies also in Italy. As a consequence of the decentralization of forestry policies, rural development programming in Italy is based on 21 different RDPs (19 Regions and 2 Autonomous Provinces in Trentino and Bolzano-South Tyrol) and 21 different forestry policy schemes. The planned expenditure for 2014-2020 is around 1,421 million € (-23.1% as compared to the programming period 2007-2013): 96.4% destined to Measure 8 and 3.6% to Measure 5 (Table 2).

Table 2: Planned expenditure for Measure 8 and 15 in Italy (Italian Rural Development Programmes 2014-2020)

Tabelle 2: Geplante Ausgaben für Maßnahmen 8 und 15 in den Regionen Italiens (Programm für die ländliche Entwicklung 2014-2020)

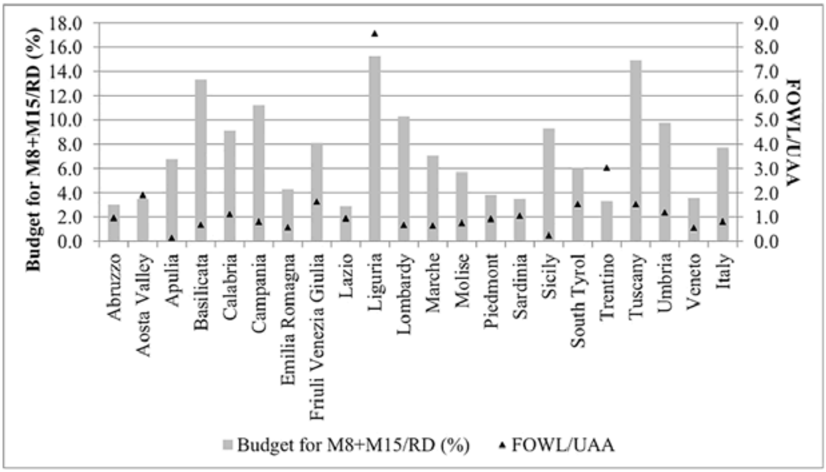
	Planed expenditure M8 (,000 €)	Planed expenditure M15 (,000 €)	Planed expenditure on total (,000 €)	% planned expenditure on total (%)	FOWL (,000 ha)	Planned expenditure/FOWL (€/ha)
Abruzzo	13,000	0	13,000	0.9	439	29.6
Aosta Valley	4,800	0	4,800	0.3	106	45.3
Apulia	110,000	0	110,000	7.7	179	614.4
Basilicata	90,762	0	90,762	6.4	356	254.6
Calabria	100,661	0	100,661	7.1	613	164.2
Campania	173,100	33,000	206,100	14.5	445	462.9
Emilia Romagna	51,148	0	51,148	3.6	609	84.0
Friuli Venezia Giulia	24,000	0	24,000	1.7	357	67.2
Lazio	22,481	0	22,481	1.6	606	37.1
Liguria	47,870	0	47,870	3.4	375	127.6
Lombardy	103,250	0	103,250	7.3	666	155.1
Marche	37,000	1,000	38,000	2.7	308	123.3
Molise	12,000	0	12,000	0.8	149	80.7
Piedmont	38,550	3,250	41,800	2.9	940	44.5
Sardinia	41,000	5,000	46,000	3.2	1,213	37.9
Sicily	202,150	4,000	206,150	14.5	338	609.6
South Tyrol	22,000	0	22,000	1.5	372	59.1
Trentino	10,000	0	10,000	0.7	408	24.5
Tuscany	143,000	392	143,392	10.1	1,152	124.5
Umbria	80,400	5,000	85,400	6.0	390	218.8
Veneto	42,440	0	42,440	3.0	447	95.0
Italy	1,369,612	51,642	1,421,254	100.0	10,468	135.8

Source: Elaborations on approved Regional Rural Development Programmes 2014-2020

The total budget for both measures is differently allocated among the Italian regions. The highest quota is allocated in Sicily and Campania (14.5% in both cases) followed by Tuscany (10.1%). The rate for Basilicata, Calabria, Lombardy, Apulia and Umbria is between 5 and 10% of the total, while in Emilia Romagna, Liguria, Marche, Piedmont, Sardinia and Veneto the rate is between 2 and 5%. Friuli Venezia Giulia, Lazio, Molise, Trentino-South Tyrol and Aosta Valley allocate less than 2% of the total resources for forestry measures.

The last column of the table shows the average amount of support per hectare of FOWL. On average, the planned expenditure per hectare is equal to 135.8 € (higher than the EU average, 40.9 €/ha) but in some regions the value is very high as for instance in Apulia (614.4 €/ha), Sicily (609.6 €/ha), Campania (462.9 €/ha), Basilicata (254.6 €/ha) and Umbria (218.8 €/ha). Liguria, Lombardy, Marche and Veneto are not far from the average while the support per hectare in the other regions is comparatively low.

Another analysis is presented in Figure 3: the quota of the budget for forestry measures on the total budget of the Regional RDPs is compared with the relative importance of forests and other wooded land as related to the Utilized Agricultural Area (UAA) in every Italian region.



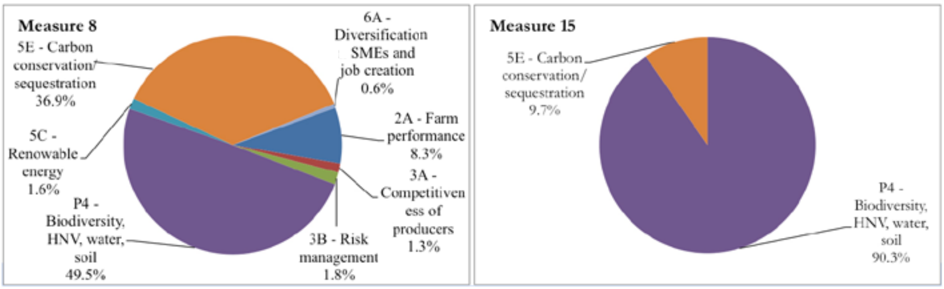
Source: Italian Rural Development Programmes

Figure 3: Relevance of forestry measures on total RDP budget and of forestry surface on utilized agricultural area (UAA) in Italian Regions

Abbildung 3: Anteil der forstwirtschaftlichen Maßnahmen am Gesamtbudget des RDP und Verhältnis Waldfläche (FOWL) zu bewirtschafteter landwirtschaftlicher Fläche (UAA) in den Regionen Italiens

In general, the surface covered by forests is relatively important in every Italian region. In nine of them, forested areas are more important than agricultural ones (Abruzzo, Trentino-South Tyrol, Calabria, Friuli Venezia Giulia, Liguria, Sardegna, Tuscany, Umbria, Aosta Valley); in two of them the importance is very low (Apulia and Sicily); in the rest of Italy the forested areas are more than the half of agricultural area (Basilicata, Campania, Emilia Romagna, Lazio, Lombardy, Marche, Molise, Piedmont, Veneto). The Figure shows the particular case of Liguria where most part of the territory is covered by forests and other wooded land (375,134 ha) while the importance of agricultural areas is very low (43,784 ha): this Region has allocated 15.3% of total RD budget for forestry measures, a very high ratio if compared to the rest of Italy. Even Basilicata (13.3%), Campania (11.2%), Lombardy (10.3%) and Tuscany (14.9%) have allocated an important amount of the total budget for forestry measures while Abruzzo and Trentino show the smallest rates. Southern regions have destined a higher percentage of budget for the selected measures as compared to northern regions although having a less important forested area as related to the agricultural area.

In Italy forestry measures will be targeted to reach mainly the objectives of Focus Area 4A, 5E and 2A. As in the rest of Europe, in Italy the specific regional patterns for forest policy in the rural areas seem to be oriented towards the management of forestry ecosystems in the prevalent dimension of ecological sustainability. As evidenced in other analysis (Edwards and Kleinschmit, 2013; Winkel et al., 2009), the forest policy perspective of Italy has environmental characteristics: forest is considered as an ecosystem and the most important targets aim to increase biodiversity and to preserve the ecosystems. This conservative orientation explains the allocation of resources in the different focus areas (Figure 4).



Source: Elaboration on Italian Rural Development Programmes

Figure 4: Allocation of planned resources in Italy for Measure 8 and Measure 15 among focus areas in 2014-2020

Abbildung 4: Verteilung geplanter Ressourcen in Italien für die Maßnahmen 8 und 15 in den Zielgebieten von 2014-2020

As concerns Measure 8, the planned expenditure is allocated to reach mainly the objectives linked to biodiversity, HNV and landscapes (FA4A, 49.5%) and carbon conservation and sequestration (FA5E, 36.9%), while less than 2% is devoted to risk management (FA3B) and renewable energy (FA5C). Different from the general European allocation, the Italian forestry measures are more oriented to the increase of competitiveness: 8.3% of planned resources are destined to improve the farm performance (FA2A, higher than the European average 3.0%) and 1.3% will fund projects aiming to improve the competitiveness of producers (FA3A, European average equal to 0.3%).

Measure 15 is destined mainly to reach the objective of Focus Area 4A (90.3%). The rest is allocated to reach the target of carbon conservation and sequestration (9.7%). Also in this case, the Italian priorities are different from EU, mainly oriented to soil protection and management (75.1% on average). Water management priority (FA4B) will not be covered by forestry measures.

As previously stated, all the forestry interventions of the programming period 2007-2013 have been proposed again in the Reg.(EU) 1305/2013 but organized in different sub-measures and grouped into Measure 8. Looking to the contents of the Regional RDPs, it can be noted that Italy will continue with the policy of afforestation and creation of woodland (8.1), protection of forests against forest fires and other disasters (8.3 and 8.4) as well as with improving the resilience and environmental value of forests (8.5). Table 3 shows the distribution of the planned budget for every intervention: 25.2% of budget for M8 will be used for interventions under the sub-measure 8.1; 38.4% under the sub-measures 8.3 and 8.4; 23.6% under the sub-measure 8.5. Sub-measure 8.2 concerning agroforestry has met difficulties in the last programming period and the budget planned for this kind of interventions still remains very low (0.7%). As concerns the investment in forestry technologies, processing and marketing (8.6) they account for 12.1% of M8 and this can be considered an important percentage.

Table 3: Planned budget for forestry measures in the RD programming period 2014-2020 and 2007-2013 and financial execution in Italy (,000 €)

Tabelle 3: Geplantes Budget für forstwirtschaftliche Maßnahmen in der Programmperiode der Entwicklung des ländlichen Raumes 2014-2020 und 2007-2013 sowie der Durchführungsgrad in Italien (,000 €)

2014-2020	2007-2013	Planned budget 2014-2020 (a)	% for sub-measures	Planned budget 2007-2013 (b)	Planned budget Octob. 2015 (c)	Expenditures Octob. 2015 (d)	Remodulation (c-b; %)	Financial execution (c/b; %)	Differences (a-b; %)
8.1	221+223	345,459	25.2	882,703	483,772	456,092	-45.2	94.3	-60.9
8.2	222	9,058	0.7	8,186	33	28	-99.6	84.8	10.7
8.3+8.4	226	526,392	38.4	435,391	550,432	461,726	26.4	83.9	20.9
8.5	227	322,891	23.6	257,873	257,506	199,877	-0.1	77.6	25.2
8.6	122	165,812	12.1	219,702	120,844	109,485	-45.0	90.6	-24.5
15	225	51,642	100.0	44,048	37,119	22,705	-15.7	61.2	17.2
Total		1,421,254		1,847,903	1,449,705	1,249,912	-21.5	86.2	-23.1

Source: Italian RDPs and National Rural Network

Table 3 shows also an important aspect concerning the implementation of forestry policies in Italy, represented by the re-modulation, that is the difference between the planned expenditure at the beginning of the programming period 2007-2013 and at the end of the period (October 2015). The re-modulation has been relevant for Measures 221 (first afforestation of agricultural land), 223 (first afforestation of non-agricultural land), 222 (first establishment of agroforestry systems) and 122 (improvement of the economic value of forests). This means that Italian regions have not realized the planned intervention during the time because of different reasons, such as a week normative framework, the scarce response from forest owners and forest enterprises, lack of competences and capabilities of the potential beneficiaries. One of the unsuccessful measures was Measure 222. It failed because of the innovative natures of this intervention and the difficulties in the realization of agroforestry systems. The planned budget for Measure 227 (non-productive investments) has been used as a whole while it has increased for Measure 226 (restoring forestry potential and introducing prevention actions) and for Measure 225 (forest-environment payments). On total, at the end of programming period 2007-2013 the total expenditures for forestry measures have been modified and 21.5% of the initial budget has been not used for forestry but transferred to other measures.

The budget re-modulation has probably oriented the planned budget for the next programming period: low level of resources have been allocated in those interventions interested by the higher rate of re-modulation.

Further information about the implementation of policy measures are included in the set of indicators established by the monitoring system (art.67, Reg.1305/2013). In particular, the output indicators give a first indication about the expected implementation of every sub-measure.

Following the analysis based on the available information in RDPs, Italy expects that about 64,800 hectares will be afforested (sub-meas. 8.1) and 2,090 hectares will be devoted to agroforestry systems (sub-meas. 8.2). About 4,146 beneficiaries will be supported for restoration and prevention projects (sub-meas. 8.3). Investments improving the resilience and environmental value of forests (sub-meas. 8.5) will involve 5,673 actions on 228,600 hectares while 293 actions will be supported for investments in forestry technologies (sub-meas. 8.6). About 82,000 hectares will receive a support for forest-environmental and climate services under Measure 15.

5. Conclusions

The analysis provides an overview of forestry measures (Measures 8 and 15) included in the new Regulation (EU) 1305/2013 of Rural Development for the programming period 2014-2020 and defined in the approved RDPs of the EU Member States. The analysis is based on the planned expenditures for both measures and on their contributions in reaching the specific targets defined in each priority and focus areas in which the new RD policy framework is structured.

This work is an additional contribution to the comprehension of future patterns in the orientation of forestry policies in the EU MS and the first step of a more accurate analysis that will be done in the framework of the monitoring and evaluation activity during the period of implementation of RD Plans.

Almost all the forestry measures implemented in the last programming period have been proposed again. They are aggregated into Measure 8 in order to simplify the administrative burden and allow the realization of integrated projects. This simplification is strategic, particularly in the strengthening of the relationships among the different subjects operating in the forestry chain and also in the perspective of a sustainable management of the forests.

In the next programming period, EU Member States will allocate 4.6% of the overall budget for Measure 8 (about 7,070 millions €9 and 0.3% for Measure 15 which is about 365 millions €). The relevance of the budget planned for both measures is highly variable, depending on the characteristics of forests and on national priorities. The majority of EU Member States have focused their programmed expenditures mostly on Measure 8. Only The Netherlands have applied for Measure 15 exclusively: a significant part of resources has been destined to this measure also in Italy and Hungary. 11 Member States have not activated M15 at all. The biggest share of funds for forestry measures is allocated in Spain (28.0%) and Italy (19.6%) which together represent almost half the total expenditure planned at EU level.

The different allocation of resources among the selected measures and sub-measures in the EU Member States reflects different views about the contribution of forestry to rural development and the spatial variability of perceptions and attitudes to forests. Looking to the priorities and focus areas, it seems that the interventions will be mainly oriented to reach the target of carbon conservation and sequestration, water management, biodiversity, HNV and landscapes as well as soil management. This distribution evidences the environmental approach of RD economy and policy: an overview in recent years points to the declining role of traditional land-using activities and the emergence of a more broad-based range of economic activities responding to the rise of new industries located in rural areas (Slee et al., 2004). In case of forests, the multifunctional role and the sustainable management is becoming more important than their productive role. With regard to this aspect, in Europe there are different situations. In Nordic countries there is still a strong orientation towards a production based rural economy: production and conservation functions have a prominent role than the multiple functions of forests (Hyttinen et al.2002). In contrast, in Central and Southern Europe, recreational and environmental services of forests reflect the wider values derived from forests.

This means that the instrument to evaluate the efficacy of forestry policies and their contribution to territorial economic development of rural areas must be based on new «mixed» and complementary methodologies able to take into account all the benefits provided by forest and their overall impact on rural economies. With this regard, the returns from timber are not always the most important component in the economic values of forestry but in some cases the non-market values and the impact on local economies must be taken into account.

With regard to the Italian case, the description of the general overview is based on the analysis of the 21 RD programmes. In Italy, in fact, regions are responsible for the management of forest policy and, as a consequence, there are 21 different schemes. This governance model has the advantage to permit a better use of resources and targeting of measures in accordance with the territorial specificity but, on the other side, it causes a lack of policy coordination at the national level. As in the rest of Europe, Italy has focused its future forestry policy mainly on Measure 8 while only 7 regions have applied for Measure 15.

In Italy, forestry measures will be targeted to reach mainly the objective of biodiversity, HNV, carbon conservation and sequestration even if the targets oriented to increase the farm performance seems to be more important than at the European average. The analysis of different sub-measures indicates that Italy will continue with the policy of afforestation and creation of woodland (25.2% of budget for M8), protection of forests against forest fires and other disasters (38.4%) as well as with improving the resilience and environmental value of forests (23.6%). The resources for agroforestry remain very low (0.7%). As for the previous programming period, the output indicators will be based on the number of hectares addressed by the different sub-measures or the number of interventions. These indicators are not adequate to estimate the potential contributions of forestry interventions to rural development and their efficiency on a global scale. As a consequence, it is desirable that further tools will be developed to explore the wider range of contributions (environmental, social and economic) of forestry measures to every single priority and focus area.

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Household composition and aging of forest owners in Japan

Zur Haushaltszusammensetzung und Überalterung der Waldbesitzer in Japan

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Keywords: Demographic analysis, Population Census, World Census of Agriculture and Forestry, size of household, age of householder, planting, timber sales, forest management

Schlüsselbegriffe: Demographische Analyse, Volkszählung, Weltagrarzensus, Haushaltsgröße, Alter des Haushaltsvorstands, Anpflanzung, Holzverkäufe, Waldwirtschaft

Summary

The total population of Japan peaked in the 2010 Population Census. In view of the subsequent decrease in the total population, a recount of the 2000 World Census of Agriculture and Forestry was conducted to clarify the composition of forest owners' households and their forest-management practices. The largest age class among forest-owning householders was 65–69 years old, indicating that an aging tendency was already statistically apparent in 2000. Considering the average lifespan of Japanese

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people, the largest age class is currently probably around 75–79 years old. The following relationships between household composition and forest management were found. The percentage of households conducting planting and/or weeding and the percentage of timber sales were both low for one-person households. According to the recent population census, the percentage of one-person households is increasing; thus, it is likely that the percentage of one-person forest owners' households is also increasing. The peak age classes for planting and/or weeding and timber sales are 60–64 years and 70–74 years, respectively. These peak age classes are one age class before and after the peak age class of householders, respectively. The population is currently aging further; hence, the current peak age class of householders is significantly greater than the peak age of timber sales in 2000. These results suggest that the increase in the percentage of one-person forest owners' households and the aging of forest owners' households will affect whether forest owners decide to conduct final cutting of the coniferous plantation forests that were planted after the Second World War.

Zusammenfassung

Bei der Volkszählung im Jahre 2010 erreichte die Gesamtbevölkerung Japans ihren Höchstwert. In Anbetracht der danach abnehmenden Bevölkerungszahl wurde eine Nachzählung des Weltagrarzensus 2000 durchgeführt um die Zusammensetzung der Waldbesitzerhaushalte und die Art der forstwirtschaftlichen Bewirtschaftung aufzuzeigen. Die Nachzählung ergab, dass der Altersgipfel bei den Haushalten der Altersjahrgänge der 65- bis 69-Jährigen lag. Demzufolge offenbarten sich bereits im Jahr 2000 statistisch nachgewiesene Überalterungstendenzen. Angesichts der durchschnittlichen Lebenserwartung der japanischen Bevölkerung ist davon auszugehen, dass gegenwärtig die Altersgruppe der 75- bis 79-Jährigen am stärksten vertreten ist. Folgende Relationen ließen sich zwischen Haushaltszusammensetzung und forstwirtschaftlicher Bewirtschaftung feststellen: Bei den Einpersonenhaushalten fiel der Prozentsatz derer, die Anpflanzungen und/oder Unkrautbekämpfung durchführten sowie ihr Anteil an Holzverkäufen, niedrig aus. Nach den Ergebnissen der jüngsten Volkszählung ist der Prozentsatz der Einpersonenhaushalte im Steigen begriffen. Daraus ergibt sich, dass auch der Anteil der Einpersonenhaushalte unter den Waldbesitzern wächst. Die obersten Altersgruppen, die sich in den Bereichen Anpflanzungen und/oder Unkrautbekämpfung sowie Holzverkauf betätigen, sind 60 - 64 bzw. 70 - 74 Jahre alt. Sie befinden sich eine Altersklasse unter bzw. über den häufigsten Jahrgängen der Haushaltsvorstände. Die Alterung der Bevölkerung schreitet derzeit weiter voran, daher ist die Gruppe der aktuell im höchsten Alter stehenden Haushaltsvorstände signifikant größer als die der Holz verkaufenden Altersschicht. Diese Ergebnisse legen nahe, dass der Anstieg des prozentualen Anteils von Einpersonenhaushalten unter den Waldbesitzern darauf Auswirkungen hat, ob diese sich für oder gegen eine Endnutzung der in der Nachkriegszeit neu angelegten Nadelwaldplantagen entscheiden.

1. Introduction

The Japanese population reached a record peak of 128,057,352 people in the 2010 Population Census. A quick estimate based on the 2015 Population Census, announced in February 2016, indicated that the total population had decreased to 127,110,047, a decrease of 0.7% over 5 years (MIC, 2016). Out of all 47 prefectures, a decreasing population was observed in 39 prefectures between 2010–2015; thus the decrease in population is widespread across Japan with the exception of only a few prefectures.

The future population was estimated by the National Institute of Population and Social Security Research (2013) based on the results of the 2010 Population Census. If current trends in birth and death rates are maintained, which is the intermediate scenario, and discounting any mass emigration or immigration, the total future population of Japan was estimated to decrease from 128,057,000 in 2010 to 41,255,000 in 2110 (Figure 1). Within 100 years, the Japanese population will decrease to almost a third of the current population. It is clear that such a decrease in total population would have widespread socio-economic effects, including impacts on forest management.

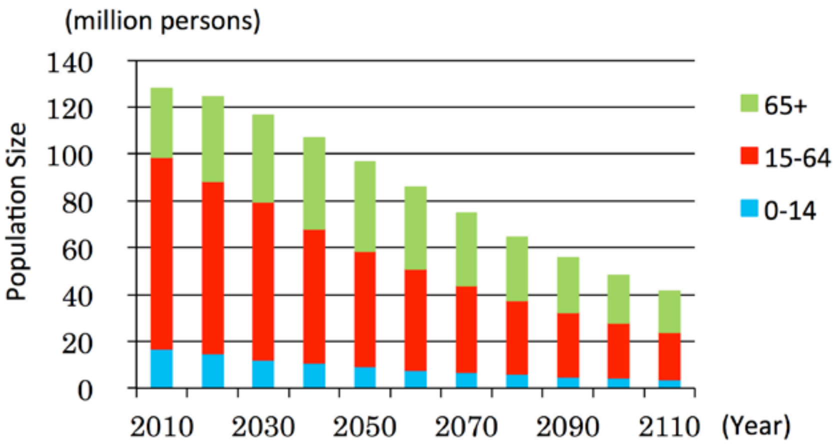

Figure 1: Predicted Population of Japan

Abbildung 1: Bevölkerungsprognose für Japan

Source: National Institute of Population and Social Security Research (2013) Population Research Series, No. 327, Table A-8, p. 79-80 (Estimation is based on average birth and death rates)

Research in Japan on the relationship between population and forestry has been conducted mainly from the viewpoint of the effects of the increasing population[1]. Various limitations in consumption or production in forests and food sources have been discussed worldwide, and the representative work is "The Limits to Growth" (Meadows, 1972). This analysis showed that, under finite natural resources, a rapid increase in total world population will lead to a decline in living standards and other complex issues. The background to this body of research rests on the basic idea that population increases will increase demands on natural resources, including forests. In Japan, after the Second World War, the total population increased to 84 million, 94 million, 105 million, 117 million and 124 million by 1950, 1960, 1970, 1980 and 1990, respectively, and this increase in total population was considered one factor leading to increasing demand for timber.

Although the population has increased overall, population migration from rural areas to urban areas began in the 1960s, and issues related to depopulation, particularly in areas where the main income resources were forestry-based, occurred at that time. Given the current decrease in the total population, there has been a new focus on the depopulation problem – namely, the possibility of local village disappearance (Masuda, 2014). The depopulation in mountainous areas started in the same period as Japanese high economic growth. At that time, many young villagers moved to urban areas, especially the three major metropolitan areas. The Rural Development Act (Act No. 64 of 1965) was established to support municipalities facing a population decrease. In 2010, this area and its population accounted for 47% and 3% of the total Japanese land area and population, respectively. Throughout Japan, the number of residents has decreased gradually, while the age of the remaining residents has increased gradually. If this continues, several small villages might become abandoned. The Ministry of Land, Infrastructure, Transport and Tourism (MLIT, 2011) estimated future inhabited areas, and concluded that approximately 20% of current inhabited areas will become uninhabited by 2050. Approximately 90% of the current land use of these future uninhabited areas, and future inhabited areas with an estimated population density of less than 10 people per 1 km^2, is land currently used in the agriculture and forestry industries, such as secondary forest, plantation forest and agricultural land (MLIT, 2011). The government started the land management survey (MIC, 2011) after the disappearance of hamlets and reported that the percentages of hamlets in which farmland and forest had been abandoned were 50.0% and 46.3%, respectively.

A breakdown of the total population is shown in Figure 1. The percentages of the population in age classes 0–14 years, 15–64 years and 65 years and over are 13.1%, 63.8% and 23.0%, respectively in 2010, and those of 2110 are estimated to be 9.1%, 49.1% and 41.8%, respectively. As the total population decreases to one third of the current number, the percentage of the productive population within the age class 15–64 years will drop to less than 50%. That is, the total population is decreasing and aging simultaneously.

[1] For example, the Basic Plan on Forest Resources in 1966 made note of a future tight timber supply worldwide.

Aging of the population can be seen in some industrialized and developed countries. Figure 2 shows the percentages of people aged 65 years and over in Japan and several other developed countries (Cabinet Office, 2015) based on "World Population Prospects" from the United Nations. The Japanese percentage of elderly people was lower than that of other developed countries in the 1960s and the 1970s, but the percentage increased rapidly around 2000 (Cabinet Office, 2015). Currently, the percentage of elderly people in Japan is the highest among these developed nations, and this will continue in the future. The rapid increase in the percentage of elderly people is a striking characteristic of Japanese demographic figures. In Japan, all industries, including forestry[2] and wood-related industries, are facing a demographic crisis.

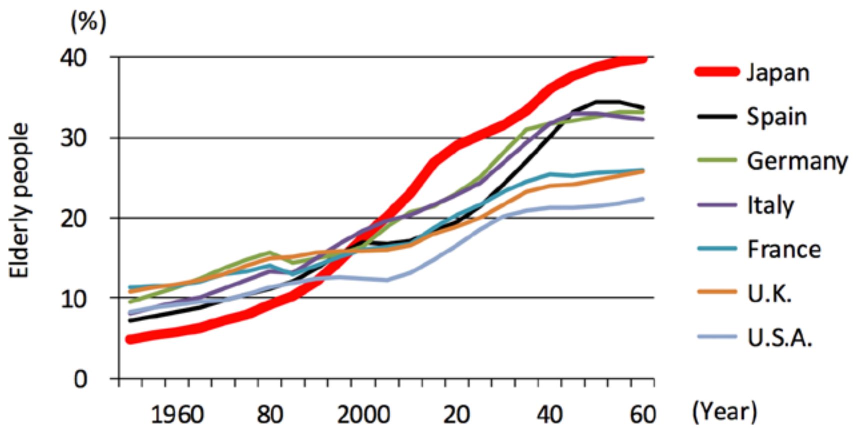

Figure 2: Prediction of percentage of population aged 65 years and over

Abbildung 2: Prognose des Anteils der Bevölkerung ab 65 Jahren und älter

Source: Cabinet Office Japan (2015) Korei shakai hakusyo (Annual Report on the Aging Society), 2015 U.N. World Population Prospects, The 2012 Revision

Here, planting activities in Japan will be explained (Matsushita, 2015). Many plantation forests of *Cryptomeria japonica* and *Chamaecyparis obtusa* were created between the 1960s and 1980s, of which 73.9% by volume is now private forest. It should be noted that whether plantation forest resources are cut and used depends on decisions made by private forest owners based on timber quantities. Considering the changes in the total Japanese population, the composition of forest-owning households has not yet been widely studied, mainly because, under an increasing population, household-level information was not necessary. In addition, during the 1960s and the 1980s, go-

[2] In this paper, the aging issues of forestry workers are not analyzed. The average age of forestry workers was 56.0 and 52.1 years according to the Population Census in 2000 and 2010, respectively (Forestry Agency, 2016). Since the Japan Standard Industry Classification changed in 2007, it is difficult to compare the average ages between 2000 and 2010; however, both were clearly younger than the average age of forest owners, as discussed below.

vernment policy targets were to increase the area of plantation forest[3], and the most important factor in implementing this intention was subsidy programs, rather than the decision-making and income requirements of forest owners. As well as the composition of forest owners' households, the relationship between the composition of these households and their forest practices will also be analyzed to consider future timber production under the demographic changes shown in Figures 1 and 2.

An analysis of recent forest practices by private forest owners identified several serious issues. First, the number of non-residential forest owners is increasing. In addition, the number of residents in mountainous areas is decreasing, while their average age is increasing more rapidly than that of the total Japanese population. In addition, the number of forests with owners unknown to residents and local forestry-related workers is increasing. Due to the increases in non-residential and elderly owners, information on forest unit boundaries is disappearing. These issues are interrelated. The Forestry Agency strongly promoted their plantation policy after the Second World War. As a result, many plantation forests are now available for use; however, recently, serious issues related to their ability to be used have arisen, including an increase in unknown ownership and unclear forest unit boundaries. The Forestry Agency started to conduct countermeasures for such situations, including the amendment of forest-related acts[4] in 2016.

To consider forest management in the future, a demographic analysis of private forest owners is necessary. Only private forest owners who engage in both agriculture and forestry can be analyzed using current statistics in Japan. Kohroki (2009) and Sato (2013) have analyzed the current situation, but the dataset they used included a limited number of households.

Therefore, our research had two objectives. The first objective was to clarify the characteristics of all households that own forests. To address this objective, data from the 2000 World Census of Agriculture and Forestry (hereinafter, denoted as the "Agriculture Census", "Forestry Census" or "Census"), the last national statistical survey of all households owning forests over 1 ha (for survey results, see Shiga (2002)) were analyzed, focusing on households that engaged in both agriculture and forestry, with a particular emphasis on the composition and aging trends of the owners. The second objective was to clarify the relationship between demographic characteristics and forest practices, such as whether there is a relationship between age and planting activities. Understanding such relationships may provide useful information for assessing forest practices under future demographic conditions, as shown in Figures 1 and 2.

The contents of this paper are as follows. The data used, as well as related explanations and definitions, are described in Section 2. The analysis results from the Census are given in Section 3 and 4. In Section 3, the size of forest owners' households and the age

[3] The issue of aging forestry workers has been examined in Japan. The percentage of forestry workers over 65 years of age increased during the 1990s, accounting for 14% and 30% according to the 1990 and 2000 Population Censuses (Forestry Agency, 2016). For a statistical analysis from the time, please see Nagata et al. (1991).

[4] In May of 2016, five acts relating to forestry were partially amended at the same time, including the Forest Act (Act No. 249 of 1951), Act on Special Measures concerning the Benefit-share Forest Act (Act No. 57 of 1958), Forest Owners' Cooperative Act (Act No. 36 of 1978), Act on Special Measures concerning the Securement of Stable Supply of Timber (Act No. 47 of 1996), and Act on Special Measures concerning Forestry and Forest Products Research Institute (Act No. 198 of 1999).

of householders are discussed. In Section 4, the relationship between the results from Section 3 and forest practices are demonstrated. In Section 5, the effects on timber production of recent demographic changes are discussed. In the final section, conclusions and future research topics are presented.

2. Method

The Forestry Census, which has been undertaken by the Ministry of Agriculture, Forestry and Fisheries (MAFF) since 1960, is the only set of statistical data on forest owners in Japan. Until the 1990 survey, the minimum holding area for owners in the survey was 0.1 ha. The number of private forest owners was 2,508,605 and the number of forestry entities other than private forest owners, such as companies, joint holdings, etc., was 354,318 (Forestry Agency, 1995). In 2000, the minimum holding area increased from 0.1 ha to 1 ha, and the number of forest owners and forestry entities greatly decreased, to 1,018,752 and 153,036, respectively (Forestry Agency, 2002).

In 2005, the survey method used in the census was completely revised, and the Agriculture Census, which started in 1950, and the Forestry Census were combined into one survey. After this reform, the survey target changed completely. Until 2000, the survey target was forest holders with a certain minimum holding area. After the 2005 survey, the concept of a Forestry Management Entity (Ringyo keieitai) was introduced, for which at least one of the following four conditions had to be satisfied:

1) Held at least 3 ha of forest, and conducted forest practices and/or cutting during the previous 5 years.

2) Held at least 3 ha of forest, and had a Forest Management Plan under the Forest Act (Act No.249 of 1951) that included 2005.

3) Conducted planting and/or forest practices as commissioned by the forest owner in the previous year.

4) Produced at least 200 m^3 of logs, as commissioned by the forest owner, and/or by purchase of stumpage in the previous year.

The number of Forestry Management Entities as defined above was 200,224 in 2005, significantly less than the total number of private forest owners and forestry entities in 2000. The numbers of Forest Management Entities in 2010 (Forestry Agency, 2015) and 2015 (MAFF, 2016) were 140,186 and 87,284, respectively.

In this study, census data after 2005 could not be used to clarify the overall situation of forest owners, as the number of surveyed forest owners was too small. The 1990 Census contains the largest dataset on forest holders, because the minimum holding in that year was 0.1 ha; however, individual data from the 1990 Census are no longer available. Therefore, the 2000 Census was used, which was the last survey conducted under the former method.

Before 2000, the Agriculture Census and the Forestry Census surveys were conducted, analyzed and published separately. Household-level information was included in the Agriculture Census only, and the same identification numbers were used for respondents for whom both the Agriculture Census and the Forestry Census applied. To attain the objective of this study, we selected respondents who were survey targets of both censuses, and combined the household data from the Agriculture Census with the forestry data from the Forestry Census to create a new dataset for this analysis. As the onsite survey in the Forestry Census was conducted for respondents with a minimum forest holding area of 3 ha, households meeting this condition were included in the analysis. Among 1,018,752 private forest owners in the 2000 Forestry Census, 283,839 owners were selected who met the above conditions, corresponding to 27.9% of the total. The percentages of the 283,839 owners classified by holding area are shown in Figure 3; the percentage holding 50 ha or more was only 1.9%.

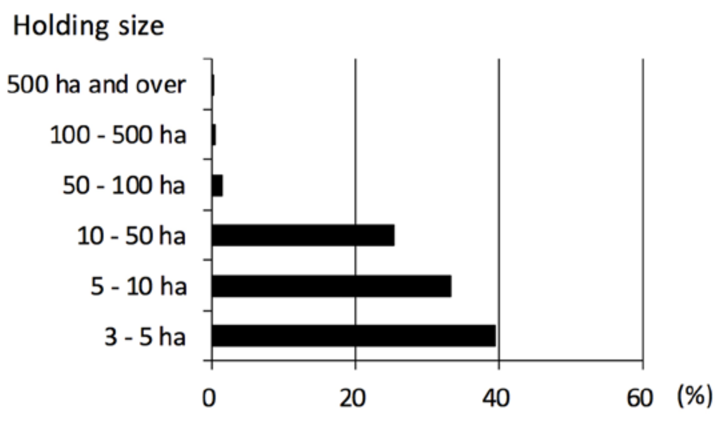

Figure 3: Holding area of forests

Abbildung 3: Forstwirtschaftliche Betriebsfläche

Source: Recount results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

Hereinafter, these 283,839 households are denoted "forest owners' households" or simply "households". In this paper, households and householders were defined in the resident register managed by municipal offices under the Basic Resident Registers Act (Act No.81 of 1967). 'Household' refers to people who share housing and livelihood; thus, people other than families and relatives may be included. In cases where the house is shared but there are separate livelihoods, the households are considered separately in the residents' register.

The householder plays the primary role in the household. Generally, in Japan, forest ownership is held by the oldest family member in the household, and forest ownership is seldom gifted before death. In agriculture, significant work is required to maintain farmland; however, in forestry, the daily workload is light, particularly for small-scale holdings, and the necessary forest practices can be entrusted to local forest owners' associations or forestry companies. Thus, forest inheritance usually occurs at death. In this paper, the householder is considered the legal forest owner; however, in some cases, the legal owner may have been older than the householder. In contrast, it is also possible that the legal owner was younger than the householder.

The Forestry Census surveyed forest management by household, including forests rented from other owners, but excluding forests lent to other owners. As the percentages of rented forest and lent forest are generally low, in this paper, data from the Forestry Census are used as data for forest ownership. All figures and graphs calculated from recounting the 2000 Census are shown in percentage form, based on a total of 283,839 owners.

Finally, elderly people are defined in this paper as those aged 65 years or over, in accordance with the classification (MIC, 2005) in the Population Census of Japan.

3. Household characteristics

3.1. Household size

Data on the size of forest owners' households in the 2000 Census were recounted, as shown in Figure 4. Two- to-seven-member households accounted for about 10% to 20% of households. Two- person households were the most prevalent household size. The percentage of one-person households was low in 2000.

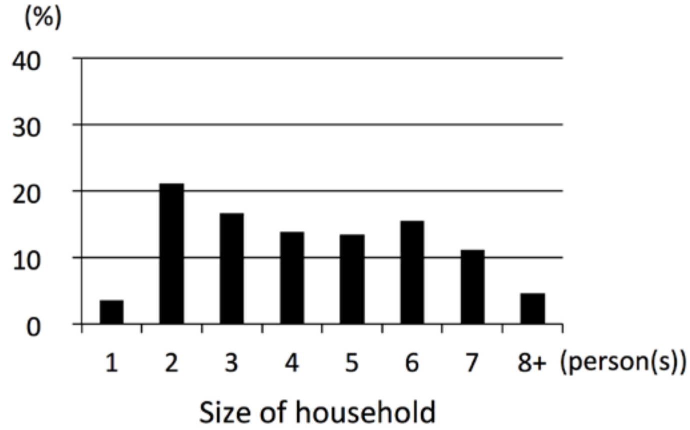

Figure 4: Size of household

Abbildung 4: Haushaltsgröße

Source: Recounting results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

Household sizes for the whole of Japan based on the 1960 and 2010 Population Censuses are shown in Figure 5. In 1960, four-person households formed the largest proportion of the total; however, in 2010, one-person households formed the largest proportion, and the total percentage of one- and two person households reached 59.6%. The total percentages in 1960, 1980, 2000 and 2010 were 17.9%, 36.6%, 52.7% and 59.6%, respectively. After 2000, more than half of all households consisted of less than two people.

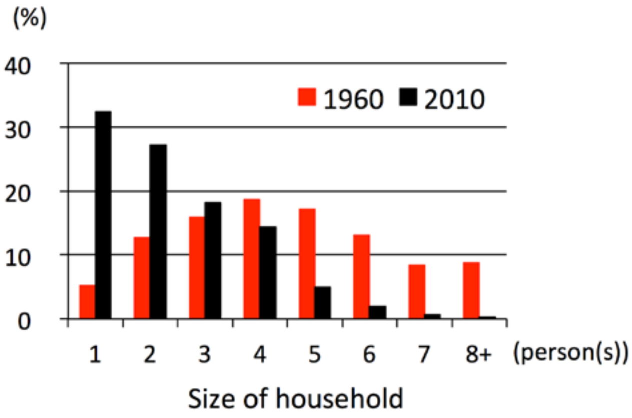

Figure 5: Household size among the Japanese population

Abbildung 5: Haushaltsgröße laut Volkszählung

Source: Statistics Bureau, Ministry of Internal Affairs and Communications: Japan Statistical Yearbook (1982 ed., 2016 ed.)

As shown in Figure 4, the total percentage of one- and two-person households was 28.4%, which is approximately half of the total found in the Population Census. As already discussed, the percentage of elderly people is currently increasing, and the total population reached a peak in 2010; thus, it is likely that the percentage of one- and two-person households is also increasing among forest owners' households.

3.2. Age of householders

The age classes of householders, with a 5-year interval, are shown in Figure 6. Inheritors of agricultural management are also shown for reference. Agricultural inheritors aged 15 years or over are shown as a survey item in household information in the Agriculture Census, including any planned inheritance.

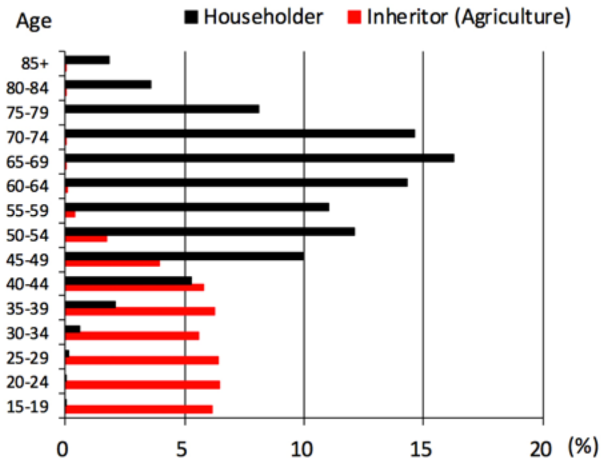

Figure 6: Ages of householders and inheritors

Abbildung 6: Alter des Haushaltsvorstands und der Erben

Note: The inheritor (agriculture) data does not equal 100%, because cases of inheritors living outside the village and cases with no inheritor are excluded.

Source: Recounting results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

The 65–69 years age class contained the highest percentage of householders; the percentage of elderly householders was 44.4%. The percentage of householders aged 50 years and over in the 2000 Census, who will be elderly in 2015, reached 81.9%, demonstrating that the aging of forest owners in Japan was already developing in 2000.

The 2000 Population Census revealed that the 50–54 years age class contained the highest proportion of the population across the whole of Japan, and the peak age was 51 years old. The most recent population estimate using 5-year intervals showed that the 65–69 years age class contained the highest proportion of the population (Statistics Bureau, 2016). Based on these figures, the peak age class of forest owners' householders appears to have shifted from 65–69 years in 2000 to around 75–79 years in 2015, considering that the average lifespan of Japanese people in 2014 was expected to be 80.50 years for men and 86.83 years for women (MHLW, 2015) and that the average remaining life time of Japanese people 65 years of age in 2000 was 17.43 years for men and 22.44 years for women[5] (MHLW, 2000). The aging of individual forest owners within householders in Japan seems to be reaching a crisis level. It appears that the

[5] Ministry of Health, Labor and Welfare (MHLW) Heisei 12 nen kanni seimeihyo (Simple life table in 2000 in Japan), http://www.mhlw.go.jp/toukei/saikin/hw/life/life00/, 2016/07/16 (in Japanese)

total percentage of owners over 80 years old, and number of forests recently inherited by younger owners, is increasing year after year.

Agricultural inheritors were distributed almost equally from the 15–19 years age class to the 40–44 years age class. Households in which the inheritor was a current occupant comprised 42.9% of the total, while households in which the inheritor lived elsewhere comprised 16.1%. Households in which there was no inheritor comprised the remaining 41.0% in 2000. The percentage of households with no inheritor is likely to be higher in current data[6]. In the case of agriculture, some work is necessary to continue the business; in contrast, forest inheritors can own a forest simply for the purpose of maintaining household property. If the inheritance was conducted simply for the purpose of keeping family property, no forestry practices and/or family labor will be conducted by the owner.

4. Forestry practices by household characteristics

In this section, we will describe the recounted forest practices results, classified by household size and householder age. Two forestry practices will be considered: planting and/or weeding, which is generally necessary for 5–10 years after planting in Japan, and will simply be denoted as “planting” hereinafter; and forest products sales, including the sale of logs from thinning. Forest product sales is further divided into two categories: timber sales and non-timber forest products (NTFPs) sales, which include all forest products other than timber. In all figures in this section, “percentage” denotes the percentage of households that conducted planting or sales during the year before the survey.

4.1. Planting

Figure 7 shows percentages of planting according to household size. It is clear that the percentage from one-person households was low. The percentages from two- to five-person households were almost equal, and those of six-person households or greater are slightly higher.

[6] Current data for the information shown in Figure 6 is not available. The only available data is the percentage of farm households with farm land of at least 0.3 ha and that have made sales of farm products in the past 1 year over 500,000 yen. In the 2010 Census, the percentage of households with no inheritor was 58.6% (inheritor living outside the village, 18.0%; no inheritor, 40.6%). In the 2015 Census, the percentage of households with no inheritor was 70.1% (inheritor outside the village, 18.8%; no inheritor, 51.3%).

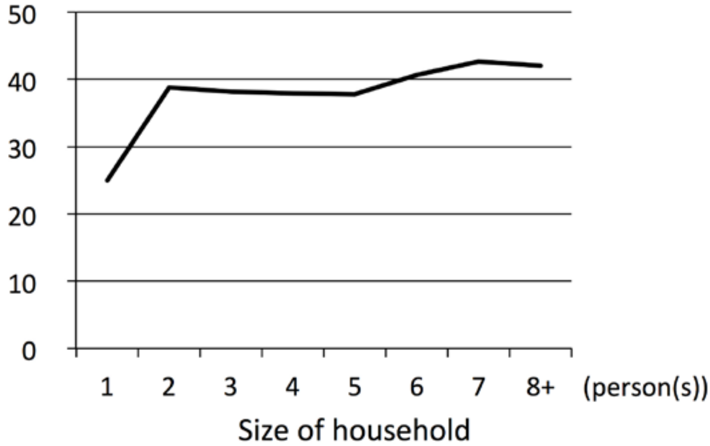

Figure 7: Planting by size of household

Abbildung 7: Bestandesbegründung nach Haushaltsgröße

Source: Recounting results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

As shown in Figure 4, in 2000, the percentage of one-person households remained low, while two-person households were the most prevalent. Considering that the 65–69 years age class contained the highest percentage of householders, as shown in Figure 6, two-person households included a high number of elderly men and their wives, and it is probable that, recently, a significant number of these households became one-person households. Hence, the percentage of one-person households, in which the percentage of planting is clearly low, is likely increasing.

The percentage of planting activity as a function of householder age is shown in Figure 8, where the peak is in the 70–74 years age class; i.e., one age class higher than the peak age of householders. In householders over 80 years old, the percentage decreases to a level almost identical to that found in householders in their 40s or 50s.

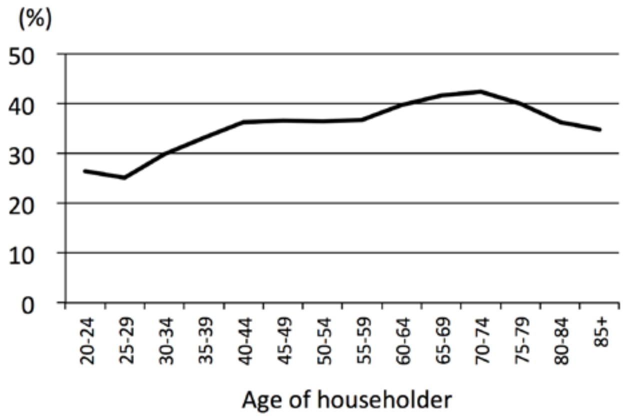

Figure 8: Planting by householder age

Abbildung 8: Bestandesbegründung nach Alter des Haushaltsvorstands

Source: Recounting results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

One reason that the peak age is in the 70–74 years age class is that forest owners can obtain subsidies for planting and weeding. In addition, forest owners' associations can undertake planting and weeding tasks for the forest owner and receive this subsidy.

4.2. Forest products sales

The percentages of forest products sales classified by household size are shown in Figure 9. The pattern differs between timber and NTFPs, such as mushrooms. For both, the percentages tend to increase with increasing household size. However, in the case of timber sales, the percentage for one-person households is extremely low, and that for two- and three-person households is slightly higher than that for four- and five-person households. The increasing tendency in the percentage of one-person households indicates that the percentage of households in which the percentage of timber sales is low is increasing.

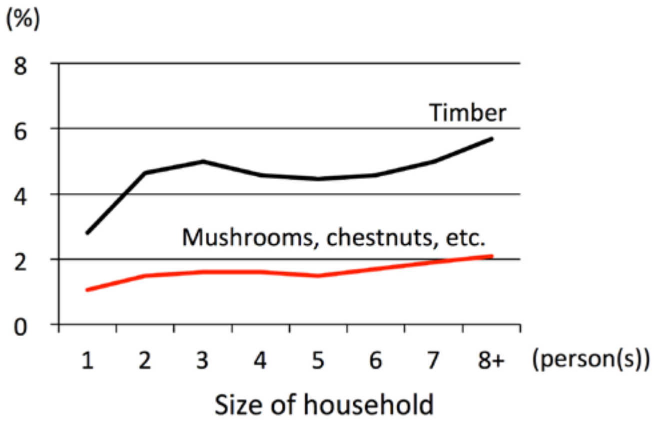

Figure 9: Forest products sales by household size

Abbildung 9: Verkauf forstwirtschaftlicher Produkte nach Haushaltsgröße

Source: Recounting results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

The percentages of forest products sales classified by householder age are shown in Figure 10. In the case of timber sales, the peak is in the 60–64 years age class, which is one age class lower than the peak householder age class of 65–69 years. For householders aged over 75 years, the percentage decreases to almost the same level as for householders in their 20s or 30s. In the case of NTFPs, the percentages are almost equal between 35 and 74 years old, and the percentage over 80 years old decreases to almost the same percentage found for householders in their 20s.

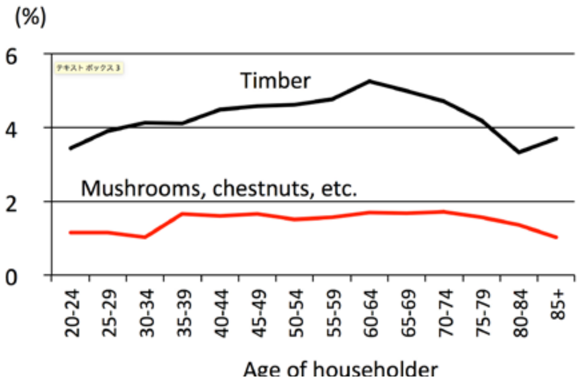

Figure 10: Forest product sales by householder age

Abbildung 10: Verkauf forstwirtschaftlicher Produkte nach Alter des Haushaltsvorstandes

Source: Recounting results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

5. Discussion

5.1. Changes in household size and their effects on forest practices

Based on the Population Census, it is evident that the percentage of one-person households increased from 5.2% in 1960 to 19.8% (1980), 27.6% (2000) and 32.4% (2010). There are many reasons why the percentage is increasing, including the death of a partner among elderly people, an increase in unmarried people in the younger age groups[7], and fewer parents and children living together. Lifespans are increasing and the birth rate is decreasing. Young people change their living situation due to taking a job or going to school, and elderly people change their living situation to acquire medical assistance or to enter care facilities. As these trends continue, the increase in the percentage of one-person households will also continue.

Why the percentages of planting and timber sales decreased in one-person households is not clear from this analysis, and future statistical research and a field fact-finding survey are necessary. Here, instead, the recounting result relating to the relationship between generations and households will be discussed. First, households were separated into one-generation, two-generation, three-generation and 'other' classes. One-generation households were further divided into man-only, woman-only and couples. Two-generation households were divided into those that included the householder's generation plus parent(s), child(ren), or 'other'. Three-generation households were divided into those containing the householder's generation plus parent(s)+child(ren), grandparent(s)+parent(s), child(ren)+grandchild(ren), or 'other'. All households not described in the above categories were included in 'other'. As household members share both housing and livelihood, combinations that cannot be classified into the categories above occur. In addition to these classifications, information on the importance of agriculture was added, which cannot be analyzed within the scope of this paper. More specifically, households were divided into four categories: full-time farming household, part-time farming household (category 1: agricultural income is greater than other incomes), part-time farming household (category 2: agricultural income is lower than other incomes) and subsistence-farming household (cultivated land is less than 0.3 ha and annual agricultural income is less than 500,000 yen). The results are shown in Figure 11.

[7] The major cause for the current birth rate decline is the tendency to marry later or to remain unmarried (Kono, 2007).

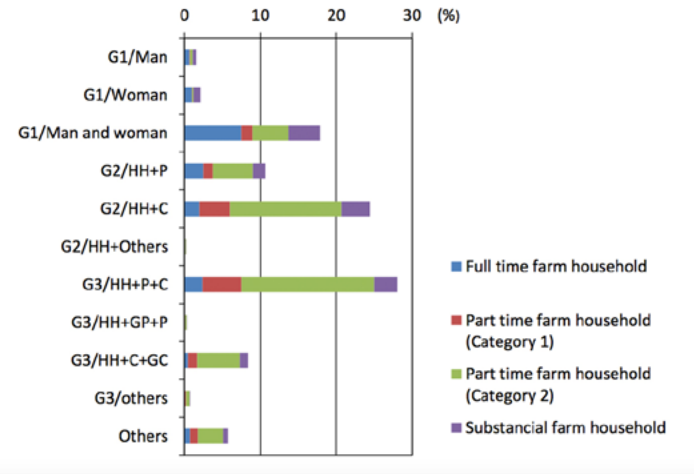

Figure 11: Detailed compositions of farming households with forest

Abbildung 11: Detaillierte Zusammensetzung land- und forstwirtschaftlicher Haushalte

Source: Recounting results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

Note: G1, G2 and G3 denote one-, two- and three-generation households, respectively. HH denotes the householder or householder plus marital partner. GP, P, C and GC denote grand parent(s), parent(s), child(ren) and grand child(ren), respectively.

The following are the four major combinations in the 2000 Census, which can be seen in Figure 11.

(A) Three generations comprising the householder's generation, parent(s) and child(ren).

(B) Two generations comprising the householder's generation and child(ren).

(C) One generation including a husband and wife.

(D) Two generations comprising the householder's generation and parent(s).

These four combinations account for 81.1% of the total.

Combination (C) represents the largest percentage of full-time households, which are two-person households containing a man and his wife. Many of these households are elderly, and the death of one member will yield a one-person household. These households are likely to have been working in agriculture together almost full-time for many years, and after becoming a one-person household, the householder will downsize the business such that it will remain manageable. It is probable that the connection to their forest will decrease after becoming a one-person household. Considering the difference in life expectancy between men and women, the percentage of women will increase in elderly one-person households. In this case, the percentage of planting and timber sales will decrease.

In combination (D), after the death of the elderly parent, the household will change to combination (C). In cases where the householder is elderly, the householder will change to one-person household status in the near future.

Most households in combinations (A) and (B) are part time farming households, mostly in category 2, where the income from agriculture is less than other income sources. It seems likely that, in these households, the dependence on forestry product income was small.

In combinations (A) and (D), the parent(s) of the householder generally seem to be old. It is probable that the parent has ownership of the forest. Although we considered the forest-holding householder as a forest owner in this paper, it is possible that the age of the legal owner is higher than the analyzed age in these combinations. In these combinations, the main income is provided by the householder, and the householder's parents also live in the household. Thus, it is important to understand how forest management or forest holding information is transferred, and this will be covered in future research.

5.2. Aging and forest practices

As shown in Section 4, it is important for timber production that, at the time of the 2000 Census, the peak age class for timber sales was 60–64 years, which is one age class lower than the peak age class of householders. However, it is important to consider the situation now, almost 15 years later, after the final census survey was undertaken using the former method. The peak age class of householders is estimated to be around 75–79 years. Although the peak percentage of planting or timber sales will also be related to economic conditions, including timber prices and forestry policies (such as subsidies), it is possible that the peak has not changed significantly compared to the situation in the 2000 Census.

For timber sales, changes in the average stumpage price must first be discussed to explain the economic situation. The price index (1980 = 100) decreased to 10.9 and 15.1 for *Cryptomeria japonica* and *Chamaecyparis obtusa*, respectively, which are the two major species of plantation trees in Japan, by March 2013 (Forestry Agency, 2015). This price was the lowest recorded, although the value recovered by March 2014, to 13.1 and 17.5 for *Cryptomeria japonica* and *Chamaecyparis obtusa*, respectively. Under these price conditions, no factor can be cited to explain a move in peak timber sales to an older age class. In the case of an elderly householder, especially those aged around 80 years, it seems likely that the basic management practice changes from cutting for profit to forest maintenance for the next generation. In any case, the percentage of timber sales by householders of 75–79 years will be low. Considering that the lifespans of healthy men and women are 71.19 and 74.21 years (Cabinet Office, 2015), respectively, in 2013, migration of people in the 75–79 year age class for health reasons will increase.

Recently, planting areas have decreased, due to decreases in clear cutting of coniferous trees and areas in which broad-leaved natural forests are cut and coniferous trees are planted, mainly for construction wood. As the area of planted forest decreases, the area requiring weeding also decreases. Thus, the level of planting and/or weeding is currently very low across all age classes, and the peak age class at which these tasks are undertaken is unclear.

To summarize, it is evident that the peak age class of householders is currently significantly higher than that of peak timber sales. Sato et al. (2006) analyzed a case in Yamaguchi Prefecture, Chugoku region, using a questionnaire survey; 53% (n = 704) of the total respondents were older than 70 years at the time of the survey, in 2003. Aging was more serious in this case than our results (Fig. 3). Conversely, according to the results of the 2010 Census, the average age of the managers of family forest management entities (Kazoku Ringyo Keieitai) was 66 years (Forestry Agency, 2016). This is younger than our estimate of the current average age of forest owners. One reason for this discrepancy may be that the survey target of the 2010 Census was limited by the introduction of the new definition of management entities, as discussed in Section 2, and that the average was calculated based on the manager of these management entities. In contrast, our study focused on householders, i.e., family members. Thus, the current statistics fail to reveal the very serious aging problem among private forest holders. Regardless, the actions of elderly people, especially those older than 75 years, must be studied in future research using improved survey methods.

Other cases in developed countries may be considered in future research. In this study, age-related variables were analyzed in terms of their age-class distributions. The average age of all 283,839 householders included in this study was 61.6 years. Hayrinen (2015) investigated forest owners in Finland using a questionnaire survey. Based on 557 valid responses, the average age of forest owners was 62 years during the survey year (2011/2012). Given that the average in 2011/2012 was almost equal to the Japanese average in 2000, aging appears to be a more serious issue in Japan; however, the two cases share similar demographic conditions and influences related to forest management.

5.3. Issues in plantation forest caused by aging

Coniferous trees were planted intensively during the 1950s and 1970s, and the Forestry Agency (2016) states that the percentage of plantation forests in the age classes of 46–50 years or over is 51% of the total plantation area. A future increase in timber production has been planned in the current Basic Plan on Forests and Forestry[8]. In the newest basic plan, published in May 2016, domestic timber production is to increase 1.7-fold from 2014 to 2025.

In the case of privately owned forests, timber production predictions based on past data may be overestimated, considering the demographic conditions discussed in this paper. Even if market and resource conditions are satisfied based on past experience, it is not clear if the final cutting decision will be made by elderly forest owners, especially those aged 80 years or above.

Although the basic conditions, assumptions and scenarios in the Basic Plan on Forests and Forestry are undisclosed, it is probable that detailed demographic data, such as household size and householder age, are not included. The decrease in the total population started in 2010; thus, it is difficult to extract the variables most related to demographic aspects of timber production for inclusion in a prediction model of domestic timber production. The possibility of introducing demographic factors into the timber production model should also be a topic for future research.

As shown in Figure 2, one of the characteristics of Japanese demographics is the rapid increase in average age, alongside almost no changes in the forest ownership system or forest practices. What are the current issues directly connected to domestic timber production? Here, we would like to refer briefly to two issues: forest unit boundaries, and forest inheritance.

First, issues relating to forest unit boundaries should be discussed. The depopulation problem in mountainous areas started during a period of fast Japanese economic growth, when forest inheritors left for urban areas. The total number of remaining family members decreased while their average age increased significantly. The problem here is that information on forest unit boundaries is mostly held by forest owners. Most planting and weeding operations have been conducted by local forest owners' associations, but consolidation of forest owners' associations was promoted by the Forestry Agency, such that the number decreased from 5,138 in March 1954 to 660 in March 2013. As a result of this consolidation, communication between associations and local villages weakened, and the number of association workers familiar with the situation at the time of planting decreased, while their population aged. Boundary certification of forest owners' associations is now difficult.

[8] Forestry Agency, http://www.rinya.maff.go.jp/j/kikaku/plan/index.html, 2016/06/21 (in Japanese)

All land information, including forest information, is managed by register offices. The problem is that almost half (MLIT, 2016) of the public maps in register offices were created during an era of land tax reform, beginning in 1873 (associated with the Meiji Restoration), and lack detailed measurements. Thus, there are differences between public maps and the real situation in many areas. After the Second World War, the National Land Survey Act (Act No.180 of 1951) was enforced, and land survey projects were conducted by municipal offices. To promote the surveys, the Act on Special Measures for Promotion of the National Land Survey (Act No.143 of 1962) was enforced, and a 10-year plan was created to promote land surveys. However, the percentage of areas where land surveying was completed was 51% of the total Japanese land area, and 44% of the total forest area (MLIT, 2016; Forestry Agency, 2016). The numbers of municipalities where land surveying has been completed, undertaken in practice, is currently on hold, or has not been introduced at all are approximately 28%, 45%, 16% and 10%, respectively. MLIT (2016) has pointed out that one of the reasons why the land survey project was not developed in mountainous areas was the increase in the percentage of elderly forest owners and forest owners living outside villages. MLIT (2016) also referred to the fact that the physical evidence and personal evidence necessary to certify land boundaries are disappearing.

MAFF (2015) prepared a questionnaire-based survey of forest resources for forestry monitors in 2015, including questions related to boundary certification. The reasons for the lack of success of the boundary certification project were queried with multiple possible answers, but the most frequently chosen answer (64.5%) was that some people owned a forest by inheritance but did not know the exact location of their forest. The next most frequently chosen answers were the lack of development of the Land Survey project by municipalities (45.5%) and that forest owners could not participate in on-site boundary certification due to their extremely old age (39.7%). These results suggest that the increase in the number of new owners who recently inherited forest but have no experience of forest practices or have not visited their forest affects issues related to boundary certification. The increased percentage of elderly people ultimately leads to an increase in younger, new forest owners through inheritance, which then poses challenges to boundary certification. Thus, clarification of forest ownership and correct forest boundaries is urgently needed to promote cutting activities in private forests.

The Forestry Agency is now promoting the creation of a Forest Management Plan (FMP) based on the Forest Act, to promote the intensification of forest practices by small-scale forest owners. At the end of the 2014 fiscal year, the percentage of forests where an effective FMP had been created was approximately 28% of the total non-national forest (Forestry Agency, 2016). One problem that has also been identified with respect to obtaining forest owners' agreement to intensify forest practices is that staff could not clarify forest boundaries due to the aging and absence of forest owners.

Forest owners cannot access sufficient subsidies without an official FMP; thus, forest practices and timber production may not increase as much as expected by the Forestry Agency.

The problems surrounding forest inheritance will also be discussed briefly. In Japan, forest ownership is transferred under the inheritance system. Formerly, the eldest son was bestowed the status of family head and all property including forests; however, this system ended with the amendment of the Civil Code in 1947. After 1947, forest succession has related mainly to family members or relatives living in the village, although the number of successors living outside the village has increased. In the case of a village where most of the residents are elderly, such that the village will disappear in the near future, it is possible that almost all forests in the village will be owned by people living elsewhere, and clarification of forest unit boundaries will become almost impossible. Therefore, forest ownership and forest boundaries must be clarified urgently based on the knowledge of elderly forest owners, most of whom are estimated to be in the 75–79 years age class.

Furthermore, at present, there are many cases in which no inheritor exists. According to the Justice Statistics[9] of 1995, 2000, 2005, 2010 and 2014, the number of cases seen by the administrator for property of the Family Court, in which inheritance was unclear, was 4,696, 7,639, 11,902, 15,083 and 19,562, respectively[10]. Furthermore, the number is increasing. As the percentage of one-person households increases, the number of such cases will also increase. The MLIT has predicted a four-fold increase in these cases by 2050, and a corresponding increase in land for which ownership is unclear (MLIT, 2011).

As shown in Section 4, the percentage of timber sales when the householders are aged 75 years or above decreases to the level of those where the householders are in their 20's. This indicates that the percentage of timber sales is low for both elderly forest owners and young forest owners who have just inherited a forest. The increase in the percentage of elderly owners will lead to a decrease in timber sales, including a decrease in timber sales by young inheritors, many of whom seem to be living outside the village. From this, it seems possible that final cutting will not be conducted at the level predicted by the Forestry Agency.

The issues surrounding forest inheritance are related to the fact that succession at the time of death follows the usual system. As seen in Figure 5, in 1960, households contained many family members in multiple generations. When multiple generations live together, the system of inheritance at the time of death does not cause problems in the transfer of forestry-related information. Even when the legal owner is the oldest person in the household, the inheritor can learn about forest management practices from the older multiple generations in the household. Sato (2009) found that the average age of female family forest management entities (Kazoku Ringyo Keieitai) was 6.1 years older than male family forest management entities, using the 2005 Census,

[9] Courts in Japan, http://www.courts.go.jp/app/sihotokei_jp/search, 2016/06/30 (in Japanese)
[10] These numbers are for all cases. The number of cases relating to forests is not clear in the Justice Statistics.

which was conducted following a different survey method than the 2000 Census, which we used. Sato (2009) suggested that this shows a failure of succession to the younger male generation after the death of the former male manager[11].

Given the current situation of decreasing total population and aging across Japan, the forest inheritance system should be assessed, which should be a topic for future research.

5.4. Policy direction for forests when the owner and/or boundary are unclear

In this study, the characteristics of households who conducted planting, weeding and forest product sales were analyzed from the perspective of demographic changes. Over the next 100 years, the population of Japan is predicted to decrease by one-third of the current population (Fig. 1). In addition, the number of residents living in mountainous areas is decreasing. Aging of forest owners is on the verge of becoming a crisis, and the percentage of households without an inheritor to manage the forests is increasing (Fig. 6). Moreover, the percentage of forest owners living outside villages is increasing, a trend that will continue in the future.

Cases where the forest owner is unknown to local residents, forestry-related workers or local forest owners' association are increasing. As shown in Section 5.3, correct boundary information is typically held in the memories of elderly forest owners, which is facing a complete loss due to aging. Here, we discuss how forests are managed when the owner and/or boundary are unclear, especially from the perspective of current policy directions, and suggest future research topics.

Article 9 of the Basic Act on Forest and Forestry (Act No.161 of 1964) outlines the obligation of forest owners, stating that forest owners must make an effort to improve and protect their forest to secure the multi-objective functionality of the forest. Although concrete measures and penalties are not included in the act, it is clear that the forest owner is obligated to manage the forest, at least in a legal framework.

The number of households without an inheritor to oversee farm management is increasing (Fig. 6); in such cases, legal successors will inherit the forest. In cases with no legal successor, other relatives can inherit the forest. In cases with no relatives, a property executor is appointed who will search for another appropriate holder besides a relative. When it has been certified that there is no appropriate holder for the forest, the forest becomes government property. Under the current framework, cases where forests can become government property are limited.

Forests with legal owners unknown to local residents or local forestry workers and organizations are becoming a major issue. Moreover, cases with no legal successors

[11] In the 2005 Census, the percentage of male and female managers of family forest management entities (Kazoku Ringyo Keieitai) were 93.5% and 6.5%, respectively (Sato, 2009), indicating that men accounted for a much greater proportion of managers.

and no residents remaining in the village are increasing. In this analysis, households participated in both agriculture and forestry; however, the situation is even less clear for households who own forested land but do not conduct agriculture. There is a high possibility that these owners live outside the village, and villagers have no information regarding the owners or their future successors. Moreover, issues related to forests with owners unknown to residents will likely become more serious in the future.

With the amendment of the Forest Act in May 2016, a new system was introduced to improve the registration of forest land with municipal offices, the details of which are now under consideration. Because municipal offices have administrative rights related to the recognition of the FMP and submission of harvesting reports, municipal offices will face difficulties in the future due to an increase in the number of non-residential forest owners and successors.

Until now, information regarding forest land was managed by several offices separately, including land surveys conducted by municipal offices, land registries managed by municipal offices, non-national forest resource databases (Shinrinbo) managed by the department of forestry of the prefectural government (Matsushita et al. 1998), and the official FMP under the Forest Act. With the amendment of the Forest Act in April 2011, a new rule that new forest landowner must submit a report to their municipal office was added; thus, the municipal office can determine forest ownership only for new owners. As stated in the amendment of May 2016, the new registry system aims to combine all of this information, which was separately managed, into a new registry managed by the municipal office. In addition, a forest land map system was added to the 2016 amendment.

In addition, the Forestry Agency hopes to use this new registry to promote intensive forest practices. The Forestry Agency plans to introduce this registry during 2016–2018. The creation of the forest land registry is the first countermeasure to combat the increase in the number of forests with unknown owners and/or boundaries. This is just the beginning of a series of policies targeting unknown forest owners.

Several difficulties are anticipated with the creation of a forest land registry. In particular, aging owners will be difficult to address. In some villages, there are no inhabitants who are able to access their forest, which is precipitating the loss of information on boundaries held in the memories of elderly forest owners. In addition, there is minimal or no dependence on forest product sales as an income source, thereby decreasing interest in caring for the forests. Moreover, the number of non-villager and/or non-farmer forest owners is increasing. These are both anticipated difficulties that the new registry aims to address.

Although these conditions are strictly related to forest owners, there is an additional issue related to the administrative sector, referred to as the vertically segmented administrative system. The 2016 amendment allows for information from the land registry and non-national forest resource database to be combined; however, information derived from fixed asset tax rolls is not included (Ueda, 2016). Even in cases where no villagers or local forestry related organizations know the legal forest land owner, the new forest owner must pay taxes, including the fixed asset tax and/or inheritance tax; therefore, the taxation office has records of the legal forest land owner and has a land registry used only for the purpose of taxation. The use of this registry for purposes other than services related to taxation is highly restricted. However, some municipal offices may have no choice, but to depend on the taxation registry. Because the new forest land registry was introduced only in May 2016, future research will need to examine this issue in relation to the management problems of forests with unknown owners and/or boundaries.

Finally, based on Census results, the number of private forest owners is decreasing. As explained above, the Census survey method changed completely after the 2005 survey; therefore, the most recent Census that included all forest owners with forests over the minimum holding size, i.e., 0.1 ha and 1 ha before 1990 and in 2000, respectively, was the 2000 survey. After 2005, the number of private forest owners who owned areas larger than 1 ha was determined for the purpose of selecting on-site survey forest owners in the new Census. Notably, the purpose of surveying the number of forest owners with areas larger than 1 ha differed before 2000 and after 2005. In 2000 and 2015, 1,018,752 and 828,973 people owned forests larger than 1 ha, respectively, representing a decrease of 18.6% over 15 years. Although these figures must be carefully interpreted, these data suggest that some private forest owners sold their forests. The proportion of forest owners with holding sizes of 1–5 ha, 5–10 ha, 10–20 ha, 20–30 ha, 30–50 ha, 50–100 ha, 100-500 ha, and ≥ 500 ha were 81.0%, 79.5%, 83.3%, 88.5%, 85.6%, 89.0%, 120.6%, and 130.3%, respectively. Notably, the number of forest owners with holding sizes less than 100 ha decreased, while those with holding sizes greater than 100 ha increased. This indicates that relatively small-scale forest owners started selling forests, possibly for the reasons discussed earlier in this section. However, this data must be analyzed carefully, and future research should conduct more detailed statistical analyses to clarify the changes in the number of forest owners.

6. Conclusion

We analyzed the characteristics of forest owners' households, limited to householders who engaged in both agriculture and forestry. It was found that the percentage of planting and timber production was low in one-person households. According to the Population Census, the total population reached a peak in 2010 and, recently, household sizes have decreased, such that the percentage of one-person households increased to 32.4% of the total in 2010. These results mean that the percentage of forestry households with low timber production is increasing. In 2000, the peak householder age was in the 65–69 years age class, which provides statistical verification that in 2000 private forests were mainly owned and managed by elderly people. The possibility of peak ages was suggested for forest practices and timber sales. The peak ages of timber production and planting were in the 60–64 and 70–74 years age classes, respectively. It is likely that the peak age of forest householders will increase to exceed the peak age of forest practices and timber production.

Although household size and age were taken as independent factors in this analysis, elderly one-person households are facing the most difficult situation. Even in the case of elderly owners in their 80's, there are no forest management concerns when the younger successor is living in the same household. In the case of a one-person household consisting of a young man, possibilities for future forest management may be expected. A more detailed analysis is necessary to clarify the characteristics of forest management activities by elderly people aged 75 years and above, and to understand why the percentage of forest practices and timber production decreases in one-person households. This should be accompanied by an on-site survey.

In this analysis, household size and householder age were the only two variables considered. Other characteristics related to forest owners' households should be analyzed, such as sex, generations, importance of agricultural income, inheritor, etc. Regional differences are also important. For example, in the Hokkaido, Shikoku and Chugoku regions, where an increase in uninhabited villages is expected, the situation will be more serious than in this analysis based on the whole of Japan. Although the current Census started in 2005 includes very few surveyed households, a method for using current survey data and connecting it to the 2000 survey should be devised.

Finally, Japanese population characteristics should be analyzed in detail in the context of an international research framework. Japan reached a peak population in 2010, after which the population decreased. According to World Population Prospects[12], 13 countries experienced a total population decrease of over 100,000 between 2010–2015, which are, in order of the decrease in population; Syrian Arab Republic, Ukraine, Romania, Japan, Spain, Bulgaria, Georgia, Lithuania, Portugal, Greece, Serbia, Hungary and Latvia. Hence, Japan is situated among South and East European countries in terms of experiencing population decline between 2010–2015. The diminishment of households and aging were found to influence timber production in this analysis; is this unique to Japan? Are there any social factors or policy problems seen in Japan in particular that exacerbate the aging problem? Analysis by means of international comparison is an essential research topic for the future.

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[12] United Nations: World Population Prospects: The 2015 Revision, https://esa.un.org/unpd/wpp/Download/Standard/Population/, 2016/06/24

rest Science held at Okayama University, Japan, in 2015, and the IUFRO (International Union of Forest Research Organization) Symposium (Unit 4.05.00, Managerial Economics and Accounting) held at the University of Natural Resources and Life Sciences Vienna (BOKU), Vienna, Austria, in 2016. We would like to express our gratitude for all the comments made at these meetings. The research using the data from the 2000 World Census of Agriculture and Forestry was conducted as part of a research project at the Laboratory of Statistical Digital Archives of Agriculture, Forestry, and Fisheries, Graduate School of Agriculture, Kyoto University. We also thank the staff of the Statistics Department of the Ministry of Agriculture, Forestry and Fisheries, of the Japanese Government.

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Application of the Local Multipliers Calculation at the Example of a Forest Enterprise

Anwendung lokaler Multiplikatoren am Beispiel eines Forstbetriebes

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Keywords: Economics, Forestry, Benefits, Local expenditures, Economic activities, Regions

Schlüsselbegriffe: Ökonomie, Forstwirtschaft, Nutzen, lokale Ausgaben, ökonomische Aktivitäten, Regionen

Summary

Forestry and related industries represent important components of local, regional and national economies. This contribution presents the information obtained from the evaluation of the importance of a forestry enterprise to the local economy. The evaluation was carried out on the Training Forest Enterprise Masaryk Forest Křtiny (TFE MF Křtiny) located close to Brno – to the north of Brno in the Southern Moravia Region in the Czech Republic. The evaluation of the economic benefits may provide valuable information not only for enterprises but also for politics and stakeholders.

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The aim of the article is to describe the benefits of the selected forestry enterprise to the local economy, with a special focus on the local expenditures of local suppliers and on the local expenditures of employees who are residents of the region.

The local multiplier scores of 2 and 3 were obtained using the methodology of the local multiplier according to Sacks (2000), the accounting information and the results of the local employees and the suppliers are done by questionnaire surveys. The surveys are done according to the methodology of Sacks (2002) and Johanisová (2007). The calculation of the local multipliers is done in two or three rounds. In the first round, the total revenue of the TFE MF Křtiny was determined. In the second round, the local expenditures of TFE MF Křtiny on employees and suppliers, divided into local and non-local expenditures, were determined. The third round focused on the way in which the local employees and suppliers redistribute their payments. Thus, it determined the local expenses of the beneficiaries of the round 2 (recipients of the TFE Křtiny funds – the local suppliers and employees).

The methodology is divided into several steps. In the first step, local multiplier 2 (LM2) focuses on the first two rounds of the circulation of the funds, i.e. on the total revenue of the examined entity and on its local expenditures. LM3 contains the first two rounds of the same pattern as LM2, but adds also the round in which it quantifies the local spending of all who received the funds of the examined body in round 2 (i.e. who were beneficiaries of the local expenditures). For organizations, these are mainly suppliers and employees.

The value of the local multiplier for TFE Křtiny, which was determined using the above-mentioned methodology, was 1.52. The comparison with table values and the values of other organizations indicates, that the score is average or even below average. This number means that TFE Křtiny creates an extra income of 52 pennies for the local economy of each crown of their expenditures. Based on this value, it is possible to deduce conclusions for the enterprise management and other decision-making processes in the area such as tenders etc. It shows clearly how the company contributes to the local economy and it can help the company in negotiating subsidies at both the national and international level.

Zusammenfassung

Das Forstwesen und die daran anschließende Industrie sind wichtige Bestandteile der lokalen, regionalen und nationalen Wirtschaft. Dieser Beitrag präsentiert die Ergebnisse einer Bewertung der Bedeutung eines Forstbetriebes für die lokale Wirtschaft. Die beispielhafte Untersuchung wurde im Lehrforstbetrieb (LFB) Masaryk Forest Křtiny durchgeführt. Die Bewertung des wirtschaftlichen Beitrages kann eine wertvolle Information für die betreffenden Betriebe selbst aber auch die Politik und andere Interessensgruppen bieten.

Ziel des Artikels ist es, die Leistungen des ausgewählten Forstbetriebes für die lokale Wirtschaft, mit einem Fokus auf die lokalen Ausgaben der Lieferanten und Angestellten, zu beschreiben.

Mit Hilfe der Methodik lokaler Multiplikatoren nach Sacks (2000) wurden auf der Grundlage von Buchführungsdaten und den Ergebnissen von Fragebogen-Erhebungen bei lokal ansässigen Angestellten und Lieferanten Ergebniswerte von 2 bzw. 3 erzielt. Die Berechnung der lokalen Multiplikatoren verläuft in zwei oder drei Schritten. Im ersten Durchgang wird das Gesamteinkommen in LFB Křtiny ermittelt. Im zweiten Durchgang werden die Ausgaben pro Angestelltem und Lieferanten errechnet. Dabei werden die Ausgaben nach lokalen und nicht lokalen Empfängern differenziert. Im dritten Durchgang wird analysiert, wie lokale Angestellte und Lieferanten die von ihnen erhaltenen Mittel weiter verwenden.

Mit dieser Methodik wurde ein lokaler Multiplikator des LFB Křtiny in Höhe von 1,52 ermittelt. Im Vergleich mit Tabellenwerten und anderen Betrieben stellt dieses Ergebnis einen niedrigen bis durchschnittlichen Wert dar. Diese Zahl bedeutet, dass der LFB Křtiny von jeder Krone seiner Ausgaben 52 Heller Einkommen für die lokale Wirtschaft stiftet. Ausgehend von diesem Wert können wir Schlussfolgerungen für das Betriebsmanagement und weitere Entscheidungen z.B. im Bereich der Ausschreibung von Bieterverfahren ableiten. Der Wert zeigt deutlich, dass sich der Betrieb an der lokalen Wirtschaft beteiligt und kann ihm bei den Verhandlungen zum Einwerben von Zuschüssen auf nationaler und internationaler Ebene helfen.

1. Introduction

Forest enterprises are a specific component of the state economy as their economic activity is bound to rural regions. The economic activities of the regions and their differences are described by the regional economy (for definitions of regional economies see Armstrong and Taylor, 2000; Čadil, 2010; Hájek et al., 2012). In this article, we refer to the regional economy as to the economy of micro-regions, namely of the municipal territories. The research was conducted in the area of the TFE Křtiny Masaryk Forest, i.e. in a micro-community (with the radius of about 30 km). The results can be related to a larger area. For example, it can be compared with the value of the investment multiplier of the Czech economy which is around 5. Regional localization of the business brings advantages, especially for a local economy (Shuman, 2000; Douthwait, 1996; Kutáček, 2007). It can lead to an increase in regional employment, promotion of local households, businesses and to raising of the overall local economy in the region. It reduces dependence on imports from outside. Forest enterprises provide a combination of social and economic benefits to the local economy. Their socio-economic benefits include, above all, cash flows to local entrepreneurs, the supply of products and services to the enterprise, as well as to employee salaries. However, the benefits which stem from the recreational function of forest ecosystems, as well as the tourism revenues which flow into the region, are also included. These benefits represent additional business and employment opportunities. (Hlaváčková, Březina, 2015). Recreational functions also provide many important benefits and contributions to the physical and psychological well-being (Chan et al., 2012).

A local multiplier is a suitable tool for determining the economic benefit of a forest enterprise, at least that of direct market activity. It allows for tracking the movement of financial resources in a local economy, and can assist enterprises in determining the contribution of their economic activity to the local economy according to Sacks (2002). Furthermore, the management can change its decision-making processes based on such analyses and focus more on the sustainable development of forestry. Both foreign and domestic authors deal with the topic of local multipliers (Sacks, 2002; Cimadono and Bénassy-Quére, 2012; Gnos and Rochon, 2000; Došek, 2006; Rejmanová, 2014; Březina, Hlaváčková, Šafařík, 2015). Research on multipliers in tourism and recreation was carried out e.g. by Archer and Owen, 1971; Dwyer and Forsyth, 2005; Crompton, Jeong, and Dudensing, 2015.

The objectives of the article are to present the results of the research which was focused on determining the benefits of a forest enterprise to a local economy and to interpret these results in relation to their use and to the management decision-making of the enterprise. Mainly, the spending of the local suppliers and employees will be examined because it plays an important role in determining the benefits of forest companies to the local economy. The value of the total annual income of the employees ranging from 3,703 € to 16,666 € was divided into 7 categories of 1,851 € each. The largest response rate was in the category ranging from 3,703 € to 5,556 €. The annual expenditures of the suppliers ranging from 0 € to 1,481,481 € were divided into 10 categories with regard to the legal form of business (persons: over 7,407 €, legal entities: over 185,185 €). The largest response rate was in the category from 14,814 € to 22,222 €.

2. Material and Method

In order to determine the values of the local multiplier, a case study was conducted for the Training Forest Enterprise Masaryk Forest Křtiny (hereinafter referred to as the "TFE Křtiny"), Czech Republic.

TFE Křtiny encompasses 10,495 ha, 98% of which is forested. The enterprise is divided into three forest districts – Vranov (3,345 ha of forest land), Habrůvka (7,006 ha of forest land) and Bílovice nad Svitavou (2,920 ha of 3,640 ha forested). (TFE, 2016).

Data from the information system of the TFE Křtiny were used to calculate the local multiplier, specifically the accounting data of incomes and expenditures of the individual forest regions. These data were necessary for calculating the so-called local multiplier LM2; for calculating the local multiplier LM3, it was necessary to survey the local employees and suppliers. We included only local expenditures.

LM2 is to focus on the first two rounds of the circulation of funds - it is the total revenue of the examined entity and local expenditures of the examined subject. The LM3 contains the first two rounds of the same pattern as the LM2 but it also quantifies local spending of all those who were examined and received funding in the round 2 (i.e. who were beneficiaries of the local expenditures). The organization typically provide income to suppliers and employees.

A questionnaire survey was conducted in 2015 asking local employees and contractors to provide information for the year 2014.

The questionnaires for employees and suppliers consisted of an introduction in which the objective of the investigation and the assurance of anonymity were stated, as well as the way the provided data would be treated, and the organizers of the research were introduced. The value of total annual income of the employees were divided into 7 categories from 3703 € to 16 666 €, every 1851 €. The largest response rate was in the category from 3703 € to 5556 €. Annual expenditure suppliers were divided into 10 categories ranging from 0 € to 1,481,481 € (persons: over 7407 €, legal entities: over 185 185 €), i.e. depending on the legal form of business. The largest response rate was in the category from 14 814 € to 22 222 €. The first part was followed by questions. Two pieces of information were surveyed in the employee's section: the amount of income from their employer in 2014 and the percentages of local and non-local spending of the 11 items – food, beverages, and tobacco; clothing and footwear; housing; water and energy; transportation and fuels; postal services and telecommunications; real estate tax; other taxes; repayments (credits, loans, insurance, saving); recreation, sport, and culture; other goods and services. The determination of these items was based on the composition of the consumer basket used by the Czech Statistical Office (CSO). The second questionnaire was addressed to the local suppliers. These suppliers were investigated in regard to their total expenditures in 2014 which were distributed into 11 categories (expenditures on staff; expenditures on suppliers; property tax; other taxes; water; energy; rent and operation of buildings; fuels; postal services and telecommunication; promotion and advertising; other goods and services). In this case, too, a distinction was made between local and non-local spending. For both questionnaires, instructions were created to help the respondents.

It was also necessary to establish a representative sample of employees and suppliers. A representative sample can be determined using a mathematical method for calculating the minimum statistical sample from the population that is representative, which means that the results can be generalized to the entire population.

Table 1 states the minimum required number of questionnaires received from the suppliers at the significance level α = 0.05, i.e. the reliability of the test of 95%, and the varying confidence interval of the achieved responses.

Table 1: Calculation of the minimum statistical sample from the population of suppliers

Tabelle 1: Berechnung des minimal erforderlichen Stichprobenumfangs der Lieferanten

Variants of solutions	A	B	C
Confidence level (%)	95	95	95
Confidence interval (%)	5	7.5	10
Population	30	30	30
Sample size	28	26	23

Source: Sample Size Calculator, 2016

For the employees, the calculation of the minimum statistical sample from a population at a significance level α = 0.05 and for different confidence intervals is shown in Table 2.

Table 2: Calculation of the minimum statistical sample from the population of employees

Tabelle 2: Berechnung des minimal erforderlichen Stichprobenumfangs der Angestellten

Variants of solutions	A	B	C
Confidence level (%)	95	95	95
Confidence interval (%)	5	7.5	10
Population	82	82	82
Sample size	68	56	44

Source: Sample Size Calculator, 2016

The sample size equals the number of respondents.

It was necessary to convert Czech crowns to Euros which was accomplished by employing the average daily nominal exchange rate of the Czech crown against the Euro for 2014 (27.533 CZK/EUR) (CSO, 2016).

The data obtained from the survey were processed using basic statistical methods. The interval estimate of quality (p) was established to enhance the presentation of the results obtained from the questionnaire survey by using the correction coefficient (k) for random error relative frequencies (Ơp) (Swoboda, 1977).

An exploratory analysis of the data from the employees' questionnaires was carried out using the STATISTICA programme. The graphs of Figures 4 and 5 show that the distribution of data in the file approaches the Gaussian distribution.

3. Results

There were 54 suppliers of TFE Křtiny in 2014. Of the suppliers, 29 were legal entities and 25 individuals. The total expenditures on these suppliers accounted for 39% in legal persons and 61% in individuals.

The case study revealed that 30 of the 54 suppliers were local to TFE Křtiny. TFE Křtiny paid 484,185 € to these suppliers which stand for 43.3% of the total expenditures of TFE Křtiny. It is approximately 57% of the total expenditures on suppliers.

In the case of the local suppliers, 23 questionnaires were filled in out of the total of 30 questionnaires. This number has met the requirements of the minimum statistical sample from a population at a significance level of alpha equalling 0.05, i.e. the reliability of the tests is 95% and the confidence interval is 10% (so-called solution variant C). The minimum required number of questionnaires for this variant is just 23. Thus, this sample is considered to be representative. The number of questionnaires constitutes for 76.7% of the population.

The group of 23 local suppliers comprises 7 legal entities and 16 natural persons. Corporate expenses represent 94.5% of the total expenditures of local suppliers. Therefore, 5.5% of local spending is of natural persons. A natural person is operating as an individual (individual people) pursuant to the Act No. 455/1991 Coll. on Trades and may not be entered in the Commercial Register.

Table 3 shows the difference between these two legal forms in individual items. There are also percentages of local and non-local spending of total expenditures of legal entities and individuals.

Table 3: Percentages of local and non-local costs of natural and legal persons

Tabelle 3: Prozentuale Anteile lokaler und nicht lokaler Ausgaben von natürlichen und juristischen Personen

Items	Legal entities		Individuals	
	Local	Non-local	Local	Non-local
Expenditures on staff	3.42	8.60	20.39	0.00
Expenditures on suppliers	8.73	59.47	25.75	1.28
Repayments	0.00	5.43	0.00	2.88
Property tax	0.11	0.00	2.26	0.00
Other taxes	0.00	8.43	0.00	4.00
Water, energy	0.00	0.62	0.14	2.73
Rent, operation of buildings	0.14	0.00	2.84	0.08
Fuels	0.93	2.37	16.81	5.95
Postal services, telecommunication	0.00	0.46	0.00	2.88
Promotion, advertising	0.24	0.01	0.00	0.00
Other goods, services	0.41	0.64	8.80	3.22
Total expenditures	13.97	86.03	76.99	23.01

From Table 3 it is clear that small businesses spend most of their expenses locally, contrary to legal entities which spend about 86% non-locally. In real figures, however, the natural persons spend locally only a third of the total local spending of the legal entities. Legal persons are defined pursuant to the provisions of Act No. 89/2012 Coll. the Civil Code and the types of legal persons pursuant to Act No. 90/2012 Coll. on Commercial Companies and Cooperatives; they are entered in the Commercial Register. From the practical perspective, it is clear that it is necessary to support small businesses (self-employed persons) who spend the majority of their funds locally and thus support the local economy. Large companies employ local staff, yet the expenditures of their employees go in chain stores and thus their funds are not spent locally.

Legal persons are major firms whose turnovers are in most cases higher than those of individuals. In both, however, the biggest part of expenditures was on suppliers and staff costs. Figure 1 shows the percentage of those expenses divided into the 4 largest items within local and non-local spending.

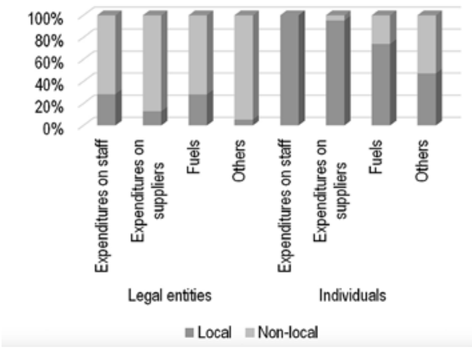

Figure 1: Percentages of the four major items of expenditure

Abbildung 1: Prozentuale Anteile der vier bedeutendsten Ausgabenpositionen

Figure 1 shows a clear distinction between legal and natural persons. The expenditures are local for the majority of the natural persons, e.g. in the case of staff expenditures it is 100%. Corporate spending is mostly non-local; in the case of staff expenditure, it is about 13%.

Focusing on the local expenditures and their volume, the total local expenditures of individuals represent approximately one third of all corporate spending. This and more can be seen from Figure 2.

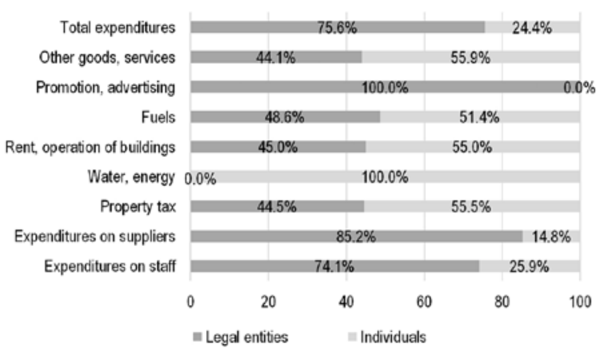

Figure 2: Percentages of expenditures of natural and legal persons

Abbildung 2: Prozentualer Ausgabenanteil natürlicher und juristischer Personen

Concerning the expenditures on staff, the share of natural persons to legal persons is 26% to 74%. The legal entities occupy more than 85% of the expenditures on local suppliers. However, this figure represents only 13% of the corporate expenditures on all suppliers.

Table 4 provides an interval estimate of local expenditures vendors using variables p = 17.47% with a range of sample N = 30; n = 23; p = 0.175.

Table 4: Interval estimation of local expenditure suppliers

Tabelle 4: Intervallschätzung der lokalen Ausgaben von Lieferanten

Items	Coefficient	%
Standard deviation	0,380	
Random error relative frequencies	0,069	± 6,9
Correction factor	0,491	
Random error relative frequencies using weighting	0,034	± 3.4

With 95% of confidence, the amount of local expenditure of local suppliers ranged between 14.07% and 20.87%.

Furthermore, 57 of the 82 local employees (69.8%) of the TFE Křtiny completed the questionnaires. Thus, a statistically significant quantity of employees was approached (the variant of solution B with the confidence interval of 7.5%). These employees spent more than 155,000 € locally, which makes up to 40% of their expenditures.

Firstly, an analysis of missing data in the questionnaires from employees was performed based on the analysis of frequency. It was discovered that only the question in the category “age” was not answered by 6 respondents. All the other details were filled in by the employees.

There were 33 men (relative frequency of 57.9%) and 24 women (relative frequency of 42.1%) of the 57 employees who completed the questionnaire. 22 employees occupied technical – economical or managerial positions (relative frequency of 39.6%), and 35 employees occupied worker positions (frequency of 61.4%). Most workers fall into the lowest wage category (40.4%) with their net income for 2014 ranging from 3,645 € to 5,468 €. The frequency of the individual categories is shown in Figure 3.

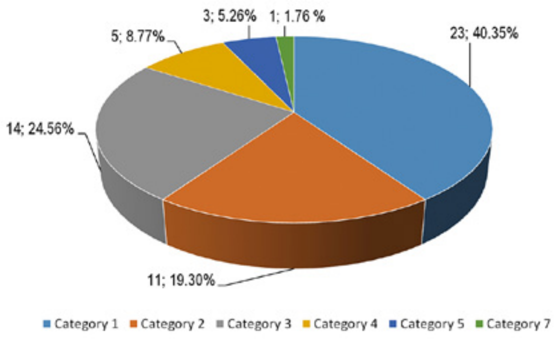

Figure 3: Frequency of wage categories of employees

Abbildung 3: Häufigkeit von Lohngruppen der Beschäftigten

The employees were divided into 7 categories in terms of age as shown in Table 5 with the largest group of employees being between 30 and 50 years. These 7 categories were divided according to the average monthly wage in the forest management by individual employees' jobs.

Table 5: Age categories of employees

Tabelle 5: Altersgruppen der Beschäftigten

Category	Age	Absolute frequency	Relative frequency
Category 1	up to 20	1	1.75
Category 2	from 20 to 30	8	14.04
Category 3	from 30 to 40	15	26.32
Category 4	from 40 to 50	16	28.07
Category 5	from 50 to 60	6	10.53
Category 6	over 60	5	8.77
Category 7	unknown	6	10.52

Table 6: Expenditure categories of employees

Tabelle 6: Ausgaben der Beschäftigten in Gruppen

Category	Local expenditure	Absolute frequency	Relative frequency
Category 1	0	3	5.26
Category 2	from € 0 to € 1000	9	15.79
Category 3	from € 1000 to € 2000	4	7.02
Category 4	from € 2000 to € 3000	19	33.33
Category 5	from € 3000 to € 4000	11	19.30
Category 6	from € 4000 to € 5000	6	10.53
Category 7	from € 5000 to € 6000	4	7.02
Category 8	from € 6000 to € 7000	0	0.00
Category 9	from € 7000 to € 8000	1	1.75

With regard to local expenditures, category 4 is the largest which means that one third (33.33%) of the employees spends locally between € 2,000 and € 3,000.

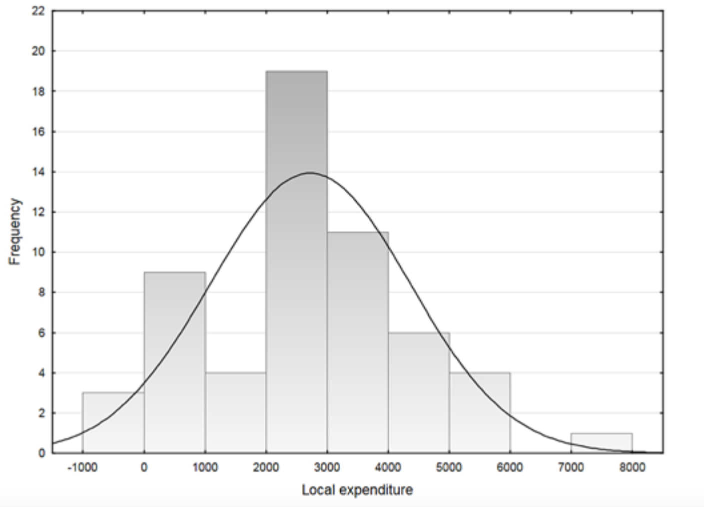

Figure 4: Histogram of expenditures of employees

Abbildung 4: Histogramm der Ausgaben von Beschäftigten

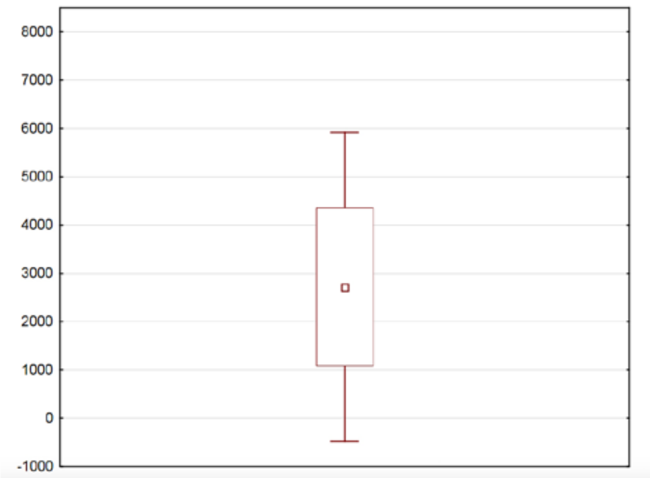

Figure 5: Boxplot of expenditures of employees

Abbildung 5: Boxplot der Ausgaben von Beschäftigten

The box graph of Figure 5 shows that the data include a remote point. After a more detailed investigation it was discovered that these data cannot be excluded from the analysis since this employee actually spends most of his salary locally on housing. Outlying data are also evident from Figures 6 and 7, especially from the quantile-quantile graph (see Figure 6).

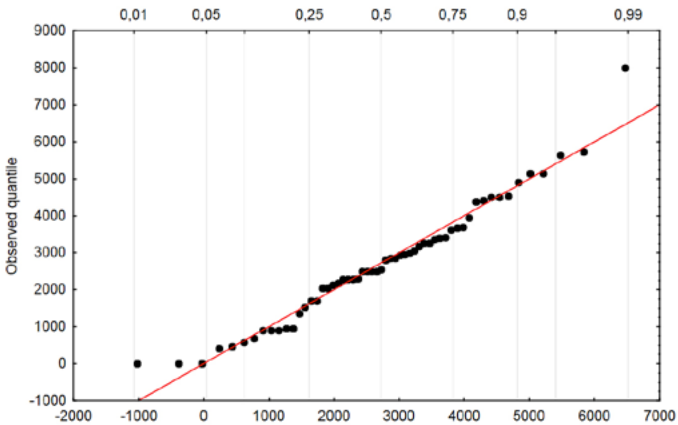

Figure 6: Quantile-quantile graph of expenditures of employees

Abbildung 6: Quantile-Quantile Plot der Ausgaben von Beschäftigten

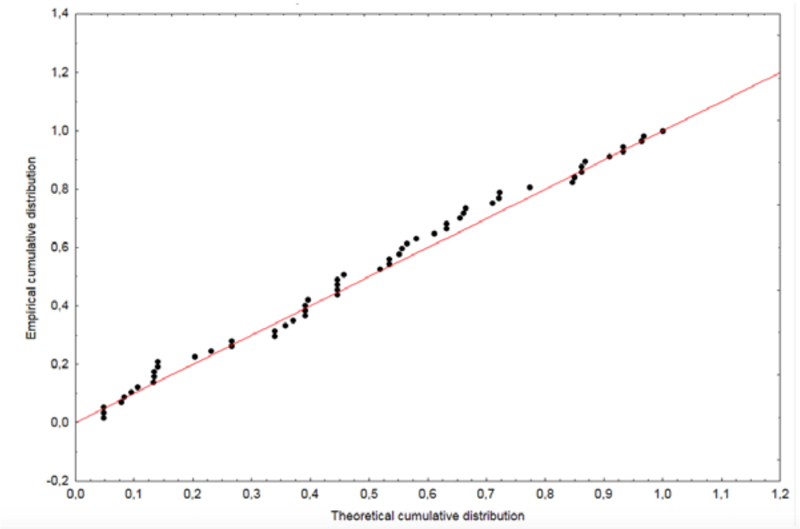

Figure 7: Graph of variance of expenditures of employees

Abbildung 7: Varianzgrafik der Ausgaben von Beschäftigten

The graph of variance (see Figure 7) indicates a slight asymmetry. Most of the diagnostic graphs show a normal distribution, although some data show deviations from this division and cannot be excluded from the analysis.

Table 7: Classical parameter estimation

Tabelle 7: Klassische Schätzungen der Parameter

parameter distribution	Value
n	57
Shapiro-Wilk test of normality p	0.148
Average	2,723
Standard deviation	1,632
The lower quartile	1,698
The upper quartile	3,623
Median	2,542
Dispersion	2,664,766
skewness	0.550

The difference between the average and the median is not so significant; with regard to the value of its skewness, a normal distribution can be assumed. The Shapiro-Wilk test of normality found that normality is not rejected.

In addition, correlations between categories of total net income, age, and local spending were examined. A correlation was discovered between net income and local expenditure.

Table 8 provides an interval estimate of local expenditures of employees using variables

p = 39.56% with sample sizes N = 82; n = 57;

p = 0.396.

Table 8: Interval estimation of local expenditures of employees

Tabelle 8: Intervallschätzung der lokalen Ausgaben von Beschäftigten

Items	Coefficient	%
Standard deviation	0,489	
Random error relative frequencies	0,054	± 5,4
Correction factor	0,556	
Random error relative frequencies using weighting	0,030	± 3.0

With 95% of confidence, the amount of local expenditure of local suppliers ranged between 36.56% and 42.56%.

The values of the local multipliers LM2 and LM3 were calculated from accounting data of the TFE Křtiny and from the surveys of employees and suppliers. LM2 was calculated as 1.23; LM3 was 1.52. This value means that CZK 1 of expenditures of TFE Křtiny generates CZK 1.52 (0.06 €) for the local economy. These values themselves are not meaningful. It is necessary to compare them with the recommended values and those of similar enterprises.

Based on the comparisons with enterprises in the industry and the region, the enterprise can deduce conclusions for improving their decision-making and management at the local level and strengthen all three pillars of sustainable regional development.

The score of local multipliers can be affected by decisions in regard to the cost structure. Cash flow monitoring will enable the organization to determine its impact on the local economy and to understand the local community. The obtained information may be used in setting of marketing objectives and strategies of the enterprise as well as in improving communication with customers, which in turn will increase the competitiveness of the enterprise. It is also possible to use the obtained information to build a corporate culture and to improve the relation with employees.

4. Discussion

The research focuses on the analysis of cash flows of the forest enterprise to determine how much of the spent money will remain in the area and to map the circulation of money spent in the area before it leaves. The results show that about 57% of the total expenditures on suppliers of the TFE Křtiny were spent on local suppliers. Although more of the suppliers are legal entities, the enterprise spends 61% of its expenditures on small suppliers (individuals). From the local suppliers' perspective, the proportion is 91 to 9 in favour of the local suppliers in terms of volume of funds.

The stated results lead to reflection on the economy of the monitored organization as well as on the potential of the given region. The enterprise may assess the actual use of its internal resources and, in the case of monitoring, the trend of the LM3 values over time to obtain valuable information about changes in the flow of monetary resources, which is also confirmed by Silovská (2015).

Generally, it is possible to notice the economic benefit of calculating the local multiplier to assess increases in regional employment, support of local households and business entities, and increases in the overall local economy of a region. According to Shuman (2000), it would consequently lead to a return of the decision-making processes back to the region, and to a decrease in its dependency on external input. Regional politics then play an important role here (Armstrong and Taylor, 2000).

According to Sacks (2002), if LM2 is from 1 to 2, then the LM3 reaches the values between 1 and 3. However, Kutáček (2007) states that the realistic value of LM3 is up to 2.20. The values of both the local multipliers 2 and 3 (1.23, resp. 1.52) appear to be very low in comparison with the recommended values, as well with those determined by Březina, Hlaváčková, Šafařík (2015) who applied the method to the National Park of Podyjí. It implies that the management of TFE Křtiny should focus on increasing the share of local suppliers or on the education of its employees.

Another goal is to reduce the difference in social groups and gender, to improve respect for human rights and to increase fairness and control in decision-making processes (Hines, 2000).

Effective deciding on the way in which the spending is being carried out can bring profits to local residents, improve the competitiveness of the investigated company and meet the objectives of development policies. If the local economy improves, the government will be able to expend fewer resources, e.g. in the form of social benefits. This would allow channelling funds of the development policies to other areas in the region.

However, both recommendations seem to be problematic. In the case of suppliers, the enterprise must observe the law concerning public procurement which forbids considering a supplier's location. Influencing consumer behaviour of employees also seems to be problematic since an enterprise is not able to order its employees to support the local shops. The only possible solution seems to be a change of regional or national policy and the introduction of tools supporting the local economy.

Since the Training Forest Enterprise Masaryk Forest Křtiny is located near the second largest city of the Czech Republic - Brno, the forests provide socio-economic benefits, especially in terms of their recreational function which is related to the aesthetic function. By providing forest ecosystem services in terms of recreational and aesthetic functions, forests additionally benefit the economy in terms of employment and business opportunities.

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Economic impact assessment of a forest pest invasion in Uruguay – Main challenges and opportunities

Abschätzung der wirtschaftlichen Auswirkungen einer eingeschleppten Blatterkrankung in Uruguay – Herausforderungen und Möglichkeiten

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Keywords: cost-benefit analysis, Eucalyptus, plant pathology

Schlüsselbegriffe: Kosten-Nutzen-Analyse, Eukalyptus, Pflanzenpathologie

Summary:

No study exists detailing the economic impact of diseases and forest pests in Uruguay, despite the growing importance of the forestry sector in the economy. This research is part of a project to assess the economic impact caused by the introduction of the foliar pathogen *Teratosphaeria nubilosa* in Uruguay, in order to contribute to the consolidation of the forestry sector from the perspective of economic sustainability. The pathogen was accidentally introduced in 2007 and has caused significant defoliation in young plantations of *Eucalyptus globulus*. The cost-benefit approach was applied

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at the economy level since this analysis is used to assess the economic efficiency of decisions affecting the use of scarce resources. The project is ongoing and during the application of the method, several challenges and opportunities were identified. The baseline scenario is defined as the situation before the introduction of the disease. Different scenarios were then defined in terms of: (1) the amount of volume of wood that was lost due to the pest, (2) replacement of *E. globulus* by other species of eucalyptus. Data were collected from available secondary information and interviews with informants and forestry producers. The use of cost-benefit analysis to study the economic impact of a forest pest for the country represents a first step for such studies. The environmental impact and the estimation of externalities caused by forest pests is to be added in future research. The results would be useful for decision makers to determine whether to allocate resources to prevent the introduction of forest pests.

Zusammenfassung:

Trotz der wachsenden wirtschaftlichen Bedeutung des Forstsektors in Uruguay gibt es noch keine Untersuchungen über die ökonomischen Auswirkungen von Schädlingsbefall in bewirtschafteten Wäldern. Diese Arbeit ist Teil eines Projektes zur Abschätzung des ökonomischen Einflusses der in Uruguay eingeschleppten Blatterkrankung *Teratosphaeria nubilosa* unter dem Gesichtspunkt der ökonomischen Nachhaltigkeit. Der Krankheitserreger wurde 2007 unbeabsichtigt eingeschleppt und hat zu umfangreicher Entlaubung in jungen *Eucalyptus globulus*-Plantagen geführt. Da es sich bei der Fragestellung um die Wirtschaftlichkeit bei der Verwendung knapper Ressourcen handelt, wurde als Forschungsansatz die Kosten-Nutzen-Analyse gewählt. Im Zuge der bisherigen Bearbeitung des noch laufenden Projektes wurden zahlreiche Herausforderungen und Möglichkeiten identifiziert. Das Referenzszenario ist die Situation vor der Einschleppung des Krankheitserregers. Darauf aufbauend wurden mehrere Szenarien entwickelt die sich in folgenden Punkten unterscheiden: (1) Der Menge an durch den Befall verlorenem Holz, (2) dem Ersatz von *E. globulus* durch andere Eukalyptusarten. Die Daten wurden durch Analyse verfügbarer Sekundärdaten sowie aus Interviews mit Experten und Holzproduzenten gewonnen. Die Kosten-Nutzen-Analyse zur Untersuchung der ökonomischen Auswirkungen der Erkrankung stellt den ersten Schritt der Studie dar. Die Auswirkungen auf die Umwelt und die Abschätzung von externen Effekten sollten Teil zukünftiger Untersuchungen sein. Die Ergebnisse dieser Arbeit sollen Entscheidungsträger bei der Allokation von Ressourcen zur Vorbeugung von Waldkrankheiten unterstützen.

1. Introduction

The forest sector in Uruguay based on exotic plantations started developing in the late 1980s under Forestry Law 15939 (Parliament of Uruguay, 1988). The total planted area by species increased from less than 50,000 hectares (ha) to 695,093 effective ha as of

2012 (around 900,000 ha affected) (Forest Division, 2012, 2016). The main industries are pulpmills and sawmills. The sector is export-oriented and its contribution to the Gross Domestic Product (GDP) was 4.8% in 2015. *E. globulus* was the most planted species in Uruguay; however, the area cultivated with this species has been decreasing over the last several years. The main reasons have been related to a poor adaptation to soils and climate and the recent unintended introduction of a forest pest, the fungal leaf spot *T. nubilosa*, which affects tree plantations at early ages.

There are many examples in the literature of introductions of forest pests and diseases in the world. The vast majority of these studies address the taxonomic identity, vehicles, backgrounds and guests colonized by the organism pest (e.g. Wingfield et al, 2008; Brasier, 2008; Elmer, 2001). However, there are still very few studies that deal with the economic impact of these biological introductions (Holmes, 2010; Holmes et al., 2009), with the exception of some research in Canada and the United States. Some studies estimated the economic impact of declining raw material supply by external factors such as the appearance of a pest or a change of control factors (Holmes, 1991; Alavalapati et al. 1998; Zhang et al., 2005; Patriquin et al., 2007; Kirschner, 2010). The methods used by these studies are of interest to study the economic impact of a forest pest because one of the main impacts identified was the reduction of the harvest volume. In the US, two episodes can be identified: the inclusion of a species of spotted owl (known as spotted owl or *Strix occidentalis*) as a protected species, and the appearance of pine beetles (mountain pine beetle). The inclusion of the spotted owl as protected species in the Western United States resulted in a ban on harvesting forest plantations where the presence of this species was identified. The first effect of this ban was an increased timber harvesting in the South of the country and the closure of several production facilities in the West. In Canada, the pine beetle attack is endemic. Starting in 1999, the affected area went from 165,000 ha to 7 million ha, strongly affecting the livelihood of the region. In this case, the immediate effect was an increase in wood supply due to the need to cut infested trees standing and take advantage of its timber, and then a decrease in supply for the anticipated shortage. The results of this work have been recommended to design forest policy actions (Holmes, 1991; Alavalapati et al., 1998; Patriquin and White, 2004; Patriquin et al., 2007).

The working hypothesis of the project presented here is that the introduction of *T. nubilosa* in 2007 had a negative economic impact on *E. globulus* plantations and consequently on the national economy. It was proposed to conduct an economic assessment of the impact of the emergence of *T. nubilosa* in *E. globulus* plantations using a cost-benefit analysis. The objective of this paper is to discuss the feasibility of conducting a cost-benefit analysis to assess the introduction of the forest pest in Uruguay.

2. Material and Method

The analysis of the economic impact of a change in a sector of the economy can be performed using three different methods: input-output analysis, general equilibrium analysis, and cost-benefit analysis. The input-output-analysis could not be used because Uruguay does not have an updated input-output matrix. The general equilibrium analysis had a complexity which exceeds this project. Therefore the cost-benefit analysis was selected to conduct the research. Cost-benefit analysis is used at a national level to assess the economic efficiency of the decisions that affect the use of scarce resources (Roche, 2013; Nas, 1996), such as the introduction of a new activity, the disappearance of an activity, the implementation of a policy or regulation in the economy of a country or a region. It is also used to analyze the suitability of a project from the perspective of the economy as a whole. The method seeks to determine the impact of the change in the country's welfare, as measured by the availability of goods and services (OPP, 2014). The starting point for the cost-benefit analysis is the correct identification of costs and benefits, i.e., consider those that will affect the well-being of society as a whole and which are generated from the changes in the sector (Roche, 2013).

A base case scenario was defined as the situation before the pest was introduced. From there, different scenarios were defined depending on: (1) how much volume was lost due to the pest, (2) the substitution of *E. globulus* by other Eucalyptus species.

The first step was to identify costs and benefits. The costs were planting costs, maintenance costs, harvesting costs, transportation costs, and industrialization costs. The benefits were *E. globulus* wood exports. Data were gathered from different sources: available secondary information and personal interviews with producers and qualified people.

Secondary information was divided into three main groups: forest areas, exports, and forest producers. Forest areas in order to analyse how much *E. globulus* area decreased; exports in order to analyse the benefits composition and trends; and forest producers in order to characterize their decision making process and to gather costs and wood volume data.

Regarding forest areas, the available information was insufficient to meet the objectives of this project. The most appropriate information for these purposes was emerging from the Forest Charts 2004 and 2012 (Dell Aqua et al, 2006; Forest Division, 2012). However, it needed an update in order to compare the evolution in time of *E. globulus* areas. Regarding export information available the most appropriate for this project was from data provided by Uruguay XXI Institute for Promotion of Exports and Investments. The data were aggregated by species: coniferous and non-coniferous, and by company and destination. Regarding forest producers information, the available secondary information was revised and supplemented by primary information.

According to the Forest Charts from 2004 and 2012, the area planted with *E. globulus* declined by 27% (Table 1). From the analysis by region, in Canelones (located in the South of the country) the area more than duplicated. This fact was explained by a new company planting in the region. On the other extreme, in Tacuarembó (located in the North of the country) the area disappeared due to the adaption problems of the species. *E. globulus* is a species that needs to be close to the sea. Therefore, adaptation problems combined with the pest introduction lead to a decrease in the *E. globulus* planted area.

Table 1: Changes in forest areas with E. globulus by region

Tabelle 1: Änderungen der Waldfläche mit *E. globulus* nach Region

Region	Area in ha 2004	Area in ha 2012	Δ 2012-2004
Canelones	4435	10613	139%
Cerro Largo	16143	5819	-64%
Durazno	15025	7577	-50%
Florida	25713	12443	-52%
Lavalleja	41761	31559	-24%
Maldonado	18782	26954	44%
Paysandú	17005	10854	-36%
Rocha	20902	27773	33%
Río Negro	17726	18032	2%
Soriano	12298	10564	-14%
Tacuarembó	41336	3026	-93%
Uruguay total	**244760**	**177756**	**-27%**
% of the total	**94.43%**	**92.94%**	

Sources: Forest Division, 2012; Dell'Acqua et all., 2006.

The benefits identified in the research were *E. globulus* product exports. The first problem found was that export prices were not available. However, the Institute Uruguay XXI provided export data in volume and in value. As a result, a proxy for export prices by product was calculated by dividing exports in value over exports in volume. Companies that export *E. globulus* wood chips and roundwood by country of destination were identified. From the interviews it was confirmed that the only species of eucalyptus that is processed in chip mills is *E. globulus*, therefore it was possible to isolate those data. The wood was exported either as pulpwood or chips. Therefore, industrial costs of processing the roundwood should be included as well. However, modelling pulp industry costs exceeded the scope of this project. Therefore, it was assumed that pulpwood was exported as roundwood as they went to Free Trade Zones, which were considered "exports" by the country. For chip mills' cost data, two interviews were conducted as only two mills were operating in the country. Currently, estimates are being developed based on the information provided.

The Uruguay XXI data for 2001 to 2015 were analyzed to determine the composition of *E. globulus* wood exports by product, company and destination. It was not possible to establish a pattern of exports, as the trend changes over the period of analysis (Table 2). However, some stability was observed in the composition of exports between 2009 and 2015, with a share of about 80 - 85% of the volume exported as chips and 15-20% exported as roundwood. These proportions were used to project exports until the end of the period of analysis. Average roundwood export prices were 79.2 dollars per ton (USD/ton) for the period 2001-2015, with a minimum of 58.6 USD/ton in 2006 and a maximum of 108.1 USD/ton in 2014. Average chips export prices were 87.7 USD/ton for the period 2003-2015, with a minimum of 62.7 USD/ton in 2009 and a maximum of 107.5 USD/ton in 2012.

Table 2: Estimated E. globulus exports (´000 USD)

Tabelle 2: Geschätzter Export von *E. globulus* (´000 USD)

Year	Roundwood	Chips
2001	23609	-
2002	23309	-
2003	16450	10499
2004	3081	33401
2005	1586	60182
2006	2071	71637
2007	16189	63922
2008	3407	161521
2009	11406	73382
2010	27119	129933
2011	21746	164450
2012	17308	73133
2013	38933	82061
2014	19542	65399
2015	17471	61305

Source: own estimates based on Uruguay XXI data (personal communication).

Primary information was obtained from interviews with forestry companies, producers and informants as well as from personal communication with contractors. Interviews with forestry companies and producers of E. globulus in the country were made. The interviews were conducted according to a pre-established questionnaire that included the following chapters: (1) general information about the company, (2) forest resource, (3) impact of the disease caused by T. nubilosa, (4) replacing E. globulus by alternative forest species, (5) marketing E. globulus wood and alternative species and (6) future production of E. globulus in Uruguay and perspectives. The objectives of the interviews were to characterize the production sector of E. globulus in Uruguay and to gather information for the Cost-Benefit analysis. The selection of respondents was conducted with the support of the Society of Forest Producers (SPF). Respondents were contacted by email. After they agreed to the interview, they were sent the questionnaire and an individual personal interview was coordinated to enrich the exchange with the interviewee. Between 24 November 2014 and 25 May 2015 15 interviews, including 11 producers and forestry companies and 4 informants were performed.

Costs at market prices are presented in Table 3. Planting costs were composed of labor (70%) and material (30%). The inputs to be considered in the analysis were generally imported, e.g., glyphosate and fertilizer accounting for 2.5% of the total. To estimate the shadow price of maintaining costs, it was assumed that the share of labor and inputs was the same as for the cost of planting, recognizing that it may not be exact but very similar. The composition of harvesting costs was 20% gasoline, 8% labor, and the rest other inputs. Transportation costs were composed by 50% labor, 15% gasoline, and the rest were other inputs.

Table 3: Costs in market values

Tabelle 3: Kosten zu Marktpreisen

Description	Value
Plantation costs (USD/ha)	1,211
Maintenance costs (USD/ha)	198
Harvesting costs (USD/ton)	20
Transportation costs (USD/ton/km)	0.12

Sources: interviews, personal communication

The Mean Annual Increment (MAI) by species is not available; therefore the volume loss due to the pest could not be obtained. Volume yields for the base case (no pest) were not easily available from secondary information. In the interviews, average yields were obtained and used for the base case. Inventory information from plots before the pest were gathered from producers by region. However, not much data were available. Furthermore, data from the Agricultural and Livestock National Research Institute (INIA) were used. Even though these had not been collected for this research, they were considered useful. Finally, inventory data of forests with the pest were collected between March-July 2015 for four regions: Rocha, Lavalleja, Florida and Canelones.

To conduct a cost-benefit analysis, it is often necessary to correct market prices for distortions caused by taxes, subsidies or monopoly prices, for which accounting prices or shadow prices are used, reflecting the opportunity cost of the use of the resource for the economy (Londero and Cervini, 2003). Shadow prices result from a change in welfare due to changes in the supply or demand of goods (Londero and Cervini, 2003). Therefore, these prices should reflect the opportunity cost for the economy of allocating resources to a certain sector. Shadow prices can be estimated from input-output matrices, using linear programming, the partial equilibrium approach or general equilibrium functions (Londero and Cervini, 2003; Harou, 1987, Squire and Van der Tak, 1975 as cited in Morales Olmos, 2007).

In order to correct this distortion, the shadow price ratio (SPR) is estimated to correct the market prices. Shadow prices can be obtained by multiplying the market price with the SPR which reflects the opportunity cost of using the resource (Equation 1)

$$SPRi = SPi / Pi \qquad (1)$$

with *SPRi* = shadow price ratio of price i

SPi = shadow price of good i

Pi = market price of good i

In many countries the Planning Offices or Ministries of Finance or Economics are in charge of calculating the main shadow prices, namely: for labor, the discount rate, and foreign exchange (Roura and Cepeda, 1999). In Uruguay, the latest shadow price estimates were published in 2014 (OPP, 2014). These estimates were considered appropriate for this research as these prices reflect recent economic conditions of the Uruguayan economy. In the case of labor, shadow costs were derived from studying the impact on labor supply due to (1) an additional labor demand, (2) a reduction in the good and services production, or (3) both (Amarante and Ferrando, 2011). In the case of the discount rate, the authors used a weighted average approach (Oddone, 2011). In the case of foreign exchange a partial equilibrium model was applied, measuring the changes in the welfare of producers and consumers caused by a change in the value of the foreign exchange (Aboal, 2012).

Labor and foreign exchange shadow prices were used to correct for market distortions. For labor, it is necessary to identify the opportunity cost of allocating workers to the activity in question rather than allocating them to alternative uses, which are to be employed in another sector or being unemployed. A SPR of semi-skilled labor in the urban interior of 0.53 was used. This value implies that if one unit is spent on labor, the impact on the economy will be less than one. For foreign exchange, the SPR is 1.21, indicating that decreasing exports by one foreign exchange unit, social costs of 1.21 foreign exchange units are triggered.

An incremental cash flow was estimated, and the Economic Net Present Value (NPVe) was calculated using a social rate of discount. The NPVe is the sum of discounted net cash flows at a selected discount rate. If the impact of the pest was negative, the incremental NPVe would be negative for the economy; if the impact was positive, the incremental NPVe would be positive; if there was not impact, the incremental NPVe would be zero. Finally, a social interest rate of 6.5% was used to discount and the period of analysis was 2007-2031 in order to include the year when the pest was introduced, 2007, and two rotations.

The economic analysis in the case of forestry is usually done in a long-term framework because there are usually many years between the initial investment is done and the first benefit is obtained. In Uruguay for a pulp regime, the period between plantation and harvest ranges between 9-12 years. Therefore, conducting a Cost-Benefit analysis considering the time horizon mentioned above and using cash flows and correcting the values using shadow prices seemed to be an appropriate approach for addressing the problem.

3. Results

Regarding forest area, a loss of around 27% of the area was observed between 2004 and 2012. Some of the loss could be explained by the species poor adaptation but most of the loss was explained by the introduction of *T. nubilosa* as it was stated by the producers in the interviews. Producers and companies recognized the fact that the introduction of the pest was important to make the decision to change the species. However, the decision was different whether it was made by a forest company or by a producer. The forest companies were more risk adverse than the producers. Therefore, they had changed the species as soon as the pest was detected in their plantations.

Regarding volume loss, the challenges were diverse. From the analysis it was observed that forests were planted with different seedlings or clones. This variety might lead to an issue when comparing plantation yields with and without the pest. Preliminary results showed that the 20% loss in the harvest volume expected by the producers had not been reached. Instead, a range from 3-5% in terms of loss was found. When this paper was written, a discussion with producers was held and the causes of the differences between their expectations and actual results were addressed. The main reason identified was the different seedlings or clones. Also, they recognized that they did not have much data available as the harvest of the first plantations with *T. nubilosa* infections are currently going on. The pest was introduced in 2007 and the rotation age for these management regimes are 9-12 years.

As it was stated before, the *E. globulus* is a high value species. Therefore, even though the loss of volume was not as high as expected by the producers, a fact that yet needs to be confirmed, the loss can be high in terms of value. Furthermore, as it is a species exported as chips mainly and sold to Free Trade Zones and knowing that foreign exchange has an opportunity cost of 1.21 the decrease of exports would be associated with a leverage of 21%.

Preliminary results under these assumptions showed that a loss of 3% of the volume would lead to a loss of 2.9 million USD in exports for the period 2014-2031 and a loss of 5% would lead to a loss of 4.9 million USD. The research has yet to be completed.

4. Discussion

The cost - benefit approach is particularly relevant in the case of forestry projects because these are long-term investments, generating revenues and costs at different points in time which make them comparable in the present (Harrison et al., 2002). However, data availability is a challenge in the forest sector in Uruguay, particularly economic data.

The use of cost-benefit analysis to estimate the economic impact of the forest pest *T. nubilosa* on the Uruguayan economy is considered to be appropriate. However, implementation presents challenges, mainly related to data availability for the forest sector in Uruguay. It also presents opportunities as the impact of a forest pest on the economy is investigated for the first time.

The economic information for the forest sector in Uruguay for this type of research is scarce and incomplete. For the primary sector, plantation costs are not available from secondary information and researchers have to rely on information from contractors. For the industrial sector, the problems are related with costs of the industrial process.

In addition to the economic data, volumes and areas by species and regions are also lacking. Average Mean Annual Increments (MAIs) by species and regions, as well as reliable information on areas by species, age and region, are needed in order to assess the impact of a forest pest. For MAIs estimates, an additional challenge is that the *E. globulus* sector has been changing the seedlings and in some cases introduced clones, so that it is all but straightforward to isolate the causes of the changes in harvest volume. Therefore it is of interest to keep track of these changes in the inventory data. For areas estimates, an update from the government is needed in order to learn how much area planted with *E. globulus* has been actually substituted and with which species. The species chosen has implications regarding yields and markets. In addition, it has implications for the estimates of whether the volumes would be exported or consumed locally. It was mentioned that *E. globulus* prices are higher than other species prices; therefore if the species was substituted by other species, the economic loss would be high.

The information identified as important for an economic impact study would be of interest for companies operating in the country as well as investors either from Uruguay or abroad. Finally, the use of cost - benefit analysis to investigate the economic impact of a forest pest for the country represents a first step to this type of studies. The environmental impact and the estimation of externalities caused by forest pests should be added in future research. The results would be useful for policy makers determining whether to allocate resources to prevent the introduction of forest pests.

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Economic analysis of short rotation coppice investment: Croatian case study

Wirtschaftliche Analyse der Investition in Kurzumtriebsplantagen: Eine Fallstudie aus Kroatien

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Keywords: forest biomass, investments, profitability, short rotation coppice

Schlüsselbegriffe: Wald-Biomasse, Investitionen, Rentabilität, Kurzumtriebsplantagen

Summary

Following the Croatian fully fledged membership in the European Union in 2013 and pursuant to the Directive 2009/28/EC on the promotion and use of energy from renewable sources, Croatia, as well as other member states had done previously, committed to increasing their use of energy from renewable sources. Consequently, by 2020 the share of energy from renewable sources in final gross energy consumption is expected to reach at least 20% at EU level. According to the Energy Strategy (2009), Croatia had set a goal for 2010 to use about 15 PJ (peta joules) biomass energy, and for

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2020, around 26 PJ. This energy will be generated in numerous biomass power plants with a total output of about 85 MW. In the last few years, investments in short rotation crops in Croatia have increased substantially due to the rising need for biomass. This case study evaluates investments in short rotation coppice (SRC) on the territory of the Republic of Croatia. SRC are mostly planned and established on land in rural areas which is not used for agricultural or forestry purposes due to its low site quality. The sample of plantations of willow clones (*Salix sp.*) studied covers an area of 3,000 ha. The time frame of the project is 15 years and the predicted annual willow yield amounts to 21 t DM ha^{-1} a^{-1} (dry mass per hectare per year). The research results presented refer to the investment launched in Valpovo Forest Range Office located in the eastern part of the Republic of Croatia. Methods of capital budgeting were used in the economic analysis (NPV-Net Present Value, IRR-Internal Rate of Return). The discount rate that was taken as a reference stood at 7 %, yet rates ranging between 5 % and 10 % were used in terms of sensitivity analysis. All the calculated indicators showed the cost-effectiveness of the project: dynamic payback period: 10.83 years, net present value: 1,789,133 € and internal rate of return 10.36 %.

Zusammenfassung

Mit Erreichen der EU-Vollmitgliedschaft 2013 hat sich Kroatien wie auch die anderen EU-Mitgliedsstaaten gemäß der Richtlinie 2009/28/EG verpflichtet, die Nutzung erneuerbarer Energie zu intensivieren. Dementsprechend soll der Anteil erneuerbarer Energie im Jahr 2020 mindestens 20 Prozent des Bruttoenergieendverbrauches auf EU-Ebene betragen. Laut Energiestrategie (2009) hatte Kroatien als Ziel für 2010 etwa 15 PJ (Peta-Joule) sowie für 2020 rund 26 PJ Energie aus Biomasse zu gewinnen. Diese Energie wird in einer größeren Zahl von Biomassekraftwerken mit einer Gesamtleistung von ca. 85 MW generiert. Aufgrund des steigenden Bedarfs an Biomasse hat sich in der letzten Zeit die Anzahl der Investitionen in Kurzumtriebsflächen in Kroatien erhöht. Die Fallstudie behandelt die Investitionsanalyse von Kurzumtriebsplantagen in Kroatien. Solche Plantagen werden größtenteils auf ertragsschwachen Böden in ländlichen Gebieten geplant und etabliert, die keiner land- oder forstwirtschaftlichen Nutzung unterliegen. Die Untersuchung bezieht sich auf gepflanzte Weidenklone (*Salix sp.*) im Ausmaß von 3000 ha. Die Projektlaufzeit beträgt 15 Jahre und die erwartete Produktivität liegt bei jährlich 21 t an Trockenmasse je ha. Die dargestellten Forschungsergebnisse beziehen sich auf die im Revier Valpovo im Osten Kroatiens eingeleitete Investition. Für die ökonomische Analyse wurden die klassischen Methoden der dynamischen Investitionsrechnung benutzt (Kapitalwert, interner Zinsfuß). Der als Referenz gewählte Zinsfuß beträgt 7%, wobei im Rahmen der Sensitivitätsanalyse Zinsfüße zwischen 5% und 10% angewandt wurden. Alle berechneten Indikatoren belegen die ökonomische Vorteilhaftigkeit des Projektes: dynamische Amortisationsdauer: 10,83 Jahre, Kapitalwert: 1,789.133 € und interner Zinsfuß 10.36%.

1. Introduction

A higher level of energy independence is a strategic interest of each country and hence exploration of the potential of use of alternative energy sources is considered as one of the priorities of sustainable development. The Croatian energy policy is closely linked to the energy policy of the European Union, which stipulates the commitment to reduce emissions by 20% below 1990 levels by 2020 as documented in the Amendment to the Kyoto Protocol accepted at the Conference of the Parties (COP 18) in Doha in 2012 and COP 21 in Paris. Croatia is to meet this objective along with the other EU member states (Duić et al. 2005).

Biomass from forest tree species can be produced also by intensive cultivation of fast growing species in short rotation coppice (SRC). These types of plantations are fundamentally intended for biomass production as a renewable and environmentally acceptable energy source. They can also be considered as an alternative “agricultural” crop (especially on marginal sites), contribute to diversification of agricultural production and provide an opportunity for an environmentally more acceptable way of wastewater and phytoremediation (Kajba et al. 2011). Moreover, they are intended for sequestration of an increased quantity of atmospheric carbon and the mitigation of climate change by means of carbon storage (Volk et al. 2004).

Throughout the previous research willow and poplar clones showed the greatest biomass production potential in short rotation of up to five years on marginal and especially on optimal soils (Kajba et al. 1998, Kajba & Bogdan 2003, Bogdan et al. 2006, Kajba & Andrić 2014). Consequently, testing of diverse clones of willow and poplar continued in Croatia, aiming to identify those with the greatest biomass production potential, especially on the so called marginal soil or soil where agricultural production has been abandoned and those that are unattractive concerning the cultivation of more valuable forest tree species (Kajba et al. 1998, Kajba et al. 2004, Kajba & Katičić 2011). Plantations of broad-leaved tree species can be used as pure energy plantations, pre-cultures and mixed plantations striving to produce wood chips for the production of short wood fibres and timber to meet the requirements of mechanical wood processing. Such biomass production efforts are in line with global trends that aim to enhance the use of renewable energy sources (Verwijst 2003, Volk et al. 2004, Smart et al. 2005, Rosillo-Calle 2007). Biomass implies non-fossilized plant material created through photosynthesis. Wood from trunks, crowns and branches is used upon classical forest exploitation and normally the diameter with bark exceeds 7 cm at its thinnest parts. Hence, up to 70% of wood mass of mature stands is used, while in young stands it can total up to 50% (Sušnik & Benković 2007). The allowable cut of 6.5 million m^3 in Croatia results in around 2 mill. m^3 of tree trunks (30 %), 650,000 m^3 of cellulose (10%), 1.3 mill. m^3 firewood (20%), whereas the remainder of around 2.6 mill. m^3 (40 %) is small dimension wood that remains unexploited in the forests as waste. Out of the previously mentioned waste 62.5 % or 1.6 mill. m^3 could be used for energy production, while 37.5% or almost 1 mill. m^3 would still remain in the forests as waste.

If 1.3 million m^3 firewood is added, one is left with a total quantity of nearly 3 million m^3 of wood for energy that could instantly be used on the energy market (Tomić et al. 2008). Intensive forest management in Croatia could increase the annual allowable cut (logging) to reach around 7.3 million m^3 which would result in almost 3.3 million m^3 of forest biomass for energy, which, compared with the current results, implies an increase of 2 million m^3.

The specific objective of the research was to analyse the cost-effectiveness of short rotation plantations, which is one of the principal prerequisites for successful biomass production from an economic point of view. Consequently, methods of investment assessment were applied. Site selection features concerning climatological conditions, soil requirements and other data were taken from previously conducted analyses (Kajba & Bogdan 2003, Kajba & Katičić 2011). Due to a long-term production cycle, small-scale capital turnover (considering the level of growing stock) and product specificity, an insight into the economic aspects of plantation management is fundamental (Posavec 2003, Keča et al. 2012). The economic analysis of establishment of short rotation plantations in the Republic of Croatia has not thus far been sufficiently scientifically explored and there is currently only a small number of scientific papers addressing this issue (Pašičko et al. 2009, Kajba et al. 2011). Insufficient attention is being paid to the economic aspects when new plantations are planned and established. This case study presents calculation schemes based on dynamic investment appraisal in regard to a complete SRC cycle.

2. Material and Method

2.1. Research area

The pilot energy plantation (experimental clonal test) that was the subject of the research was established on a 5 ha plot in April 2008 from cuttings taken from the nursery of the Department of Forestry Genetics, Dendrology and Botany located in Valpovo Forest Range Office (Eastern Croatia). The plantation comprises 10 clones created through diverse combinations of hybridization of White Willow (*Salix alba L.*) and the Chinese Willow (*Salix matsudana Koidz.*), as well as white willow clones (*Salix alba L.*). The test was based on a randomized complete block design with four repetitions. Each clone was represented with 30 ramets per repetition at a spacing of 1.30 × 0.8 m (9,615 plants per hectare). The test was performed on a marginal site, i.e. the soil that according to its pedological characteristics is unsuitable for agricultural crops (Kajba et al. 2012).

The time scheme for the establishment of the plantation and the production of wood chips is presented in Table 1. Provided a short rotation plantation of willow has been established in an area covering 1,000 ha at an annual basis, a total of 3,000 ha covered with short rotation plantation of willow would be established over a three-year period. According to the planned rotation period, the cut in short rotation plantations of willow would be performed every two years during the period of 15 years. Upon the share of moisture in the produced wood chips standing at 30% (as assumed within the economic analysis presented in the following chapter) and an average yield of 21 t DM ha^{-1} a^{-1}(dry mass per hectare per year) at an annualised level, it was projected that 42,000 tons of wood chips would be produced per 1,000 ha.

Table 1: Time schedule of establishment of short rotation coppice and production of wood chips with corresponding areas and projected yields

Tabelle 1: Zeitliche Planung der Gründung von Kurzumtriebskulturen und der Produktion von Hackschnitzeln mit den zugehörigen Flächen und geplanten Erträgen

Area [ha] (Fläche [ha])	Year (Jahr)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.000	Planting (*Pflanzung*)	cutting the sprouts (*schneiden der Sprossen*)	cut (*Holzeinschlag*)		cut (*Holzeinschlag*)		cut (*Holzeinschlag*)		cut (*Holzeinschlag*)		cut (*Holzeinschlag*)		cut (*Holzeinschlag*)		
1.000		Planting (*Pflanzung*)	cutting the sprouts (*schneiden der Sprossen*)	cut (*Holzeinschlag*)		cut (*Holzeinschlag*)		cut (*Holzeinschlag*)		cut (*Holzeinschlag*)		cut (*Holzeinschlag*)		cut (*Holzeinschlag*)	
1.000			Planting (*Pflanzung*)	cutting the sprouts (*schneiden der Sprossen*)	cut (*Holzeinschlag*)		cut (*Holzeinschlag*)		cut (*Holzeinschlag*)		cut (*Holzeinschlag*)		cut (*Holzeinschlag*)		cut (*Holzeinschlag*)
Cut surface [ha] (*Holzeinschlag Fläche [ha]*)			1.000	1.000	2.000	1.000	2.000	1.000	2.000	1.000	2.000	1.000	2.000	1.000	1.000
yield [t DM ha^{-1} a^{-1}] (*Nutzung* t DM ha^{-1} a^{-1})			21	21	21	21	21	21	21	21	21	21	21	21	21
Total yield [t DM ha^{-1}] (*Gesamt Nutzung t DM ha^{-1}*)			42.000	42.000	84.000	42.000	84.000	42.000	84.000	42.000	84.000	42.000	84.000	42.000	42.000

2.2. Methodology

Capital budgeting or the assessment of cost-effectiveness is the process of identification, analysis and investment project selection in regard to projects where the returns (cash flows) are expected to exceed the time frame of one year (Holopainen et al. 2010). It is a decision-making process on long-term investment into the real corporate assets. The capital budgeting process includes project cash flow forecasting and the assessment of their financial effectiveness through implementation of criteria of financial decision-making comprised in a number of capital budgeting methods, such as IRR and NPV (Orsag 2002). The general objective of investment project assessment is to gain insight as to the justifiability and the economic acceptability of a project. Key features of capital budgeting are the time value of money, the concept of cash flow, discount rate as opportunity costs of corporate investment, as well as risk and uncertainty (Orsag & Dedi 2011). Capital budgeting rules imply specific criteria according to which projects are rejected or accepted. The criteria according to which projects are accepted or rejected are the results obtained through implementation of specific methods of financial decision-making. The assessment of project cost-effectiveness takes into account time preferences impacting on a considerably more realistic and a more accurate project assessment. The assessment of cost-effectiveness is also referred to as a dynamic assessment of effectiveness and the dynamic parameters are calculated using the following preconditions:

• 15-year long evaluation period, due to the land productivity. Typical harvesting rotation periods are between 2 and 7 years, but may also be extended longer. For willow SRC usually after 15 years the cultivation is either replanted or replaced by other crops (Dallemand et al. 2007). Depending on the SRC conditions, yields may be stable for the 5 to 6 two-year rotations and then decrease, once the plantation is getting older.

• Nominal discount rate of 7% (according to the Croatian National Bank (CNB 2016) and Croatian Bureau of Statistics (CBS 2015), and sensitivity analysis with 5%-10 %)

• Annual price increase of 2,9% (the average inflation rate was 2,5% in year 2009, according to the Croatian National Bank report CNB 2016)

• Investment in the establishment of short rotation coppice in equal shares over the first three years so that a willow plantation covering an area of 1,000 ha is established at an annualised level (1/3 of the stand or 1000 ha is in stand establishment phase, 1/3 or 1000 ha stand is growing, and 1/3 or 1000 ha is for cutting, hence a total of 3,000 ha). SRC should ensure continuity of income and delivery of biomass and bioenergy plantations should be located successively at different ages of production cycle and in the same proportion to the area of individual landowner (3 × 1,000 ha).

• Short rotation coppice maintenance costs concerning the cutting maintenance (stooling) and application of herbicides by spraying, to name a few, are planned between the second and the fourth year and costs concerning 1,000 ha of willow coppice are planned for each year;

• Investment into machinery and equipment for logging, transportation and processing of wood chips is projected during the third year;

• Costs related to operation and maintenance of machinery and equipment for logging, transportation and processing are assessed during the period commencing from the third year to the completion of the project;

• Procurement of new fixed assets upon termination of the amortization period;

• Revenues from wood chip production are defined by valorization of wood chip at 30% moisture content totaling 35 €/t FCO forest road (assortments price ex forest road).

The assessment of project cost-effectiveness is shown through several key financial indicators including the projected profit and loss account, cash flow, net financial flow of the project and profitability indicators (payback period, net present value - NPV - and internal rate of return - IRR) according to (Klemperer 2003).

The interest rate of the forest (discount rate) that is opted for during the analysis of forest management has a crucial role for the economic results (Klemperer et al. 1994, Price 1997, Brukas et al. 2001). The significance of the interest rate of the forest is fundamental, since, due to an inadequately selected interest rate, forestry can be ranked amongst activities with no economic justification. The degree of risk in forestry is vital upon the selection of the interest rate of the forest (Brukas et al. 2001). Risky projects are expected to show higher return on invested capital and hence their discount rate is higher in order to realistically show the potential returns. A sensitivity analysis is a technique used to determine how different values of an independent variable impact a particular dependent variable under a given set of assumptions. Sensitivity analysis, also referred to as what-if or simulation analysis, is a way to predict the outcome of a decision given a certain range of variables. This research used an analysis with discount rates ranging from 5% to 10 % in increment steps of 1 % for the NPV calculation.

3. Results

The total revenues and expenditures, as well as net profit as dependent from the model specification above are documented in Figure 1.

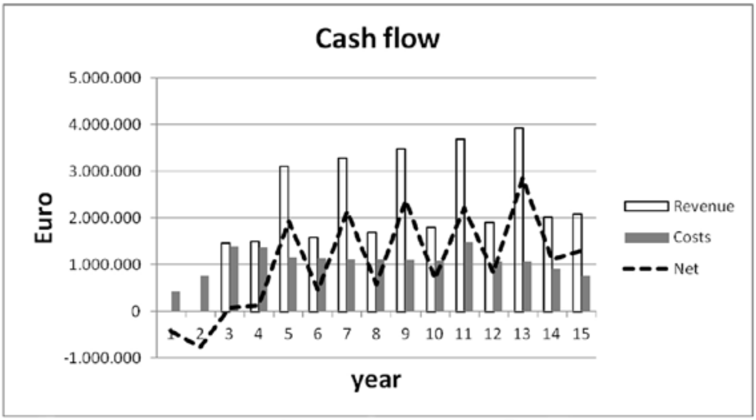

Figure 1: Investment project cash flow

Abbildung 1: Darstellung des Geldstromes des Investitionsprojektes

Costs were expected to prevail at the commencement of the investment period, primarily due to capital investment into the lease of land and purchase of machinery (Figure 1). The main costs (table 2) for plot establishment and maintenance are: silviculture costs, planting and seedlings, crop maintenance, land concession, equipment costs with 10% annual depreciation. Opportunity costs are not taken in account in this case study.

Table 2: Short rotation coppice costs (€/ha/year)

Tabelle 2: Kosten der Kurzumtriebsplantage (€/ha/Jahr)

Tangible costs	
Silviculture	17.09
Planting	133.73
Maintenance	26.64
Concession	130.71
Average labor costs per man	6.69
Depreciation for equipment*	86.44
Service**	113.29

Following the first logging after the third year the revenues exceed the expenditures, which does not imply that at that point (after three years) all the invested resources have been recouped. The payback period can be determined only upon taking into account also the time preference of money (Figure 2).

The optimal forest rotation period is influenced by productivity (quality) of the land, the value of the timber produced, the harvesting costs, taxes and administration costs, forest interest rate and non-timber forest products and services (Chang 1983, Terreaux & Peyron 1997, Moog & Borchert 2001, Posavec et al. 2011, Price 2011).

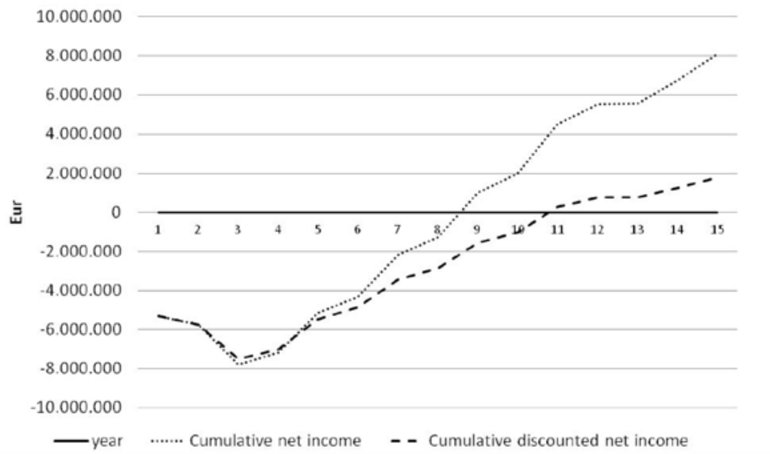

Figure 2: Payback period

Abbildung 2: Amortisationszeitraum

Payback period has been shown both in discounted and in non-discounted terms. The non-discounted amount can be interpreted only as an orientate value, whilst the discounted payback period of return takes into account the risks of work and the time preference of money. Consequently, the discounted payback period provides a more accurate overview of the investment project, because it takes in account inflation rate or nominal interest rate. Additional calculation was performed as shown in Table 3 aiming to establish the cost-effectiveness of the investment at diverse discount rates.

Table 3: Net present value trends in relationship with discount rate

Tabelle 3: Kapitalwert in Beziehung zum Diskontsatz

Discount rate [%] *(Diskontsatz [%])*	**Net present value [€]** *(Barwert [€])*
5	**3,165,707**
6	**2,443,842**
7	**1,789,133**
8	**1,194,414**
9	**653,379**
10	**160,464**

As expected NPV was lower in case a higher discount rate was used. It is important to highlight that NPV was positive also upon high discount rates (8% -10 %). The results shown in Table 3 confirm the fact that capital investment in SRC (short rotation coppice) has its economic justification and can generate significant profits for the investor. For the purpose of financing and maintenance, as well as logging, transport and biomass chipping from short rotation coppice a loan was required and hence the loan terms were taken over from the Croatian Bank for Reconstruction and Development loan programs intended for projects of this type. All the calculated indicators showed the cost-effectiveness of the project: discontinued payback period 10.83 years, net present value 1,789,133 € and internal rate of return 10.36%.

4. Discussion and conclusions

Biomass potential in Croatia is considerably large and it includes forest residue, wood residue in timber industry, firewood, agricultural residues and the biomass collected upon the maintenance of roads and infrastructure facilities. In addition to forest biomass standing at almost 1.6 mill. m³, which is currently unexploited in Croatian forests in the form of residues, short rotation plantations also have a huge potential. Potential surfaces for establishing short rotation plantations total 1.7 million ha comprising abandoned or marginal forest soil and uncultivated or unsuitable agricultural soil. The research provides a model of establishment of short rotation coppice, commencing from land consolidation, the procurement of planting material up to the wood chip production system. The analysis was performed on the basis of the results obtained from the research conducted in energy plantations of selected willow clones in the Valpovo Forest Range Office. Biomass production potential depended on the soil, selected clones, plant spacing and management of the plantation. All the costs have been shown without subsidies and non-repayable funding and the project can be more cost-effective in the event of subsidies provided. Moreover, it has to be highlighted that project duration is not limited to 15 years as indicated in the analysis but could be extended. Furthermore, it does not need to be restricted to 3,000 ha as shown in the analysis. Concerning the environmental benefits of biomass in relation to fossil fuels through restorability and sustainability, as well as an almost irrelevant atmospheric burden of carbon dioxide upon the use of biomass fuel and the impact of the project on producers, consumers and the local community, it can be concluded that the project of the establishment of short rotation plantations has been economically cost-effective and environmentally and strategically desirable (Richardson et al. 2002).

Economic analysis in this case has its specific features and it differs from the classical analysis of natural forest management. In case of short rotation coppice at the beginning of the investment period, bleak treeless areas need to be afforested, implying substantial financial expenditures for the investors and it simultaneously also implies a risk from planting failure. Moreover, in order to achieve revenue sustainability from these crops, afforestation will not be implemented in one year, but it will be arranged according to plans throughout the years of the duration of one rotation period (e.g. 10 to 15 or 20 years). Due to a faster growth and increment in SRC compared with natural forests, from the financial aspect SRC are considerably more suitable for investment due to a shorter payback period. On the other hand, due to intensive production, presence of only one or few genotypes and artificial regeneration such plantations are more vulnerable to natural disasters. Subsequently, higher discount rates need to be used in case of SRC than is the case upon economic analysis of natural forest management (Beljan 2015). Hence, natural forests imply less risk, yet also a lower internal rate of return (Brukas et al. 2001).

High discount rates can be noted in the example of Paulownia plantations (Paulownia sp. Siebold et Zucc. 1836). This species provides a high rate of growth in wood pulp production and hence also an increase in profit. The uncertainty of such investment is questionable, since the market orientation can instantly change and focus on an alternative species. In this specific case it is obvious that an adequate interest rate of the forest is high and stands at 7% - 8%. Subsequently, it is not recommended to establish short rotation plantations, and the same applies to any other investment in forestry, without prior comprehensive capital budgeting analysis. Short rotation cultures imply investment over a period of time that is substantially shorter compared with the investment in traditional forestry. This research confirms that this type of biomass production, i.e. energy generation from renewable sources is feasible and can generate profit for the investor. There is a possibility to activate some of the unexploited areas and agricultural land in which this type of production could be established in order to enhance rural development, increase the share of energy generated from renewable sources and hence create new jobs.

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Compensation payments for alternative forest management supporting nature conservation – a case study based on SIBYLA tree growth simulator and silvicultural cost model

Kompensationszahlungen für alternative Waldbewirtschaftung zur Unterstützung des Naturschutzes - Eine Fallstudie basierend auf dem SIBYLA Baumwachstumssimulator und einem waldbaulichen Kostenmodell

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Keywords: Annuity, Payment for Ecosystem Services, Single-tree Simulator SIBYLA, Silvicultural Costs, Shelterwood, Transition to Selection Forests

Schlüsselbegriffe: Annuität, Zahlung für Ökosystemleistungen, Einzelbaumsimulator SIBYLA, Waldbaukosten, Schirmstand, Überführung in Dauerwald

Summary

Compensation payments can allow or support nature protection instead of conventional forest management. The Forest Act of Slovakia enables agreement about compensation payments for special purpose forest management. Four management options were simulated for individual stands forming the Great Polom Nature Reserve

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and its buffer zone in northwest Slovakia. Compensation payments were estimated for change from management option "Conventional Management" towards "Alternative Management" meaning transition to selection forests, special "Forest Reserve Management" combining reserve and buffer zones, and "No Management" as a control reflecting just natural processes. Financial single net cash flows of different types of cutting operations was estimated with the single-tree simulator Sibyla. The study integrates a financial silvicultural model for simulation of stand establishment and young stand development including costs for planting and tending. When all stand generations in the study region were considered, afforestation and tending costs reduced compensation payments for managed options compared to the unmanaged option. Assumption for calculation of compensation payment considered only stand generations which were existing at the beginning of the contract period while following generation of young stands regenerated during this period were excluded from the financial calculation. The contract period comprised 45 years. In relation to "Conventional Management", compensation payment was 25 €/ha/year for "Alternative Management" towards selection forest, 70 €/ha/year for change to special "Forest Reserve Management" and 129 €/ha/year for change to "No Management". Only long contract periods enable objective estimation of financial differences between conventional management and alternative opportunities, because short term results were biased by specific developments related to age structure of mature stands. When the contract period is much shorter than rotation, afforestation and tending should not to be carried out to avoid costs, because income from such investments could not be achieved within the contract period. Only cycles of one stand rotation will substantially change age and size structure and therefore can support nature protection.

Zusammenfassung

Eine Kompensationszahlung kann Naturschutz anstelle von konventioneller Forstwirtschaft erlauben oder unterstützen. Das slowakische Forstgesetz ermöglicht eine Vereinbarung über Kompensationszahlungen für eine Forstwirtschaft für spezielle Zwecke. Vier Bewirtschaftungsoptionen wurden für individuelle Bestände simuliert, die das Naturreservat Groß Polom und seine Pufferzone im Nord-Westen der Slowakei bilden. Kompensationszahlungen wurden für den Wechsel von der Bewirtschaftungsoption "Konventionelle Bewirtschaftung" hin zu "Alternative Bewirtschaftung" mit einem Übergang zu einer Einzelbaumnutzung, hin zu einer speziellen "Bewirtschaftung für ein Forstreservat" mit einer Kombination aus Reservat und Pufferzone, und hin zu "Keiner Bewirtschaftung" als Kontrolle mit Berücksichtigung nur natürlicher Prozesse ermittelt. Die Bestimmung der einzelnen finanziellen Netto-Zahlungsströme für die unterschiedlichen Arten der Erntemaßnahmen wurde mit dem Einzelbaumwachstumssimulator Sibyla ausgeführt. Die Studie beinhaltet ein finanzielles waldbauliches Modell für die Simulation der Bestandesbegründung und der Entwicklung des jungen Bestandes einschließlich der Kosten für Pflanzung und Pflege. Wenn alle Bestandesge-

nerationen in der Studienregion berücksichtigt wurden, dann reduzierten die Kosten für Aufforstung und Pflege die Kompensationszahlungen für die bewirtschafteten Optionen im Vergleich zur unbewirtschafteten Option. Die Annahme für die Berechnung der Kompensationszahlungen berücksichtigte nur Bestandesgenerationen welche am Anfang der Vertragsperiode existierten wohingegen die nachfolgende Generationen von jungen Beständen, die während dieser Periode verjüngt wurden, von der finanziellen Berechnung ausgeschlossen wurden. Die Vertragslaufzeit umfasste 45 Jahre. Die Kompensationszahlungen betrugen in Relation zu "Konventionelle Bewirtschaftung" 25 €/ha/Jahr für einen Wechsel zu "Alternativer Bewirtschaftung" im Sinne selektiver Bewirtschaftung, 70 €/ha/Jahr für einen Wechsel zu einer speziellen "Bewirtschaftung für ein Forstreservat", und 129 €/ha/Jahr für einen Wechsel zu "Keine Bewirtschaftung". Nur lange Vertragslaufzeiten ermöglichen eine objektive Bestimmung von finanziellen Differenzen zwischen konventioneller Bewirtschaftung und alternativen Möglichkeiten da in kurzer Zeit die Ergebnisse durch spezifische Entwicklungen verbunden mit der Altersstruktur der ausgereiften Bestände beeinflusst wurden. Wenn die Vertragslaufzeit deutlich kürzer als die Umtriebszeit ist, dann kann die Berechnung Aufforstung und Pflege als nicht ausgeführt berücksichtigen um die Kosten zu vermeiden falls der Mittelrückfluss aus einer solchen Investition nicht innerhalb der Vertragslaufzeit erreicht werden kann. Nur ein langer Zeitraum von einer Bestandesgeneration wird deutlich die Alters- und Größenstruktur verändern und kann so den Naturschutz unterstützen.

1. Introduction

1.1. State of compensation payments for Ecosystem Services

Compensation payments can allow or support nature protection instead of conventional forest management. It opens opportunities for management change when no constraint or prohibition of management should be forced by legislation. Implementation of compensation payments in the sense of trading among property rights and usage rights is only possible when those rights are clearly defined and allocated and there is the possibility for contracts (Coase 1960; Herbert et al., 2010). Individual contracts enable joined benefits for all partners (Hayes et al., 2015) because they allow for individual solutions rather than general anonymous policy instruments implemented by law or demands by interest groups which typically allocate costs only to forest owners (Hahn and Schall, 2013). Another option is to change ownership or forest management to ensure responsibility of the forest area, but in this case the long-time experience and knowledge of the forest owner or forest managers is sacrificed.

Different approaches to estimate the value of ecosystem services exist. Costanza et al. (1997) estimated a value of ecosystem services for different types of ecosystems. Based on an approach of market equilibrium dependent on demand and supply, Zhang and Stenger (2014) demonstrated that results of Costanza et al. (1997) represent "Willingness to pay" on the side of demand but are too high to represent a market volume. Approaches to calculate financial differences between management options and define them as compensation payments represent opportunity costs of supply. Therefore, only the difference in financial value between the ecological and the conventional option can be defined as additional ecosystem service levels compared to conventional options (Wunder, 2005). Often contracts about compensation payments for conservation will be individual agreements, because few markets with prices exist, such as when the supply for ecosystem services is low for a rare and endangered species (Wunder, 2005).

Nevertheless, markets for ecosystem services are evolving. Payments for Ecosystem Services (PES) are used most often in developing countries in the tropics of Asia and South America (Wunder, 2005), but only rarely in Europe. PES can be categorized as a public payment to private land owners (either standardized or individual), formal markets with open trading (regulatory by legislation or voluntary), self-organized private, tax incentives or certification programs (Herbert et al., 2010).

Markets are most developed for carbon pricing to mitigate climate change, with an estimated value of 100 billion US$ in 2008 (Stanton et al., 2010), with only a small portion attributed to forests (Goldstein, 2015). Important markets exist also for water quality protection (9 billion US$ in 2008) (Stanton et al., 2010) and biodiversity (2 to 3 billion US$ annually) (Madsen et al., 2010). Both are related to forestry and characterized by small voluntary markets, but the numbers are rough estimations because the markets are not transparent.

Buyers in forest carbon markets and finance were mainly from Europe and North America and mainly paid in voluntary markets but some also participated in compliance markets (Peters-Stanley et al., 2013). Regional programs for Reduced Emissions from Deforestation and Forest Degradation (REDD), initiated by donor governments, are important activities in Latin America and Africa (Peters-Stanley et al., 2013). Fifty percent of forestry projects were carried out on private lands in 2012 (Peters-Stanley et al., 2013). The majority of market share was certification by Verified Carbon Standard (Peters-Stanley et al., 2013, Goldstein, 2015). In 2014, 700 million US$ related to carbon storage in forests were paid: 260 million US$ were market-based payments, 220 million US$ were non-market-based payments (from government to government), and 230 million US$ were paid within REDD (Goldstein, 2015).

Currently Payments for Watershed Ecosystem Services are typically small-scaled local projects common globally (Stanton et al., 2010). Nowadays real established markets for Watershed Services have the highest practical relevance in the Peoples Republic of China (Zhang et al., 2010; Stanton et al., 2010). Payments in China especially improve water quality by supporting farmers to establish trees on slopes which are characterized by soil erosion (Stanton et al., 2010). Mechanisms to pay are calculated dependent on measured change in water quality standards regarding nitrogen, phosphorus, salinity or temperature. So-called Water Quality Trading exists primarily in the United States (Stanton et al., 2010).

Various schemes for Payments for Biodiversity Services exist or are currently being developed in many countries. Compensatory Mitigation Programs can be classified as Compensation Funds, One-Off Offsets and Mitigation Banking (Madsen et al., 2010). Most advanced markets are in the United States. There, in cases in which developers threaten or endanger species, they have to compensate for their damage, for example, by buying third party credits within Conservation Banking Credit Pricing to protect endangered species elsewhere. Additionally, offset programs exist for wetland mitigation (Madsen et al., 2010). In Europe there is still need to develop programs. Especially within the European Union there are efforts to implement trading systems for biodiversity (habitat banking). The German Program for Impact Mitigation Regulation is largest in Europe, law requires restoration and replacement compensation when impact cannot be avoided (Madsen et al., 2010).

The relevance of compensation payments might increase not only for nature conservation, but also due to increased rates of land use change. For instance, the rate of land use change in Germany is 81 ha per day. It is associated mainly with agricultural land being converted to settlement and traffic purposes, nature protection laws stipulating the need for compensation (BMEL, 2014). Conversely, in developing countries especially in tropical regions there are high losses of forest cover due to conversion into agricultural land (Goldstein, 2015, Kindu et al. 2016). Policy instruments of taxes, unconditional grants or subsides (Herbert et al., 2010) are used to influence market equilibrium. Nevertheless they often lead to unwanted side effects because people might try to reach benefits by other means than those intended (Nürnberger et al., 2013). Therefore, defined goals like the rule of "no net loss" regarding the initial state used for example in the German Impact Mitigation Regulation (Madsen et al., 2010) aims to avoid such shifts. On the global level, nature conservation or bio-economy (in terms of renewable energy) policy must consider the effects of policy instruments on land use change. Instruments might reduce employment patterns and consequently reduce access to sufficient and healthy food, human rights and social standards (BMEL, 2014). Nature protection for biodiversity in a forest will lead to reductions in managed forest area, employment in the forest sector, the amount of harvested timber and trigger an increase in timber prices. Nature conservation and biodiversity protection can conflict with the goal of carbon sequestration as well as the production of renewable energy. Such goal conflicts have to be considered in policy frameworks (BMEL, 2014) as well as by management planning. Therefore, from the forest owner point of view, compensation payments might resolve conflicts over optimal forest management regarding ecological and socioeconomic aspects in opposition to "Conventional management" or financially optimal management. In this study only the forest owners' point of view based on the concept of opportunity costs will be applied, while the concept of "Willingness to pay" will not be considered.

1.2. Legal framework of the common and special forest management in Slovakia

Under the Slovak Forest Act 326/2005 (hereinafter the Act), common forest management is such a way of reforestation, thinning, harvesting, wood transport and other forest management options, which permits in accordance with the principles of sustainable forest management the rational exploitation of all functions of the forest. In fact it is a proposal of management options in forest management plans (targeted primarily at wood production) before applying a special management regime (§ 14 para. 1). The special management regime is defined indirectly in § 14 para. 1: Special purpose forests are forests that have been declared as such and whose purpose is to ensure the specific needs of society, legal entities or persons, and the provision of which significantly changes the way of management compared to common forest management (hereinafter referred to as "special management regime"). The concept of the special management regime is to be prepared by a person licensed for forest management planning or by a professionally qualified member of a nature protection organization in case the special purpose is nature conservation (§ 14 para. 2e of the Act).

If the application for a declaration of special purpose forests is submitted by a person other than the forest owner, the application must include the consent of the owner or forest user with a statement of special purpose forests, and an agreement on determining the amount and nature of compensation for restricting property rights (§ 35 paragraph. 3) due to the special management regime. Compensation for the restriction of property rights is granted on the basis of an agreement determining the rates and the manner of its provision, proposed to the owner or forest user by the person, whose request or proposal limits property rights. If no agreement is reached, the amount or method of providing compensation for restrictions of ownership rights according the Act is determined by the Court (Kulla et al., 2015). The aim of this study is to examine a quantitative approach for calculation of opportunity cost which corresponds to compensation for nature protection by nature conservation (e.g. by state) to the forest owner.

2. Material and Method

2.1. Model territory and management options

The model territory, selected within the “Research Demonstration Area Kysuce”, part Polom (114 ha, 828-1066 m.a.s.l., hereinafter model territory) in northwest Slovakia (Fig. 1), represents a strictly protected forest reserve and adjacent buffer zone with a different degree of forest management restrictions. Forests are dominated by mature even-aged structures, 96% are spruce stands, 52% are more than 85 years old. Several types of management treatments “Shelterwood”, “Clearcut”, “Transition to Selection” and “No Cutting” were simulated for individual stands. Management options of “Conventional Management” (CM), “Alternative Management” (AM), “Forest Reserve

Management" (FRM) and "No Management" (NM) consisted of these stand treatments (Fig. 2).

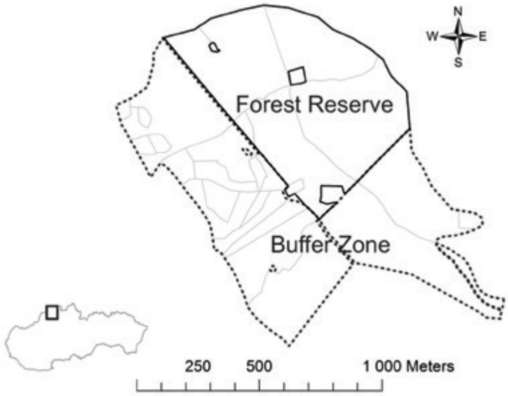

Figure 1: Forest reserve and buffer zone stands in the model territory

Abbildung 1: Bestände des Waldreservates und der Pufferzone im Modellgebiet

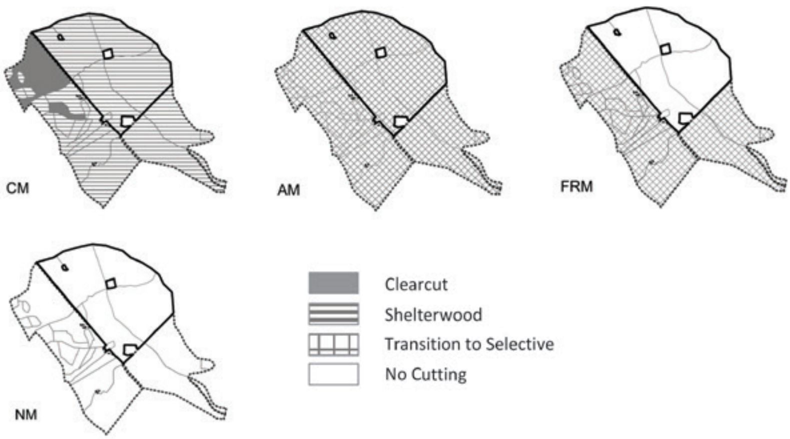

Figure 2: Management treatments according to management options applied for simulations in the model territory

Abbildung 2: Waldbehandlung entsprechend den in den Simulationen angewendeten Bewirtschaftungsoptionen im Modellgebiet

The management program for CM, which is implemented by state approved standard forest management models (FMM) without any restrictions, was applied to all stands as a reference base. The most common CMs in Slovakia are the shelterwood system with application of 2-3 phase shelter cuts, and clear-cut system in specific conditions, both with rotation period of ca 100 – 120 years and most common regeneration period 30 – 40 years. In the model territory, according to FMM shelterwood treatment prevails (102 ha) with only a few stands allowed for clearcut (12 ha). The special management regime, (in our study AM) differs substantially from CM based on approved FMM for given site and stand conditions. The most common special management in Slovakia related to nature protection represents a different level of restrictions from "no management" to "close to nature" forms of management expected to be applied in NATURA 2000 sites. For the purpose of this study, AM "Transition to selection" treatment was applied for all model territory. FRM management option combines treatment "Transition to selection" within buffer zone (67 ha) with "No cutting" within the core part of the forest reserve (47 ha). Additionally, an extreme variant of NM was implemented for the whole model territory to show the development of the forest in case of a total stop of management. Compensation payments were calculated for change from conventional management option CM towards the other management options AM, FRM and NM.

2.2. Financial calculation of compensation payments

Compensation payments were calculated as the difference between annualized net present values (NPV) for management alternatives of different lengths of contract periods (Faustmann, 1849). NPV is calculated as the sum of discounted net cash flows NCFs for each stand age t during rotation period T (Equation 1).

Equation 1:

$$NPV = \sum_{t=0}^{T} NCF_t/(1+i)^t$$

Stands already existed in the model region and, therefore, simulations started with current stand ages t. Therefore, method adapted by holding value (Deegen et al., 2000) was a more appropriate method than *NPV*, because the predefined maximum simulation time *z* of 45 years is too short to cover one complete rotation period *T*. Therefore, adapted method is not able to decide if investment would be beneficial. Additionally, no rotation period *T* exists for *AM* and *NM*, which is needed for accurate *NPV* calculation. For the purposes of this study, adaptation of holding value was used as a concept for an age independent *NPV (AINPV)* also allowing for calculation in case of unknown stand age. *AINPV* was used for the simulation time span of contract period z only rather than T and the simulation year s instead of a stand age t. Instead of expectation value, *AINPV* calculation considers the difference of discounted net stumpage value of the remaining stand (*NVRS*) between final simulation year of contract period z minus starting year 0. Additionally, the *AINPV* calculation considered the sum of discounted single *NCF* from the *NPV* approach (Equation 2). Such a concept is a wider interpretation of *NPV* defined by Klemperer (1996) and was applied for uneven-aged forests (e.g. Roessiger et al. 2016). The interest rate used for calculations was 2% which is relatively low but typical for Central European conditions characterized by low growth rates and management restriction by law (e.g. Roessiger et al. 2011, 2013, 2016). *NCF* of all cutting operations was calculated for each stand or its subunit (regeneration unit, *RU*). Hence finite compensation payment (*CP*) corresponds to the sum of discounted differences in *AINPV* between management options for all stands during the defined contract period from simulation year $s = 0$ to z (Equation 3).

Equation 2:

$$AINPV = \sum_{s=0}^{z} NCF_s/(1+i)^s - NVRS_0 + NVRS_z/(1+i)^z$$

Equation 3:

$$CP_z = AINPV_{CM,z} - AINPV_{AM,z}$$

Soil expectation value can be converted to an annuity (*ANN*) (Möhring et al., 2006) (Equation 4). *ANN* describes the mean annual payment over longer time periods. Therewith, annuity is a helpful indicator to compare options with different rotation lengths (Heidingsfelder and Knoke, 2004), and was applied in this study. For the purpose of this study we applied in equation 4 z instead of T.

Equation 4:

$$ANN = AINPV \cdot \frac{(1+i)^z}{(1+i)^z - 1} \cdot i$$

2.3. Combination of two models for financial evaluation

Estimating the financial values of stand development was split and evaluated within two systems (Kulla et al., 2015): The stand establishment phase, pruning and tending of young stands, was assessed within the newly developed silvicultural cost models

(Kovalčík and Kulla, 2015). Growth of older forest, including specific thinning and cutting operations, was simulated with a single-tree simulator Sibyla (Fabrika, 2005; Fabrika and Ďurský, 2005), which was developed from the Silva simulator (Pretzsch et al., 2002). Only thinning and final harvest period were generated and simulated in Sibyla because of its limitations in calculating costs and revenues in stages less than 7 cm diameter at breast height (dbh). Simulation of a point of time of natural regeneration in Sibyla is calculated with the help of random coefficients and therefore does not allow for reproduction within a deterministic approach. Because of these two reasons, young stand establishment and tending period up to this age are skipped in Sibyla; a new stand is generated at initial thinning age only.

The decision of when to change between the two models was the timing of the first thinning. Initial thinning age (*Ai*) was defined as the age at which mean dbh of the tree species in given conditions expressed by site index (*SI*) reaches 10 cm (Halaj and Petráš, 1998). In mixed stands, species proportions were considered. Finally *Ai* was classified in 5 year increments to comply with simulation periods of Sibyla (Equation 5, Table 1).

Equation 5:

$$Ai = a \cdot SI^{b}$$

Table 1: Coefficients to estimate initial thinning age (Ai)

Tabelle 1: Koeffizienten zur Bestimmung des Alters der ersten Durchforstung (*Ai*)

Main tree species	a	b
Spruce	1339.2	-1.07
Fir	1000.8	-0.98
Pine	761.27	-0.954
Oak	454.93	-0.789
Beech	517.13	-0.780

The starting year of simulation for stands older than the initial thinning age (*Ai*) was the first year of the contract period. Simulation started for newly established stands or stands less than *Ai* at the point at which they reached *Ai*.

2.4. Site and growth conditions in Sibyla

Growth characteristics, especially *SI*, were calibrated within Sibyla Localizer by stand characteristics from FMP including forest ecoregion, altitude, aspect, slope and forest site type. *SI* of stands was calculated by Sibyla based on climate, site and soil coefficients (Fabrika, 2005). In the case of differences between *SI* calculated by Sibyla and *SI* defined by *FMP*, conditions in Sibyla were adjusted to fit *SI* according to FMP.

2.5. Generation of already existing older forest stands within single-tree simulator Sibyla

Generation was at the beginning of simulation for existing stands older than initial thinning age, *Ai*. To initialize growth simulation, data about stand characteristics according to the Forest Management Plan (FMP) were entered in Sibyla. Required general data included stand area (ha) and storey (stand layer). Required data for each tree species included stand age, mean dbh, mean height, volume, damage proportion, quality classes A, B or C, and degree of diameter variability. Degree of diameter variability was possible in steps from 1 to 3: 1 in the case of even aged, 2 in the case of partially uneven-aged, and 3 in the case of regularly uneven-aged (according to text description in FMP).

2.6. Generation of young forest stands in the future within Sibyla

In cases of stands younger than initial thinning age *Ai* or stands to be established in the future, stands were generated in the year in which the young stand is expected to reach initial thinning age *Ai*. Tree species composition for the future stand was planned according to FMP or, for long time horizons, not regarded in the FMP according to Remiš et al. (1988) site-specific model. Stand characteristics (mean dbh, mean height and growing stock) were obtained from yield tables (Petráš et al., 1996) for tree species with specific *SI* and common Ai for all tree species in the stand. Damage was set as 0; quality was B (middle). Dbh variability was low in the case of artificial planting and high in the case of natural regeneration. Growing stock of each tree species obtained from yield tables was reduced by the species-specific mean stocking in initial thinning age (STi). Stocking proportion according to the Forestry information system (NFC, 2014) generally is dependent on tree species, age (*A*) and *SI* (Equation 6, Table 2).

Equation 6:

$$St = a - b \cdot LN(A) - c \cdot (d - SI)$$

Table 2: Coefficients to calculate stocking in initial thinning age (STi)

Tabelle 2: Koeffizienten zur Berechnung der Bestockungsdichte im Alter der ersten Durchforstung (STi)

Species	a	b	C	d
Spruce	1.132786	0.089567	0.001987	31.79786
Fir	1.178112	0.103318	0.000667	31.88332
Pine	1.138551	0.088645	0.002464	31.75582
Oak	1.109452	0.072289	0.004057	31.78860
Beech	1.127668	0.081571	0.002533	31.72065

2.7. Simulated thinning operations

During growth simulation, management by cutting operation was applied by Sibyla Cultivator. Nine simulation periods of 5 years each were applied. In each period, options of no harvest, thinning or final harvest were simulated. Between periods trees were removed due to simulated natural mortality, which was based on continuous rates with no large-scale calamities. Only thinning operations for the 1st decade were prescribed by FMP because no further planning was given in the FMP. Intensity of thinning operations in subsequent periods was defined by a special default curve of a decennial thinning percentage by Halaj et al. (1986), specified by tree species, *SI*, and stand density. Frequency of thinning for shelterwood and clearcutting treatment was once per each decennium in which no final harvest was planned. The type of thinning was neutral thinning in case of shelterwood and clearcut management treatments, and intensive thinning from above in the case of transition to selection management.

2.8. Simulated final cuttings

In order to mimic the reality as closely as possible, each stand was divided into a number of RU equal to the number of decades planned for final cutting (regeneration period). Each RU was considered to be one stand for simulation purposes. Each RU was simulated with a representative plot size of 0.25 ha and the results recalculated for the true stand area size according to the FMP. Clearcutting was simulated as removal of all trees on the RU. Age of next stand generation (and all related silvicultural costs taken from silvicultural cost models outside of Sibyla) started immediately after the final cut. Shelterwood was simulated on each RU standardly as a two-phased regeneration cut within ten years. The starting age of the next stand was shifted to the middle of the period between the first and the second shelter cut to consider some delay for natural seeding and artificial regeneration, as underplanting and/or consequent additional planting of missing species. Transition to selection management was simulated as a three-phased shelterwood with a long regeneration period of up to 60 years. The next generation was assumed to be established 5 years after the first regeneration cut.

2.9. Timber prices and harvesting costs

The relation between timber volume harvested or remaining in the stand with financial costs and prices was defined within Sibyla Calculator. Timber prices in €/m³ for each tree species were derived for quality and diameter classes from the State statistical examination "Forest" executed by the Ministry of Agriculture and Rural Development of the Slovak Republic (2014). Timber prices depend on tree species, quality class, and diameter class, and varied from 27 to 171 €/m³ for Spruce, 23 to 116 €/m³ for Pine, 27 to 169 €/m³ for Fir, 18 to 159 €/m³ for beech, and 19 to 476 €/m³ for oak.

2.10. Adjustment of harvesting costs

The Sibyla Calculator used default values of wages, social costs and material consumption instead of costs per cubic meter (m³). These values were modified based on regulations and localization for the model area in Slovakia to match actual market conditions. Prices for cutting, yarding and conversion wage tariffs were adjusted to 5 €/hour, material consumptions for tractor were 2.15 €/m³, material consumptions for chainsaw were 1.20 €/reduced normal hour (rNH). Values of other indices were adjusted to 1.30 for Compensation and 0.38 for wage taxation.

Cutting, yarding and conversion cost adjustment was specific to conditions in the case study region. The method of cutting was cutting of stem by chainsaw with removal of branches and tree top including working breaks. Branches of a typical tree covered more than 1/3 of the stem. Detailed criteria for setting the tree class are provided by cutting norms (Nr. 230-2165/234/83-EP) and yarding norms (Nr. 91/1992-230). Regarding norms, specific terrain and stand conditions affected costs and time consumption for operations. Based on these conditions, norms were adjusted for slope steepness and complicated slippery terrain, snow cover and unfriendly weather, regeneration cutting, decay trees, young and dense stands, calamity cuttings for extraction, skidding and unloading. Extraction and skidding distance, slope and skidding direction were taken from the FMP. Calculations considered time for rollout, measuring, cutting, loading and movement.

2.11. Silvicultural cost model for young stands

Scheduling of silvicultural options and costs up to the initial thinning age Ai were implemented outside of Sibyla. Silvicultural models of young stand establishment (*SC1*) and tending (*SC2*) were processed according to optimized technologies proposed by Remiš et al. (1998), which were updated and adapted for current conditions (Kovalčík and Kulla, 2015). Models included costs for planting, pruning and tending. Time schedules and costs for single silvicultural operations are specific for tree species, site, region and management alternative.

For the first phase – establishment, options were differentiated according to site units (combining nutrient status, water regime and AVZ), and processed for the time period since initial stand formation to the expected time of secured young stand establishment according to FMM as silvicultural costs 1 (SC1, Table 3). For the second phase – tending, options were differentiated according to site units and stand type, and processed for the time period since young stand establishment to initial thinning age Ai as silvicultural costs 2 (*SC2*, Table 4). Site unit for each stand was defined according to FMP. Stand type was chosen according to prevailing main tree species in the stand.

Table 3: Silvicultural costs for stand establishment (SC1) in conditions of the model territory in €/ha

Tabelle 3: Waldbauliche Kosten für die Etablierung des Bestandes (SC1) für die Bedingungen des Modellgebietes in €/ha

	Treatment	Clearcut						Shelterwood, Transition to Selection					
Age	Site units	Acidic, 5. *AVZ*			Acidic, 6. *AVZ*			Acidic, 5. *AVZ*			Acidic, 6. *AVZ*		
[years]	Management	A	P	W	A	P	W	A	P	W	A	P	W
1	Area cleaning	1006			1051			1006			1051		
1	Afforestation	2108			1975			2108			1975		
1	Protection, Weeding		127	148		131	132		127			131	
2	Re-afforestation	928			869								
2	Protection, Weeding		127	148		131	132		127			131	
3	Protection, Weeding		127	148		131	132		127			131	
4	Protection, Weeding		127	148		131	132		127			131	
5	Protection, Weeding		127	148		131	132		127			131	
6	Protection, Weeding		127	148		131	132		127	148		131	132
7	Protection, Weeding		127	148		131	132		127	148		131	132
8	Protection, Weeding					131						131	
	Total costs	5971			5867			4301			4338		

A: Other management related afforestation (Area cleaning; Afforestation; Re-afforestation);
P: Individual tree protection against the game; W: Weed and sprout removal

Table 4: Silvicultural costs for tending (SC2) in conditions of the model territory, age in years, costs in €/ha

Tabelle 4: Waldbauliche Kosten für die Pflege des Bestandes (*SC2*) für die Bedingungen des Modellgebietes, Alter in Jahren, Kosten in €/ha

Stand type	Spruce stand				Beech-fir-spruce stand			
Site units	Acidic, 5. *AVZ*		Acidic, 6. *AVZ*		Acidic, 5. *AVZ*		Acidic, 6. *AVZ*	
	age	costs	age	costs	age	costs	age	costs
	year	*€/ha*	year	*€/ha*	year	*€/ha*	year	*€/ha*
Age establishment	7		8		7		8	
1st tending	16	182	17	182	15	186	15	186
2nd tending	26	182	25	182	22	173	23	173
3rd tending					30	139	30	139
Ai intial thinning age	35		34		38		38	
Total costs [€/ha]		364		364		498		498

3. Results

Compensation payments of management options were based on developing *AINPVs* of stand treatments. When all stand generations (including those expected to be established in the future) in study region were considered, afforestation and tending costs decreased *AINPV* immediately after final cutting of the high proportion of old stands for actively management treatments (Fig. 3). Minimum *AINPV* was reached after simulation year s of 15 years for "Shelterwood", 30 years for "Clearcut" and 40 years for "Transition to Selection". Decreases of *AINPV* for "Clearcut" were large, relative to "Shelterwood" and "Selection Cutting" because additional costs were considered for weed and sprout removal, reforestation and fencing. Decreases of *AINPV* for "Selection Cutting" was slower and lasted longer due to the long regeneration cycle (Fig. 3).

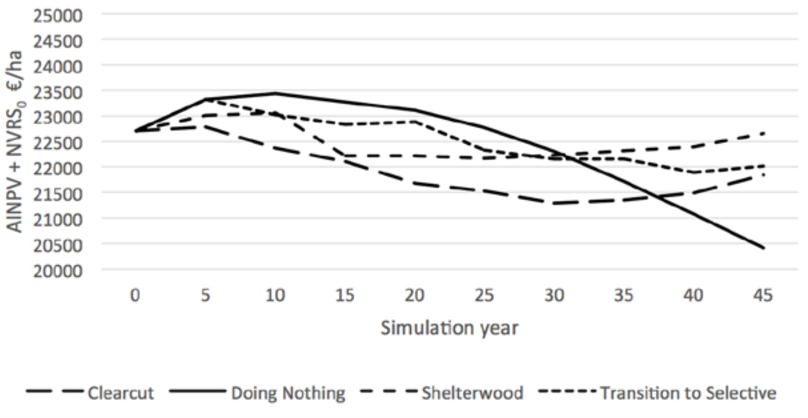

Figure 3: Development of mean AINPV during simulation period s plus NVRS0 in €/ha for reference stand treatments, considering 1st and 2nd stand generation (i.e. including silvicultural costs)

Abbildung 3: Entwicklung des mittleren *AINPV* während der Simulationsperiode s plus NVRS0 in €/ha für die Bestandesbehandlungen, unter Berücksichtigung der 1. und 2. Bestandesgeneration (d.h. einschließlich waldbaulicher Kosten)

In addition to establishing new stands, development of timber stocking and timber values of existing stands differed between treatments. Intensive cutting in "Shelterwood" and "Clearcut" relative to other options in the first two decades temporarily decreased growth potential of standing timber volume and caused lower *AINPV* in this period, relative to "No cutting" and "Transition to Selection". After 10 years, preparatory "Shelterwood" cuts limited stand value growth because stocking density had to be reduced by cutting operations to suboptimal levels. Nevertheless, "Shelterwood" still benefited from additional growth on the remaining stand part which was left after first cut supported by regeneration cuts when compared to “Clearcut” and, therefore, became more profitable financially than “Clearcut”. In the long run, “Shelterwood” also was beneficial compared to “Transition to Selection” because AINPV of “Transition to Selection” suffered from the long regeneration cycle, while in “No Cutting”, timber quality strongly decreased with time (Fig. 4).

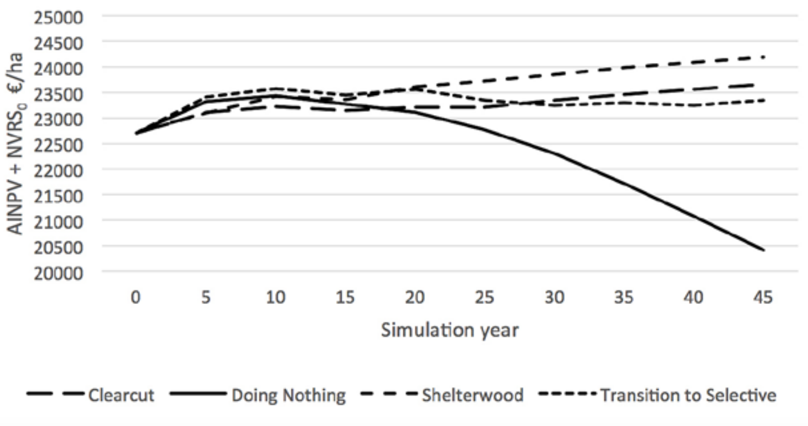

Figure 4: Development of mean AINPV during simulation period s plus NVRS0 in €/ha for stand treatments, considering only already existing 1st stand generation, excluding costs and revenues of 2nd stand generation

Abbildung 4: Entwicklung des mittleren AINPV während der Simulationsperiode s plus NVRS0 in €/ha für die Bestandesbehandlungen, wenn nur die 1. Bestandesgeneration berücksichtigt wird, d.h. ohne Kosten und Erträge der 2. Bestandesgeneration

Compensation payments of management options (Fig. 5 and 6) resulted in differences in *AINPVs* of stand treatments (Fig. 3 and 4), related to specific stand management of management options and transformed to annuities (Kulla et al., 2015). When all existing and newly established young stands in the study region, including afforestation and tending costs, were considered, only contract periods of 35 and more years generated positive compensation payments (Fig. 5).

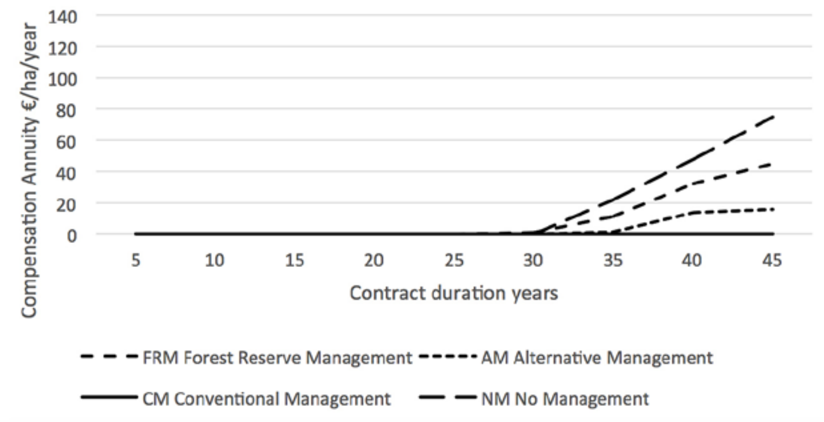

Figure 5: Mean annual compensation payment for management option for different contract period length in €/ha/year, difference to CM, 1st and 2nd stand generation including silvicultural costs considered

Abbildung 5: Mittlere Annuität der Kompensationszahlungen für Bewirtschaftungsoptionen in €/ha/Jahr, Differenz zu CM, 1. und 2. Bestandesgeneration einschließlich waldbaulicher Kosten berücksichtigt

In contrast, contract period of 20 and more years generated positive compensation payments when stand generations were considered, which existed at the beginning of simulation while young stands regenerated during contract period were excluded from financial calculations (Fig. 6). In the second case, in relation to CM, after contract period of 45 years compensation payment was 25 €/ha/year for change to AM towards selection forest, 70 €/ha/year for FRM and 129 €/ha/year for change to NM (Fig. 6). "Transition to selection" seems to be a good alternative how meet economical goals of forest management with relatively low and in time stable loss, quantified as compensation payment for nature conservation.

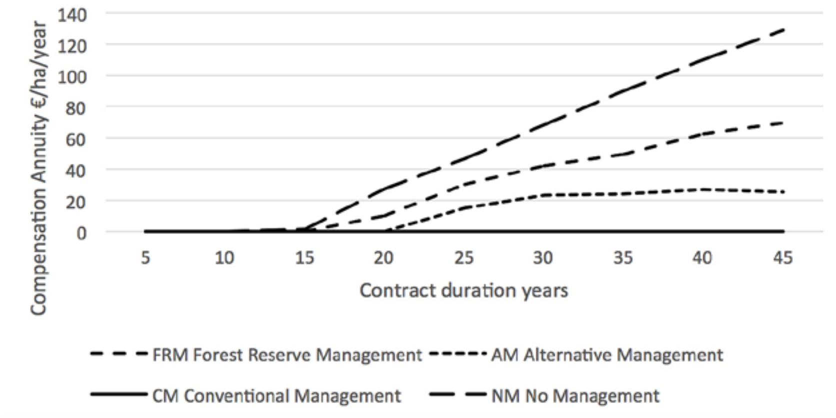

Fig. 6: Mean annual compensation payment for management option for different contract period length in €/ha/year, difference to CM, considered only stand generation existing at the beginning, ignoring costs/ revenues of 2nd generation

Abb. 6: Mittlere Annuität der Kompensationszahlungen für Bewirtschaftungsoptionen in €/ha/ Jahr, Differenz zu CM, nur am Anfang existierende Bestandesgeneration berücksichtigt, Kosten und Einkommen der 2. Bestandesgeneration ignoriert

Previous results were carried out for mean of all 25 stands for relation with simulation time s. Fig. 7 and 8 enable us follow the composition of total *AINPV* consisting from *AINPV* of 25 single stands displayed according to their stand age t instead of s. *NPV* cannot be derived by *AINPV* because no complete rotation period was simulated. Nevertheless, discounting *AINPV* additionally with simulation year s but also with stand age t in simulation year 0 formed uncompleted untrue time series comparable to *NPV*. As examples, "No Cutting" and "Transition to Selection" treatments were selected to demonstrate influence of passive and active management on *AINPV*. "Transition to Selection" represents actively managed stands, which all are relatively comparable (Fig. 8). Minimum and maximum of *AINPV* trend for all 25 single stands represent variability of growth conditions in the study region (Fig. 7 and 8).

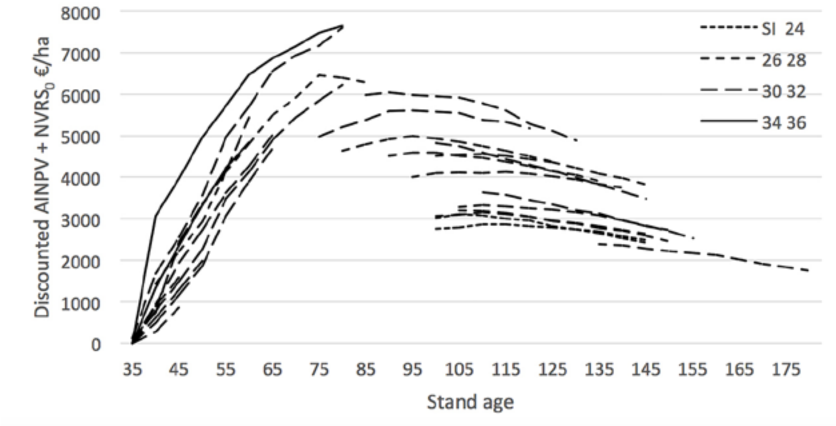

Fig. 7: Development of AINPV plus NVRS0, discounted by stand age in simulation year 0, untrue time series, dependent on stand age t for 25 single stands, stand treatment considering only already existing 1st stand generation, excluding costs and revenues of 2nd stand generation, ages lower than 35 years with 0 €/ha are removed, continuous line: high site index SI, dotted line: low SI, treatment "No Cutting"

Abb. 7: Entwicklung des AINPV plus NVRS0, diskontiert mit dem Bestandesalter im Simulationsjahr 0, unechte Zeitreihe, abhängig vom Bestandesalter t für 25 Einzelbestände, die Bestandesbehandlungen, berücksichtigt nur die 1. Bestandesgeneration, ohne Kosten und Einkünfte der 2. Bestandesgeneration, Alter geringer als 35 Jahre mit 0 €/ha sind entfernt, durchgezogene Linie: hohe Bonität SI, gepunktete Linie: geringer SI, Behandlung "Keine Ernte"

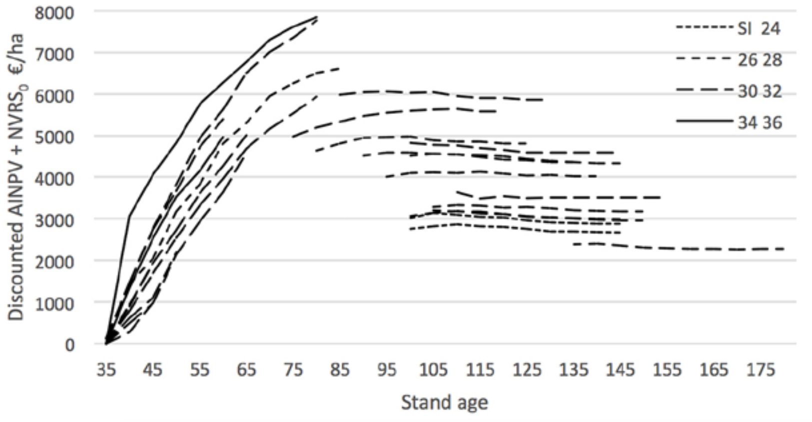

Fig. 8: Development of AINPV plus NVRS0, discounted by stand age in simulation year 0, untrue time series, dependent on stand age t for 25 single stands, stand treatment considering only already existing 1st stand generation, excluding costs and revenues of 2nd stand generation, ages lower than 35 years with 0 €/ha are removed, continuous line: high site index SI, dotted line: low SI, treatment: "Transition to Selection"

Abb. 8: Entwicklung des AINPV plus NVRS0, diskontiert mit dem Bestandesalter im Simulationsjahr 0, unechte Zeitreihe, abhängig vom Bestandesalter t für 25 Einzelbestände, die Bestandesbehandlungen, berücksichtigt nur die 1. Bestandesgeneration, ohne Kosten und Einkünfte der 2. Bestandesgeneration, Alter geringer als 35 Jahre mit 0 €/ha sind entfernt, durchgezogene Linie: hohe Bonität SI, gepunktete Linie: geringer SI, Behandlung: "Übergang zu selektiver Nutzung"

While in Fig. 7 and 8 for young stand ages t from 35 to 80 “Transition to Selection” and “No Cutting” are comparable, for older stand ages t bigger than 80 years for “No Cutting” *AINPV* was reduced caused by decline in timber quality compared to “Transition to Selection” in case of longer simulation ages s. Stands starting simulation beginning from stand age of 35 years or younger are characterized by Sybila with continuous increase in growth potential and can reach high levels of AINPV at age 80. Contrary, stands starting simulation beginning from middle stand ages of 85 years are characterized by much lower starting levels and AINPV stagnates regarding growth potential when discounted with 2% (Fig. 7) or even decreases in case of “No Cutting” (Fig. 8). Differences between minimum and maximum levels in study region (Fig. 7 and 8) are caused by different site index SI, different mixture of tree species and/ or different history of stand management. In future AINPVs are expected to differ but only by little extent caused by different management except of “No Cutting” in case of older stands. Nevertheless, the differences caused by management are still high enough to justify compensation payments.

4. Discussion

Nature conservation can limit forest management options substantially (Kovalčík et al., 2012), but often is not fully compensated. Kovalčík et al. (2012) summarized property losses by management restrictions from nature protection laws, through reductions in timber revenues which correspond to 20 €/ha/year (22 million € per 1.1 million ha) for all levels of protection in Slovakia or 24 €/ha/year (1.6 million € per 68,000 ha) for the strictest level of protection without harvesting. Payments within the Rural Development Programme 2007–2013 for Natura 2000 (strictest level of protection) ranged from 40 to 200 €/ha/year, with a mean of 47 €/ha/year for Slovakia (Kovalčík et al. 2012). Payments differ between states across Europe, ranging from 3 to 220 €/ha/year, with mean of 90 (European Network for Rural Development, 2014, Sarvašová and Kulla, 2015). Options for distributing such compensation payments can be quite different. Small private forests in Southern Finland experienced a wide range of possibilities, for example, including voluntary contracts (Primmer et al. 2013).

Dög et al., (2016) provided a study based on questionnaire and simulation about financial differences of current existing management restrictions regarding protection and recreation as compared to a reference management. Study considering not only current additional expenses but also simulated changes of NCF expected to occur in future on enterprise level. The difference is an annuity of 42 €/ha for private forest enterprises and 35 €/ha for corporate forest enterprises resulting from simulation over 200 years for conditions in German forestry.

Results of study presented in this paper were influenced by limited time horizon and by specific developments related to the age structure of mature stands. Planting, pruning, and thinning decreased AINPV immediately after final cutting. Such future investments will fully prove their benefits for management goals only after one complete regeneration cycle of 100 years or more. Newly established stands with ages from 35 to 40 years not allow for thinning with positive NCF and, therefore, have only negative financial impact on AINPV. Simulation starts mainly with old stands and, therefore, this might explain why NM has higher AINPV in the first 35 years, compared to managed scenarios. In the case of managed scenarios the costs reduced stand value during the development stage characterized by mainly young stands. An owner who knows the length of contract period would not carry out afforestation if he or she is not forced to do so. Positive returns are possible only in the long term, due to positive income from thinning operations and at least with regeneration cut operation of next stand generation benefits of investments in young stands can be realized.

The simulator Sibyla generally assumes natural regeneration while managed options are based on planting. Therefore, the study does not consider differences in stumpage value of young stands between natural and artificial regeneration directly. The stumpage value of managed young stand simulated by Sibyla might be underestimated because silvicultural treatments can improve the financial value of the established stand. To some extent quality differences are reduced by the lower variability of dbh in planted stands.

NPV or holding value reflect positive effects of silvicultural treatments in young stands as they mature. Unfortunately, the AINPV approach used in this study is not able to reflect such effects due to the limited time horizon of the simulations. For these reasons, compensation payments can be calculated without afforestation and tending to avoid costs when income from such investments could not be achieved within the contract period (i.e. when the contract period is substantially shorter than the management rotation length).

Omitting establishment costs for the next stand generation reduced the time until positive compensation payments for managed options appear from 20 to 35 years. The reason for negative compensation in the first 20 years involves the growth dynamics after cutting operations. In the short term, cutting operations will limit stand growth because the RU´s after the final regeneration cut do not contribute to stand value growth, while on the long term cutting allows for positive income beginning with thinning age of the next stand generation. After drop in AINPV during phase characterized by implementation of regeneration, with minimum AINPV from 15 to 40 years for actively managed scenarios, the benefits of these investments in regeneration were realized, indicated by continuous increase in AINPV. Therefore, shorter contract periods do not allow stable differences in stand AINPV. Only long contract periods enable objective estimation of financial differences between CM and alternative opportunities.

Only long cycles of one stand rotation will substantially change age and size structure and, therefore, support nature protection. Compensation payments for such long contract periods can be calculated by the methods for opportunity costs used in this study by considering revenues and costs from planned stand generations. Nevertheless, decisions about management options after very long time periods without management might be very different from previous conventional management because stand age structure, timber quality, natural regeneration, tree species composition and other characteristics might differ strongly from the desired state for financially optimal management. Difference in financial value of remaining stand at the end minus value at the beginning of the contract period do not fully represent expectation value. Forest owners theoretically have the option of reconsidering management options after the end of the conservation contract. For these reasons, a realistic approach for theoretical decision about long term consequences requires NPV or holding value. Such an approach can be applied for compensation payments, but require predefined information about optimal rotation length (Clasen and Knoke, 2013). A fixed rotation length does not exist for management treatments “Transition to Selection” and “No Cutting”. Therefore, a simplified AINPV approach was used, although ignorance of the expected value is a shortcoming but it allows calculation when long-time rotation cycles are not defined. NPV or holding value could be applied for treatments “Transition to Selection” and "No Cutting" when simulation time z can be extended until the desired steady state is reached. Expectation value then could be derived by the steady state. Matrix simulation model (Roessiger et al., 2016) offers evaluation specific for such uneven-aged forest states.

Intense harvest operation, as well as opening of crown cover with sudden light increase, might cause damages, especially in older stands (Griess et al., 2012), possibly reducing timber quality. Destabilization leads to the higher risk of stand failure (Griess et al., 2012) and its consequences of decrease of stand value (Roessiger et al. 2011, 2013). Neither damages nor stand failure were considered in this study.

Spruce forests have declined rapidly in the region of interest due to bark beetles, with the damage on 12% of forest area and the risk of outbreak increasing by 32% of forest area (Hlásny et al., 2010). Decreases can be avoided operationally by active management against bark beetles in the case of calamity, tactically by changing management treatment towards forming more resistant structures, or strategically by changing tree species composition to reduce spruce proportion. Therefore, in the case of NM and FRM there is risk of fast total value decrease of the remaining spruce stands and thus their value might be overestimated.

In contrast to NM, AM allows the introduction of rare tree species and therefore can support change to near-natural tree species composition over long time horizons. FRM only partly allows change of tree species in buffer zones. Avoidance of "Clearcut" reduces costs for stand establishment and allows for benefits from natural regeneration and naturally-driven stand development and therefore can support rare shade-tolerant tree species.

A general debate still exists over whether changes in management from conventional treatments towards selection logging are beneficial, specifically in tropical regions. Brandt et al. (2014, 2016) reported higher deforestation in European concessions in Congo with selection logging according to the FMP. This deforestation rate has been associated with more intense roads network compared to unassigned concessions or Asian concessions without FMP. Conversely, Karsenty et al. (2016) found lower deforestation rates in concessions managed with FMPs compared to those without FMP. They also detected weaknesses in the methodology of Brandt et al. (2014, 2016), especially with excluded and included territory. Such debate calls for more intensive research about single tree selection management and its impact on various ecosystems.

The ownership structure of the study area in Slovakia is dominated by state ownership. In the case of state forests, no real payments can occur as the state will not pay himself. Nevertheless, opportunity costs exist (Kovalčík et al., 2012) and therefore are relevant for political debate and management decisions. While in the private sector, discussions will be between private forest owners and nature protection organizations, there must be public discussion for the state sector, because tax payers and voters have to carry costs and can consume benefits of either forest management or nature protection. Therefore, public forest administration should report and consider real payments as well as opportunity costs to enable public debate about goals of forest management.

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Time Series Analysis for Short-Term Forest Sector Market Forecasting

Die Zeitreihenanalyse als Instrument für kurzfristige Prognosen von Marktentwicklungen im wald-basierten Sektor

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Keywords: Time Series Analysis, Forest Sector, VAR, VECM, Cointegration, Nonstationarity, Forecasting

Schlüsselbegriffe: Zeitreihenanalyse, Forst- und Holzwirtschaft, Kointegration, Nichtstationarität, Prognose

Summary

Among the various functions of the forest its special significance as a source of raw materials for the timber industry can be emphasized. Wood is an environmentally friendly and a renewable resource. By the growing and simultaneously competing use of the natural resource wood, its commercial role becomes increasingly important. To bring economic potentials into conformity with social and environmental requirements for the performance of the ecosystem forest, wise management of the use of the natural product wood is necessary, also with respect to a successful, sustainable-oriented and bio-based economy. Reliable predictions about possible

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short-term changes in the timber market are scarce although they play a key role in supporting decision making. Forecasts help to recognize and minimize risks in the supply chain management e.g. initiating the adjustment of timber harvesting to fast changing market conditions. In this context, the relevance of the statistical technique of time series methods in forest sector research is highlighted in this paper. The main purpose of this research method is to extract important information out of the time series itself as well as possible causal relationships between the time series and to use this information to identify future economic developments. The fact that time series methods provide strong results combined with only modest data requirements underlines their unique usefulness for the analysis of forest economic issues. To some extent, they can serve as an alternative for the often very complex models of the forest sector. Therefore, this work aims at sensitizing to the advantages of time series for forest sector short-term modelling. Based on this, a breeding ground is provided for progressive research in the forest sector through the application of time series analysis.

Zusammenfassung

Unter den zahlreichen Funktionen des Waldes ist seine besondere Bedeutung als Rohstofflieferant für die Holzindustrie hervorzuheben. Als eine umweltfreundliche und nachwachsende Ressource findet Holz eine breite Verwendung. Durch die in den letzten Jahren gewachsenen und gleichzeitig miteinander konkurrierenden Nutzungsansprüche gewinnt die kommerzielle Rolle von Holz immer stärker an Bedeutung. Um wirtschaftliche Potenziale nutzen und parallel dazu den gesellschaftlichen und ökologischen Anforderungen an die Leistungsfähigkeit des Ökosystems Wald Rechnung tragen zu können, ist ein umsichtiger Umgang mit der Naturressource Holz geboten, auch hinsichtlich einer erfolgreichen, nachhaltig orientierten und bio-basierten Wirtschaft. Zuverlässige Prognosen über mögliche kurzfristige Veränderungen auf dem Holzmarkt sind rar, wären jedoch für die Entscheidungsfindung von Bedeutung. Vorhersagen helfen, Risiken im Supply-Chain-Management zu erkennen und zu minimieren z.B. durch Anpassung der Holzernte an sich schnell ändernde Marktverhältnisse. In diesem Zusammenhang wird in dieser Arbeit die Relevanz der statistischen Techniken der Zeitreihenanalyse für die Forschung im Forstsektor hervorgehoben. Der Hauptzweck dieser Methode ist, wichtige Informationen über zeitliche Zusammenhänge aus der Zeitreihe selbst sowie mögliche kausale Zusammenhänge zwischen den einzelnen Zeitreihen zu gewinnen und diese anschließend für die Prognose künftiger wirtschaftlicher Entwicklungen weiter zu nutzen. Die Tatsache, dass Zeitreihenverfahren zu sehr guten Ergebnissen trotz nur geringer Datenanforderungen führen, unterstreicht ihr enormes Potential für die Analyse von waldwirtschaftlichen Fragestellungen. Damit wird auch den im Forstsektor oft sehr komplexen Modellen Rechnung getragen. Das Ziel der vorliegenden Arbeit ist es daher, für die Vorteile von Zeitreihen bei kurzfristigen Modellierungen des Forstsektors

zu sensibilisieren. Darauf aufbauend wird, basierend auf der Anwendung von Zeitreihenmodellen, der Nährboden für weitere Forschung im Bereich des Forstsektors bereitet.

1. Introduction

To bring economic potentials into conformity with social and environmental requirements for the performance of the ecosystem forest, wise management of the use of the natural product wood is necessary. In this respect, an optimal institutional framework is fundamental for a successful, sustainable-oriented and bio-based economy, which not only Germany but the European Union as a whole has committed itself (BMBF and BMEL (2014), European Commission (2012)).

Therefore, reliable predictions about possible changes in the timber market play a key role in supporting decision making. Especially predictions about future developments of quantities and prices are crucial for the management in forest industry as well as for traditional forest management such as timber production. Forecasts help to recognize and minimize risks in the supply chain management e.g. by adjusting timber harvesting to changing market conditions.

For this purpose, the statistical technique of time series analysis is presented and its relevance for forestry economics is examined. Time series analysis has been widely used in different fields of science for many years. Time series models are basically used to disclose the underlying relationship in a sequence of observed (past) values of a variable as well as the possible causal relationship between time series. After fitting a model they help to predict the future values of the variable of interest. The main purpose of this method is to extract important forecasting information out of the time series and to use this information to identify future (economic) developments.

Empirical literature on forest industry and timber markets focuses primarily on the study of long-term scenarios. Less attention has been paid to the short-run behaviour of forest products and timber markets, and there are even fewer studies that are explicitly concerned with the short-term forecasting issues, as stated by Hetemäki et al. (2004). Due to globalization and internationalization, forest product markets have become more interrelated. They are urged to respond quickly to fast changing market conditions. Therefore, short-term forecasts play an essential role.

Hänninen (2004) takes a swipe at consultants, analysts and private organizations publishing short-term forecasts for the forest sector as they are based on ad hoc assumptions and often not even well documented. He emphasizes the advantage of economic forecasting based on econometric and time series models, where existing knowledge of how the economy works is presented. These models provide forecasts and policy advices, and produce frameworks for progressive research strategies.

With this in mind, and in order to encounter the scarcity of short-term forecasting models for the forest sector, a selection of existing scientific literature in forest sector modelling is presented and analysed. Special attention is attached to the issue of short-term forecasting of quantities and prices in the forest sector based on times series analysis. The statistical improvements of the forecasting techniques over time are highlighted and the selection of the explaining variables is examined. The results of different studies are compared and the underlying methodology is assessed in order to find a useful approach allowing for a simple short-term modelling where at the same time providing meaningful predictions of future developments in the forest sector.

This work aims at sensitizing to the advantages of time series and along with this at preparing the ground for further research in the field of forest sector short-term modelling. The basic techniques of time series analysis and their historical improvement over time are presented in the beginning. Selected important error measures are then given, often applied in forecasting to help assess the goodness of a forecasting model. Hereinafter, a structured historical overview of forest research literature based on time series analysis is provided. Finally, some closing remarks and conclusions for future analysis are discussed.

2. Material and Method

The application of time series analysis has a long history in different fields of science. The pioneering work of Box and Jenkins (1970) with the underlying model class of autoregressive integrated moving average (ARIMA) processes constitutes a milestone in the history of time series analysis. Starting with the predominant class of univariate ARIMA processes, Box and Jenkins (1970) developed a first multivariate time series method, which accounted for the statistical character of time series. Hamilton (1994) provides background knowledge about the most popular method of time series analysis, the Box-Jenkins method. Starting with scalar time series models introduced by Kalman (1960) and Box and Jenkins (1970), the ARIMA models build the predominant class of time series models. These go back to Wold (1938) who stated that any purely non-deterministic stationary time series can be expressed as an infinite moving average (Wold decomposition theorem), which can be described by the infinite sum of the past errors with decaying weights (Pfaff 2008).

Judge et al. (1988) define stationarity as a property that ensures constancy of the means, variances and autocovariances through time. This implies that stationary time series must not have trends, fixed seasonal parameters or time-varying variances. For convenience reasons, these underlying implications might be very useful as they help to understand the basic inherent explanatory power of time series. In reality, however, these friendly stationarity properties of economic data are often violated, so that this assumption appears to be very restrictive and to not correctly reflect economic reality.

Thus, a lot of research has been done since then particularly concerning the properties of time series which on their part directly influence the significance and consistency of research outcomes. In many cases, the fact that time series analysis focuses on available data is often considered as both a restriction and a challenge. And yet, besides the tacit simplicity arising from the employment of already available data, in the course of this work the advantage of vector models more precisely will be highlighted where there is no necessity for distinction between exogenous and endogenous variables. Based on this, a breeding ground is provided for progressive research in the forest sector through the application of time series analysis.

Harvey and Shepard (1992) interpret that the principal univariate structural time series models are therefore nothing more than regression models in which the explanatory variables are functions of time and the parameters are time-varying. Following this, adding observable explanatory variables to structural time series models is seen as some kind of a natural extension as alike is seen the construction of multivariate models.

The most common class of multivariate time series is the class of vector autoregressive (VAR) models which were originally designed for stationary processes. Usually though, economic time series are of a dynamic nature. This is the reason why they are characterized by non-stationarity (see Figure 1). A non-stationary process is featured by a non-constant mean level, a non-constant average size of fluctuations and a varying type of dependence.

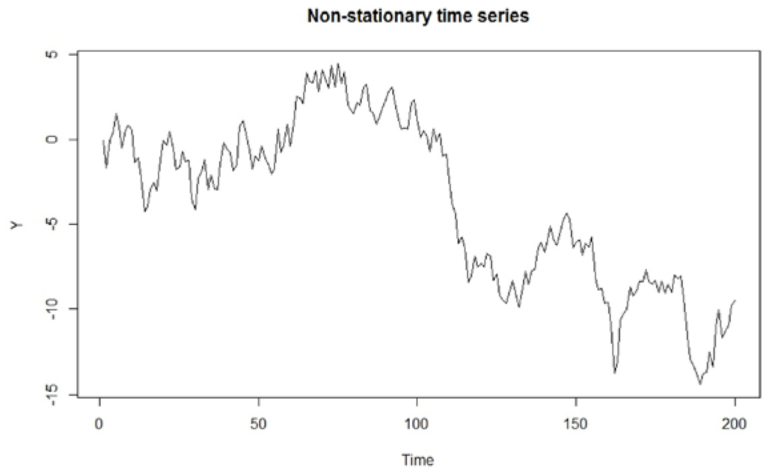

Figure 1: Example for a non-stationary time series

Abbildung 1: Beispiel einer nicht-stationären Zeitreihe

Engle and Granger (1987) have shown that when time series are characterized by non-stationarity, cointegration is a particularly appropriate statistical technique to deal with spurious regression resulting from non-stationarity. In the presence of a cointegration relationship between time series the use of a vector error correction model (VECM) appears to provide better results in terms of forecasting quality.

The fact that time series methods provide strong results combined with only modest data requirements underlines their unique usefulness for the analysis of forest economic problems, given the often very complex models which forest sector research is confronted with. Thus, the methodology of time series analysis along with their improvements over time is introduced in this part. It presents, further, important error measures often applied in forecasting models to evaluate the goodness of the forecasting model.

2.1. The econometrics of unit-root processes

One important feature of time series data as opposed to e.g. cross-section data is that different observations are likely to be correlated. Another one is the possible dynamic relationship between variables so that the change in a variable today may affect the same and/or another variable today as well as in future time periods. This is why it is important to know for how long in the future this relationship holds and how strong is its impact quantitatively to better assess the consequences of economic decisions.

To illustrate the dynamic relationship of time series, a brief look is taken at a simple first-order autoregressive process (AR(1) process):

$$y_t = \varphi y_{t-1} + \epsilon_t \qquad (1)$$

The current period's value of y_t is explained by its previous one and an error process ε_t, where ε_t is a white noise (uncorrelated, with a mean of zero and a constant variance). When forecasting is the objective, a representation of this kind enables to use the knowledge accumulated in the past from the observation to predict future values of the variable of interest (Judge et al. 1988). The path of this process depends on the value of φ. If $|\varphi| \geq 1$, then shocks accumulate over time and hence the process is non-stationary. If $|\varphi| > 1$, the process grows without bounds, and if $|\varphi| = 1$ is true, the process has a unit root (Pfaff 2008).

Usually the generating process of a time series is more complicated than a simple AR-process and may depend on further past values of y_t additionally as e.g. $y_{(t-2)}$, $y_{(t-3)}$ and so on. So that it can be generalized to an autoregressive process of order p (AR(p) process) of the form:

$$y_t = \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + \cdots \ \varphi_p y_{t-p} + \epsilon_t \qquad (2)$$

For reasons of simplicity the lag operator notation is used to describe the lagging of a variable, where e.g. $Ly_t = y_{t-1}$ when the lag operator L is applied once, and $L^2 y_t = L(Ly_t) = Ly_{t-1} = y_{t-2}$ when L is applied twice. In terms of lag operator L the AR(p) process in (2) can be rewritten then as

$$y_t = \varphi_1 L y_t + \varphi_2 L^2 y_t + \cdots \ \varphi_p L^p y_t + \epsilon_t \qquad (3)$$

$$\varphi_p(L) y_t = (1 - \varphi_1 L - \varphi_2 L^2 - \cdots \ \varphi_p L^p) y_t = \epsilon_t \qquad (4)$$

Setting $\varphi_p(L) = 0$ it can be rewritten as

$$\varphi_p(L) = (1 - \varphi_1 L - \varphi_2 L^2 - \cdots \ \varphi_p L^p)$$

$$= (1 - \varphi_1 L)(1 - \varphi_2 L) \ldots \left(1 - \varphi_p L\right) = 0 \qquad (5)$$

For an AR(p)-process to be stationary it is required that for all roots z of the polynomial

$$\varphi_p(z) = (1 - \varphi_1 z_1)(1 - \varphi_2 z_2) \dots (1 - \varphi_p z_p)$$

$$= (1 - \varphi_1 z - \varphi_2 z^2 - \cdots \varphi_p z^p) = 0, \quad \text{where } z = \sqrt{\varphi_p} \qquad (6)$$

$|z_i|>1$ is true. The modulus of a complex number $z = z_1 + iz_2$ is defined to be $|z| = \sqrt{(z_1^2 + z_2^2)}$. In view of this stationarity condition, when returning back to the case of an AR(1)-process, as the one in (1), $|\varphi| < 1$ is required because the only solution to $1 - \varphi z = 0$ is given for $z = 1/\varphi$, and the modulus $|z| = |1/\varphi| > 1$ is true only when $|\varphi| < 1$ (Judge et al. 1988). If $|z_i| = 1$ then a unit root exists implying non-stationarity which can be removed by detrending or by differencing as shown next.

2.2. Deterministic "detrending"

Having a deterministic trend δ in a time series makes it variant to displacements in time:

$$y_t = \delta + \gamma t + \epsilon_t \qquad (7)$$

and

$$E(y_t) = \delta + \gamma t \qquad (8)$$

By subtracting $E(y_t)$ from both sides of the former equation (7)

$$y_t - E(y_t) = \delta + \gamma t + \epsilon_t - \delta - \gamma t = \epsilon_t \qquad (9)$$

the deterministic trend is filtered out of the time series and one ends up with a stationary white noise process which is called trend stationary.

2.3. Difference stationarity

Even after deterministic “detrending” economic time series often show stochastic properties that are inconsistent with the assumptions of stationarity. This is met by the approach of Box and Jenkins (1970) where time series are differenced until stationarity is achieved. Such a time series is called integrated defined by Engle and Granger (1987) as follows.

Definition: A series with no deterministic component that has a stationary, invertible ARMA representation after differencing *d* times is said to be integrated of order *d*, which is denoted as $x_t \sim I(d)$.

A series is then an integrated process of order *d (I(d))* when d differences are required to make the series stationary. Such a stationary time series is illustrated in Figure 2.

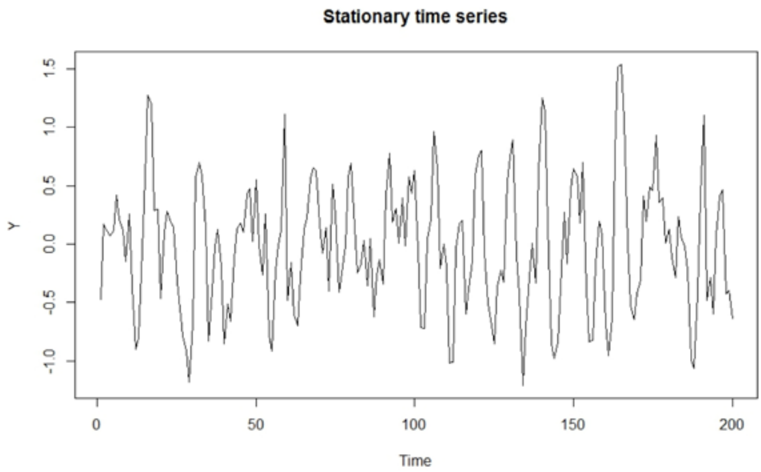

Figure 2: Example of a stationary time series

Abbildung 2: Beispiel einer stationären Zeitreihe

Difference stationary time series is often said to have unit roots (i.e., roots of the autoregressive polynomial that lie on the unit circle (Pfaff 2008)).

2.4. Spurious regression

The application of the method of ordinary least squares (OLS) in the presence of integrated time series appears to be problematic. The residuals (errors) may be serially correlated (or autocorrelated) and have a growing variance over time. Especially in the case of difference stationary data the error term often seems to be highly correlated. Hence, the result is the so called spurious regression (or nonsense regression) given by very high coefficient of determination R^2 of the regressions and high significance of explanatory variables where there may not be any significance at all. The phenomenon of spurious regression can be traced back to Yule (1926) and Hooker (1901). In Hendry (2004) and Hendry (1986) a historic background of nonsense regressions is provided (Pfaff 2008). This phenomenon is very often connected to and especially typical for the fact, that economic time series simply have trends. When the original (non-detrended or non-differenced) data are used for regression, they correlate without any causal relationship. This problem is less present when cross-sectional data are used. To cope with spurious regression, difference stationarity is applied by testing for unit roots as well as the techniques of cointegration.

2.5. The existence of cointegration

Using differenced data in time series analysis is often considered problematic as the information filtered out by differencing may be very important with regard to a possible existence of long-run equilibrium relationship between level-data (undifferenced) which economic theory usually relates to (Davidson et al. 1978).

Granger (1981) introduced the concept of cointegration which accounts for the existence of a stable long-term relationship between several non-stationary time series. It was further formalised by Engle and Granger (1987) where for following definition of cointegration is found:

Definition: The components of the vector x_t are said to be *cointegrated of order d,b*, denoted $x_t \sim CI(d,b)$, if (i) all components of x_t are $I(d)$; (ii) there exists a vector $\alpha \neq 0$ so that $z_t = \alpha' x_t \sim I(d-b)$, $b>0$. The vector α is called the *cointegrating vector*.

Although the individual series are non-stationary, they are tied to each other by the cointegrating vector. Deviations from a long-run equilibrium path are possible, but these errors are characterized by a mean reversion to its stable long-run equilibrium. And this fact is what made the concept of cointegration so valuable to economists, namely the possibility to detect a stable long-run relationships among non-stationary variables (Pfaff 2008).

In Sims (1980) the possibility was presented to developed models for many time series and the vector autoregressive model (VAR) was born. An approach to apply this method for multivariate time series was designed by Johansen (1988) and Johansen and Jusélius (1990). They state further that in the presence of cointegration, a multivariate system can be defined in a general error correction representation which would relate the change in one variable to past equilibrium errors, as well as to past changes in both variables (Engle and Granger 1987, Johansen 1988). A reduced form error correction model (ECM) is given by:

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + \Phi D_t + \mu + \varepsilon_t \qquad (10)$$

Where $\varepsilon_t \sim i.i.d.N(0,\sigma^2)$ is a vector of independent, identical, normally distributed errors, D_t is a matrix of saisonal dummy variables, μ is a vector of constants and X_t is a vector of used variables. The left-hand side of the ECM is stationary. To balance the model, the right-hand side has to be stationary as well. To achieve stationarity on both sides, the term ΠX_{t-1} must be stationary.

The number r of cointegration relations (vectors) is to be determined, which means for the rank of the $p\ ^{x}\ p$ *matrix* $\Pi = \alpha\beta'$ is to be tested. Each column of matrix β corresponds to one long term equilibrium and α describes the weights, also interpreted as the speed of adjustment, with which the system returns to the equilibrium after a disturbance. The term ΠX_{t-1} is stationary if the matrix Π has full rank. If the rank is zero, it is the null matrix (r = 0), then the term is no longer of interest. If it is of reduced rank (r < p), than there is cointegration. Then there exist r matrices $\Pi = \alpha\beta'$ for which ΠX_{t-1} is stationary.

2.6. Performance of forecasting models

After fitting the in-sample model with data and verifying it with out-of-sample data, the accuracy of the predicted values is to be assessed. This is done by comparing the forecasting performance of the estimated model with the out-of-sample data. To do this, there are different measures available some of which are presented below.

The mean absolute percentage error (MAPE) measures the average differences between predicted y_t and actual $\hat{y}_t$ values. Only absolute deviations are considered irrespective of whether the differences are positive or negative. This avoids offsetting of over- and underestimates.

$$\frac{1}{T}\sum_{t=1}^{T}\left|\frac{y_t - \hat{y}_t}{y_t}\right| \qquad (MAPE) \tag{11}$$

The root mean square error (%RMSE) is another measure for forecasting quality. Basically, it is the root of the mean of all squared forecast errors. RMSE avoids the use of absolute values. It is more sensitive to outliers then MAPE because it amplifies and punishes large errors more severely. Chai and Draxler (2014) conclude that any single metric emphasizes only a certain aspect of the error characteristics. Therefore, a combination of metrics is often required to assess model performance.

$$\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left|\frac{y_t - \hat{y}_t}{y_t}\right|} \qquad (RMSE) \tag{12}$$

In view of this statement, Theil's inequality coefficient, also known as Theil's U-statistic (Winker 2010), is shortly discussed as a more accurate metric of the forecasting performance of a model, since the importance of large errors is emphasised here by weighing large errors more strongly than smaller ones. Theil's inequality coefficient originally developed by Theil (1966) compares errors of the forecast model with errors of the so called naïve model (when the predicted value is the same as one period before: y_t =) y_{t-1}, i.e. the status quo is assumed for the future). The coefficient verifies that actual changes in the endogenous variable are predicted. Here, y_0 in the denominator is the final value of the in-sample time series and T the number of forecasting points in time. In the case of Theil's U-statistic equalling one, the status quo is precisely projected into the future. It is one or greater when the naïve model describes the data as good as or even better than the model respectively. It means the forecasting model does not succeed in providing better results than the naïve model and it should be dropped then. The smaller Theil's inequality coefficient is the more accurate forecasts are obtained using the proposed model. It equals zero when the model perfectly meets the realized values of the analysis period.

$$U = \sqrt{\frac{\sum_{t=1}^{T} u_t^2}{\sum_{t=1}^{T} (y_t - y_{t-1})^2}} \qquad (Theil's\ U) \tag{13}$$

3. Application of time series forecasting models in forest research literature

In this section, an overview of the application of time series methodology in forest sector modelling is given while at the same time investigating their forecasting performance and their practicability. A comprehensive synthesis of existing research conducted worldwide on modelling the forest sector is offered below. To remedy the scarcity, or rather absence of short-term forecasting in the forest sector, the focal issue of this synthesis lies on the attempts done by now to predict demand and supply, as well as prices for forest products.

3.1. ARIMA – the Box-Jenkins approach in the forest literature

As aforementioned, an early major contribution in time series methods for short-term forecasting modelling refers to the univariate Box-Jenkins method. The method provides forecasts using exclusively past values of the variable of interest, or in other words the historical behaviour of a series (Hoff, 1983). This most popular method, also called ARIMA analysis, seemed to provide accurate short- to medium-term forecasts. The pioneering studies by Buongiorno et al. (1979), Buongiorno et al. (1984) and Buongiorno et al. (1988) followed, shifting the focus from univariate to multivariate time series analysis. Below, a structured overview of forest research literature based on time series analysis is provided (see Table 1). The focus here lies primarily on short-term forecasting models for quantities and prices in the forest sector using the technique of times series analysis. In addition though, based on selected studies the improvements of this technique over time are extracted. At the same time, the attention is focused also on the considered variables helping to predict forest quantities and prices.

Table 1: Overview of forest research literature based on time series

Tabelle 1: Übersicht über forstwissenschaftliche Untersuchungen die auf Zeitreihenanalysen aufbauen

Author		ARIMA	Multivariate Regression	Cointegration	VAR	VEC	Short-run Forecasting
Buongiorno et al. (1979)			x				
Buongiorno et al. (1984)		x	x (bivariat)		x		
Buongiorno et al. (1988)			x				
Lewandrowski et al. (1994)		x					x
Buongiorno and Uusivuori (1992)	law of one price			x			
Alavalapati et al. (1997)	law of one price			x			
Hänninen (1998)	law of one price			x			
Nanang (2000)	law of one price			x			
Yin et al. (2002)	law of one price			x	x		
Yin and Baek (2005)	law of one price			x			
Jennings et al. (1991)					x		
Hetemäki and Kuuluvainen (1992)				x			x
Toppinen and Kuuluvainen (1997)				x			x
Toppinen (1998)			x	x			x
Heikkinen (2002)				x	x	x	x
Brännlund et al. (1999)		x	x				
Kim et al. (2003)			x		x		
Limaei et al. (2011)			x				
Hetemäki et al. (2004)		x	x	x	x	x	x
Hetemaki and Mikkola (2005)		x	x	x	x	x	x
Baek (2012)				x			
Nanang (2010)			x	x		x	
Hietala et al. (2013)				x	x		
Nagubadi and Zhang (2013)				x		x	x
Bolkesjo and Buongiorno (2006)					x		x
Song et al. (2011)				x		x	
List et al. (2016)							x
Total	*27*	*5*	*10*	*17*	*9*	*5*	*10*

Buongiorno et al. (1979) analyzed monthly imports of Canadian softwood lumber to the United States explained by the variables import price, domestic wood price, overall price level, housing starts in the United States and one-period-lagged import quantity. Domestic wood price was found to have the largest effect on import quantity followed by housing starts and import price. In all five alternative models considered here import price influenced import quantity negatively. Despite good statistical characteristics and accurate postsample forecasts of the model at first glance, it did not employ unit roots test to check for non-stationarity.

Buongiorno et al. (1984) compared an econometric model based on housing starts, prices, and past imports, with a univariate time series model using past imports only, and a bivariate time series model of imports and housing starts to forecast United States softwood lumber imports. While the econometric model appeared to remain superior for policy analysis, the bivariate time series model showed the best forecasting quality whereas at the same time it required much less information. They foreshadowed that theoretical synthesis of multivariate and econometric approaches would possibly lead to future advances.

Four years later, Buongiorno et al. (1988) developed a multivariate time series model equivalent to the reduced form of a dynamic structural model to reveal the reasons for the duplication of Canadian softwood lumber imports into the United States, using monthly data for the domestic lumber price and the exchange rate. For the exchange rate, no significant influence on imports could be found. On the contrary, the price was found to have a significant impact on import quantities and vice versa. This effect seemed to hold in the short as well as in the long run.

Using quantitative analysis of univariate time series Lewandrowski et al. (1994) developed an ARIMA model using monthly data to forecast the short-run behaviour of lumber markets for three regions of the United States and Canada. Own prices, expected future prices and finished-product inventories were the key factors affecting the short run. They found that lumber markets respond quickly but only to regional market disturbances. No cross-price effects between the U.S. regions could be found which implies that local policy decisions cannot negatively influence producers in other areas. Significant cross-price effects were though found between Canada and areas of the United States. Notwithstanding the fact that the ARIMA model used here managed to forecast short-run (monthly) behaviour of lumber markets, a big downside can be seen in the neglecting of the non-stationarity problem of time series.

3.2. VAR and VEC models (The superiority of the cointegration method)

A common feature and major shortcoming of the above mentioned studies was that none of them considered the problem of non-stationarity. It was not until after the development of the cointegration methodology by Granger (1981) and Engle and Granger (1987) and the maximum likelihood estimation for ECM by Johansen (1988) and Johansen and Jusélius (1990) that a more effective way was found to cope with non-stationarity and spurious regression. New time series econometric models have been developed since then, which can be used to provide reasonable and more accurate short-term forecasts, such as vector and cointegration models.

The seminal work of Johansen and Jusélius (1990) paved the way for further research in the forest sector based on this newly developed approach. A series of papers using cointegration followed, to study the theory of the "law of one price" (e.g. Buongiorno and Uusivuori (1992), Yin et al. (2002) and Yin and Baek (2005) for the United States, Alavalapati et al. (1997) and Nanang (2000) for Canada, Hänninen (1998) for the United Kingdom). Depending on the region or product group of interest, they came to contradicting outcomes. For instance, Yin et al. (2002) could not find evidence for the "law of one price" with regard to saw timber and pulp wood in the United States, whereas Yin and Baek (2005) could support this theory for softwood lumber markets.

A three-lag VAR model with ten macroeconomic variables by Jennings et al. (1991) examined the Canadian lumber industry, aiming at demonstrating the usefulness of the VAR method. The results confirmed those of Buongiorno et al. (1988) that exchange rate had no significant influence on lumber production and export quantity of lumber from Canada to the United States. No evidence was found that any variable describing the Canadian wood market influenced the GDP, except for the variable inventory of lumber held by lumber manufacturers. Housing starts in the United States seemed to be the only variable having a significant influence on export quantity.

Cointegration theory based on Johansen's multivariate cointegration method and the "general to specific" modelling approach as proposed by Hendry et al. (1988) and Spanos (1990) was used by Toppinen (1998) to estimate a dynamic error correction model. Employing recent developments in time series econometrics, she reformulated the short-run demand and supply models of the Finnish sawlog market. The method used monthly data for a relatively short period of less than 12 years and resulted in two cointegrating vectors (rank equaled two) theoretically consistent with the demand and supply equations. In previous studies by Hetemäki and Kuuluvainen (1992) and Toppinen and Kuuluvainen (1997), where no price effect was present on either supply of or demand for sawlogs, the models estimated were, thus, regarded as incapable of performing short-term forecasting. As opposed to these investigations, in Toppinen (1998) both in the short and long run, sawlog supply was effected positively by stumpage price, whereas the price effect in sawlog demand did not hold in the short run. Moreover, Toppinen (1998) highlighted the use of the cointegration approach in modelling price and quantity of forest product markets as beneficial and as well transferable to forest markets in other countries.

A modelling technique for short-run (yearly) decision making was proposed by Heikkinen (2002). He examined the applicability of cointegration to study the correlation between expected asset returns in the Finnish forestry and an optimal investment portfolio. VAR and VEC models were estimated and their impact on the optimal portfolio was then compared. Six major Finnish timber assortments and three major investment alternatives (stocks, government bonds, and deposits) were included in the asset set. Forestry returns seemed to be correlated with the other types of assets in the long-run while not much relevant for the short-run performance prediction of the investment portfolio in terms of asset returns.

Brännlund et al. (1999) applied a multivariate technique to forecast prices of Swedish forest products, which was based on the idea that time series of prices and quantities from different forest sectors typically co-vary over time. Unfortunately, the applied maximum autocorrelation factor approach could not significantly improve the forecasting performance of the naïve-ARIMA models.

A VAR model was calculated by Kim et al. (2003) to estimate the impacts and to evaluate the dynamics of the currency value change on the forest products import quantities in Korea. Depending on exchange rate and import price, they examined import quantities of different wood products to Korea and found a significantly negative effect of exchange rate on import quantity. However, the model fitted the data only moderately. Granger causality of exchange rate on import quantity was found only for hardwood roundwood but not on softwood roundwood import quantity.

A basic multivariable regression analysis was done by Limaei et al. (2011). They investigated the effect of GDP, population size and domestic wood production on export and import of wooden products in Iran. The augmented Dickey Fuller (ADF) test for a unit root in a time series data by Dickey and Fuller (1979) was used to show the stationary process of the predicted autoregressive model for export of wood. They demonstrated the possibility to predict the wood export via a first order autocorrelation function. As a result, GDP seemed to have the largest impact on export quantity, but not a significant impact on import.

Hetemäki et al. (2004) partly agree with these findings. They compared the short-term predictive ability of four different models referring to lumber import demand of Germany, Finnish lumber export to Germany as well as Finnish sawlog demand. The categories considered here were ARIMA models (referred to as the naïve models), single-equation multivariate models (denoted as partial models), as well as VAR and VEC models as system models. The results indicated that one could clearly improve on the ARIMA forecasts by moving to the partial single-equation or systems approaches (VAR and VEC models). Only for the lumber import demand, the partial model fitted best both in-sample as well as out-of-sample. Although it fitted best in-sample also in the case of Finnish lumber exports to Germany, the VEC model turned out to be the best forecasting model in both cases, of the Finnish lumber exports as well as of the Finnish sawlog demand.

To contribute to the scarce literature on short-term forecasting, similar models and a structural time series model were estimated by Hetemaki and Mikkola (2005) to analyze the import demand for coated printing and writing paper in Germany, using quarterly data. Results indicated that forecasting quality increases when moving from single-equation to multivariate VAR models. By optimally combining different models, Hetemäki and Mikkola (2005) assumed a possibility of improvement in terms of forecasting accuracy.

Baek (2012) applied the Phillips-Hansen fully-modified cointegration (FM-OLS) framework, developed by Phillips and Hansen (1990), to study the import quantity of Canadian lumber to the United States, since the FM-OLS method seems to be less sensitive to changes in lag structure and to perform better for finite sample size than the cointegration techniques by Engle and Granger (1987) or Johansen (1988). Using a cointegration procedure for monthly data he came to the conclusion, that a long-run equilibrium relationship exists and that the exchange rate plays no significant role in explaining the import quantity.

These findings substantiate the results of Nanang (2010). Using Johansen's multivariate cointegration approach, he revealed a significant positive long-term effect of exchange rate and income on exported timber products. He employed the augmented Dickey Fuller unit root tests to check for non-stationarity of time series.

Hietala et al. (2013) estimated an unrestricted VAR model with six equations for Finland and Sweden for the period from 1995 to 2008. Following the methodology of Johansen (1992) and the specification of Pantula (1989), they used a cointegration framework to study the exchange rate pass-through in Finnish and Swedish sawnwood exports to the United Kingdom. Although the size of the impact seemed to be country specific, they found a significantly positive effect of the exchange rate on export quantity for both countries. This empirical result is contrary to the general assumption, that in a small open economy exporters are price takers and thus, the relative competitors' prices determine the quantities exported from each country of origin. Finnish exports appeared to have been affected to a great extent by currency fluctuations, while in contrasts, the pricing strategy exploited by Swedish exporters appeared to have been somewhat less affected by currency movements. The authors argued that the lower total costs of transportation from Sweden to the United Kingdom might have been one reason for the more stable export demand faced by Swedish exporters and the more stable Swedish sawnwood price.

The impact of import price, influenced by various trade restriction measures, on the import quantity of Canadian softwood lumber into the United States is part of the investigation by Nagubadi and Zhang (2013). Following Buongiorno et al. (1979), they added some additional variables to the model, like U.S. softwood lumber imports from the rest of the world, interest rate, seasonal factors, and policy dummy variables representing various dispute phases. Monthly data on Canadian softwood lumber imports for more than 32 years were employed. Comparing OLS regressions with a multivariate cointegration framework (Johansen 1988, 1995), ADF unit root and Granger causality tests, they found housing/construction activity and the U.S. domestic lumber prices having a positive impact in the long run, while Canadian lumber import prices having a negative long-run impact on U.S. lumber import quantity from the Canadian provinces covered by their investigation. Estimating a VECM they showed that in the short run, trade dispute and resulting trade restrictive phases negatively impacted the U.S. softwood lumber imports from the covered Canadian provinces.

To test the short- and long-run impacts of exchange rates on the trade of various forest products, Bolkesjo and Buongiorno (2006) estimated a reduced form bivariate dynamic model using monthly observations of U.S. exports to various countries, and U.S. imports from Canada. In the short run, exchange rate was found to have a quite significant negative impact on export quantity, while in the long run the elasticity decreased but remained still significant. Short- and long-run elasticities of import quantity with respect to the exchange rate were positive, but insignificant in the short run. Due to the fact that only few of the export and import series were non-stationary, VAR models were used here instead of cointegration, to obtain results suggesting that exchange rates do matter in international forest products trade, both in the short and in the long run.

An error correction model was derived by Song et al. (2011) estimating a system of dynamic demand and supply equations to analyze the U.S. softwood lumber market using monthly data. Demand and supply of U.S. softwood lumber seemed to be relatively price inelastic in the short run, and not much more elastic in the long run. Similar to this, Canadian supplies were also not price elastic in both, the short and long run. Canadian imports though, as softwood lumber supply to the U.S., seemed to be slightly more price elastic than the domestic lumber supply, in the short and long run. Along with other variables, they used the exchange rate as independent variable and came to the conclusion that exchange rate had significantly positive effect on import quantity, so that import quantity rises when exchange rate rises and the dollar grows stronger.

A convenient and simple way how to use time series for forecasts is presented by List et al. (2016). Based on List (2015) they compare 30 different so-called "naïve forecasts" of monthly supply quantities of timber in two case-study regions with different marketing conditions. Using relatively simple data naïve forecasts provide a rough estimation of the timber supply in the different forest owner associations considered in the study. It turns out that for each of the regions in Styria and Burgenland, the accuracy of the generated forecasts is significantly different and hence, a different model type seems to be superior in each of the regions.

A final glance at Table 1 discloses the general prevalence of cointegration analysis in the empirical modelling of supply, as well as demand and prices for forest products. 17 out of 27 cited studies have used the cointegration approach for investigation. In recent years, an increasing tendency can be observed towards the application of VEC models for short-term forecasting, despite the fact that only few research is as yet done in this field, and even less when it comes to forecasting timber prices. Hence, it can be deduced that further research is required to better assess the potentials of these models for short-term forecasts in the forest sector.

4. Conclusions

Due to economic developments like European integration, globalization, emergence of new information and communication technologies, fluctuations in economic variables are conveyed at a faster speed than ever before (Hetemäki et al. 2004). Globalization and internationalization have accelerated the interdependencies of forest sector markets worldwide. Thus, the need for accurate short-term forecasts of forest products is increasingly moving into the spotlight.

As yet, available short-term forecasts in the forest discipline, mainly conducted by private consulting organizations, are very often based on ad hoc and not well documented assumptions, as pointed out at the beginning. The lack of transparency and of discerning scientific foundation questions the reliability of the information content of assertions based on such forecasting analysis. To provide authoritative statements for future developments of the forest sector, more sophisticated analysis based on reliable and scientifically proven outcomes are necessary.

Economic forecasts based on econometric and time series models benefit from existing knowledge of how the economy works. In the forest research literature, there are few forecasting models and they are primarily limited to long-term scenarios. This paper reveals existing gaps in this field of research. Further, it sensitizes for the advantages of time series models' employment for forest sector short-term modelling while based on this preparing the ground for further research analysis.

Forecasting models in the forest sector are often characterised by a high degree of complexity requiring an extensive knowledge of data to different subjects (such as economic, forest growth, environmental protection etc.), which hampers the practical feasibility and the general applicability of the models. Data sets used are often large and complex and appear to be impractical in terms of compatibility of various objectives considered all rolled into one. The limited availability of appropriate and precise data with respect to all subjects taken into account even further aggravates the feasibility and along with this the usefulness of forecasting models. In many cases data can be obtained only as quarterly or only as annually data, or are often collected not in a uniform manner or not time-consistently. This fact can considerably weaken the validity of the models, additionally.

In this sense, time series methods have the advantage that they produce solid results while working with modest data. The most well-known method for analysis of time series data, the Box-Jenkins method with the class of the ARIMA processes by Box and Jenkins (1970), marked the unique movement away from the widespread perception of stationarity of time series.

Since then, a lot of research on econometric tests such as unit roots test has been done to make methods based on time series more efficient. More particularly, the development of the cointegration approach by Engle and Granger (1987) broke new ground allowing for the consideration of time series having a long-run relationship, irrespective of whether they are non-stationary but moving together rather than away from each other over time.

In the presence of cointegration, error correction models have proven to be far superior to traditional methods in econometric time series theory like e.g. the OLS method, especially when it comes to effectiveness in terms of forecasting quality. With development of the maximum likelihood method by Johansen and Jusélius (1990) the estimation of an error correction formulation was enabled, to handle the problem with non-stationarity and spurious regression.

Important aspects, contributing to a better understanding of economic forecasting and the prevalence of forecast failure, are depicted by Hendry and Clements (2003). They crown the technique of cointegration as the most useful modelling device when it comes to forecast accuracy, in the presence of non-stationarity due to stochastic trends or unit roots.

The usefulness of this particular technique generally originating from the development of time series methods over time, and their applicability for predictions in the forest sector have been highlighted in this study. A great deal of commitment to the technique of cointegration has likewise been shown in Abildtrup (1999). The book contains papers covering different fields of the forest sector where the ability of the technique of cointegration is examined, specifically geared towards the analysis of forest economics problems. Here again, little research is dedicated to the study of short-run dynamics.

Consulting organizations have recognized the shortage of and the increasing need for short-term forest sector forecasts leading to the fact that, unfortunately, often unreliable forecasts are delivered, not based on firm theoretical framework and regardless the high cost of forecasting errors with regard to the decision making process. In that respect, to say it with Buongiorno (1996), regardless of methodological shortcomings and data quality, a formal model that lays out all assumptions unambiguously, is a better way to study the forest sector than no model at all.

Given the problem of the accuracy and the high degree of complexity of existing forest sector models, this paper aimed at sensitizing to the advantages of time series analysis by analyzing the development of short-term forest sector forecasting models. As the technique of time series analysis provides a comparably simple approach for short-term modelling using already available data while at the same time performing quite well in terms of useful results, the increasing need for accurate short-term forecasts of forest products seems to be partly met by the application of time series and more precisely by the application of VEC models to which an increasing attention has been paid in recent years.

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Non-timber innovations: How to innovate in side-activities of forestry – Case study Styria, Austria

Nichtholz-Innovationen: Über Innovationen in forstlichen Nebentätigkeiten, Fallstudie Steiermark, Österreich

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Keywords: Forestry, innovation system, non-timber forest products (NTFP), case study, Styria, Austria

Schlüsselbegriffe: Forstwirtschaft, Innovationssystem, Nichtholzprodukte (NHP), Fallstudie, Steiermark, Österreich

Summary

Since non-timber forest products (NTFP) are usually associated with side-activities of forestry, their development is often neglected by companies and innovation systems. Their real value, however, is underestimated and interesting innovative examples of marketed NTFP exist. Our article thus asks: How do innovations happen in a situation where there is very limited institutional innovation support, and how could non-timber innovations be fostered? This is studied in the regional case study of the Austrian province Styria in which the role of policies and actors in innovation processes is ex-

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amined. We find that support for non-timber products is given from several sectoral innovation systems, including forestry, agriculture and nature conservation. Their influence, however, is limited as in none of them NTFP are in their specific focus but only recognised on the side. Non-timber innovations are typically generated from bottom-up in small, regional and often cross-sectoral "ad-hoc" networks. Effective diffusion of innovations is only reached through institutional innovations such as the formation of producers' associations. The best model for fostering innovations in NTFP would be "top-down support for bottom-up innovations". The article documents two successful examples for this model where the institutional system was able to give substantial and systemic support to local creativity and capacities, namely the forest-oriented LEADER-Region "Zirbenland" and the Styrian Nature Parks Association.

Zusammenfassung

Da Nichtholzprodukte (NHP) üblicherweise mit forstlichen Nebentätigkeiten assoziiert werden, wird deren tatsächlicher Wert oft unterschätzt und NHP werden von Forstbetrieben und relevanten Innovationssystemen wenig beachtet. Da in der Praxis aber interessante und innovative Beispiele zu finden sind, stellen wir folgende Frage: Wie laufen Innovationen in einem solcherart ungünstigen Umfeld ab und wie können sie besser unterstützt werden? Zur Beantwortung untersuchen wir anhand der regionalen Fallstudie Steiermark die Rolle von innovationsrelevanten Akteuren und politischen Programmen in entsprechenden Innovationsprozessen. Es zeigt sich, dass die Entwicklung von Nichtholzprodukten von unterschiedlichen Innovationssystemen (Forstwirtschaft, Landwirtschaft, Naturschutz) unterstützt werden, wobei deren Einfluss aber sehr begrenzt ist, da keines dieser Innovationssysteme auf diese Produkte fokussiert. Nichtholzinnovationen entstehen typischerweise in kleinen, regionalen und vielfach sektorübergreifenden Netzwerken, die sich ad-hoc im Einzelfall bilden. Eine wirksame Verbreitung von Innovationen wird aber nur durch institutionelle Innovationen erreicht, etwa als Zusammenschluss der Produzenten. Als bestes Modell für die Förderung von Nichtholz-Innovationen erscheint eine „zentrale Unterstützung von dezentralen Innovationen" oder die „Unterstützung von oben für Innovationen von unten". Der Artikel dokumentiert zwei Beispiele, in welchen lokale Ressourcen und Kreativität erfolgreich durch das institutionelle System unterstützt wurden. Diese sind die forstlich orientierte LEADER-Region „Zirbenland" und der „Verein Steirische Naturparke".

1. Introduction

Non-timber forest products (NTFP) are often presented as a potentially promising but neglected business field of forest holdings (Lawrence, 2009). As forestry understands itself as being oriented towards timber production, NTFP are often termed „minor" or „secondary forest products". Forest laws often talk of „by-products" or "side-products" of forestry, and research projects on NTFP markets are oriented towards "niche markets" (Mantau et al., 2001) or even "non-market goods" (Mavsar et al., 2008). Much more often than of a business field, non-timber products and services are talked of as ecosystem services and they are assumed as being provided in the "wake" of regular timber production. NTFP are then dealt with from a welfare economics perspective as „forest ecosystem services", as part of „total economic value" or as an element of „quality of life" or „well-being". In view of the broad range of market sectors that are concerned – including food and beverage, medicinal, pharmaceutical and chemical products as well as craft and decoration – a generalisation is, of course, very difficult. Except for a few products such as cork or mushrooms in some Mediterranean countries, it is certainly the typical case that forest holdings and forest industry and policy actors focus on the production of timber and do see other products as side-, by-, or minor products (Weiss and Rametsteiner, 2005; Vacik et al, 2014). As a result, the field of non-timber products and related business opportunities is hardly visible and recognized, although their potential seems to be bigger than often thought (Vacik and Wolfslehner, 2009). Following this, the basic reasons and challenges behind the fact that these latent opportunities of NTFP are often neglected, are found with regard to two issues, marketability and innovation. First, there is a limited marketability of many forest products and services, which is sometimes connected to an often existing public good character of such products (Mantau et al., 2001; Mavsar et al., 2008) as well as to a weak competitiveness against cheaper imports or against cultivated products originating from plantations. Second, on top of this challenge, there is also a limited attention of established sectoral innovation systems, thus providing only limited support of or acting even as barriers against their development (Rametsteiner et al., 2005; Weiss et al., 2011). In primary sectors such as forestry, innovation efforts are typically directed towards rationalisation and less towards diversification or higher value products (Breschi and Malerba, 1997; Hansen et al., 2014; Hirsch-Kreinsen and Jacobson, 2008). Barriers may arise when established actors direct the support measures of innovation systems towards self-interested sectoral innovations and fight other interest groups or products (Buttoud et al., 2011). Regional innovation systems may be better suited to support that kind of innovations (Asheim, B.T. and L. Coenen, 2005).

In Austria, innovations in non-timber products or services have often been developed without specific support from single policy fields or, in other words, "between" established innovation systems (Kubeczko et al., 2006). Instead of sectoral, regional innovation systems or regional development policies may rather play important roles; examples include the development of the very successful biomass-based district heating plants (Weiss, 2004) and recreational services of forests (Weiss et al., 2007).

Non-timber forest products are neither in the focus of national or regional innovation policies nor of forest sectoral policies, an appraisal which is confirmed also for other European countries (Ludvig, Tahvanainen et al., 2016). Relevant policy measures that may be utilised are related to regional or rural development programmes. Their aims are to develop new (sustainable) products and markets in order to counteract emigration from rural areas, increase attractiveness of the regions by creating or securing job opportunities and to enhance cooperation within the rural population through networking to support knowledge transfer. Appropriate institutional support becomes a central question if non-timber innovations should get a chance to develop and diffuse (Ludvig, Corradini et al., 2016). The EU LEADER programme is well suited because of its innovation orientation and because of its bottom-up working method. The LEADER instrument, however, has not been strongly used within forestry throughout Europe (Feliciano et al., 2011).

This paper starts from the observation of a limited innovation system support and aims to analyse in an empirical example what this unfortunate institutional environment means for innovations in the field of non-timber products. Our research question thus reads as follows: How do innovations happen in a situation where there is very limited institutional innovation support, and how could non-timber innovations be fostered?

2. Methodology

In order to answer our research question, this study applies an innovation system approach as described above and chooses the region of Styria (Austria) as an empirical case study (Yin, 2009). The methodological approach to study the role of sectoral and regional innovation systems in supporting forest sector innovations has been developed over years and applied in several studies, including forestry innovations in central Europe (Rametsteiner et al., 2005) and a comparison of five regional forestry clusters across Europe (Weiss et al., forthcoming-a).

2.1. Case study: Styria, Austria

Austria is a predominantly alpine Central European country with an area of 83,871 km² situated in the Central European climatic zone (moderate, humid). Styria is the second largest province out of nine federal states in Austria with an area of 16.401 km², situated in the south-eastern region of the country and influenced by illyric, pannonian and sub-alpine climate. Around 1.2 Mio. inhabitants are spread across 13 districts with a strong conglomeration in the capitol of Graz and its surroundings where approximately 33 % of total inhabitants are located (Statistics Austria, 2011).

In the last decades there have been massive structural changes in the agricultural and forestry sector in Austria in general (e.g. decrease in traditional family holdings, increase in sideliners/part-time farmers and "new" forest owners). In 2010 the number of forest holdings in Styria, which is continuously decreasing since the end of the 1990s, was around 39.000 providing employment for nearly 96.000 people (Statistics Styria, 2013). Timber production is the main production goal of forest enterprises and has helped to develop a strong timber industry. NTFP have been of high relevance historically (e.g. resin tapping, leaf and litter collection) with some traditional uses that are still important today (e.g. hunting, fishing, gravel digging). New modes of utilization that often strongly relate to forest services emerge additionally, for instance: i) protection against natural hazards, ii) kerbing of drinking water, iii) horse-back riding, or iv) mountain biking (Rametsteineret al., 2005). Nevertheless, NTFP are being reinvigorated recently – and this holds true for small-scale forest owners as well as for bigger forest enterprises. Vacik and Wolfslehner (2009) estimated the value of marketed forest-related NTFP and services in Austria for the year 2005 to nearly 220 Mio. €, comprising 43 % of total value (i.e. 95 Mio. €) for NTFP and 57 % (i.e. 125 Mio. €) for services. Although the income from NTFP is still low compared to that generated by timber production (i.e. 770 Mio. €), there seem to be high latent potentials for Austrian forestry (Vacik et al, 2014). As the majority of forest properties in Styria belong to rural areas it can be assumed that this may trigger an array of positive effects for regional development, taking into account that product diversification has the potential to increase labour opportunities and to provide new ways of income generation.

2.2. Material and methods

The methods used include document analyses, questionnaires and interviews. Documents on and from relevant organisations and policies that are important for supporting innovation processes in the field of non-timber forest products in the region of Styria have been qualitatively analysed. The documents have been screened in order to determine their relevance regarding NTFP innovations, including their respective aims, measures and activities. A questionnaire has been sent in 2014 to 19 potentially relevant public and private sector organisations with a response rate of five, who explicitly considered the theme relevant for them and answered. The other actors explicitly or implicitly considered themselves not relevant for this topic. Semi-structured face-to-face interviews have been conducted with central innovation system actors and with innovators in specific innovation case studies between 2014 and 2015. Analysis questions include from which administrational levels the relevant support policies are and from which sectors, and what are the goals and measures applied. Besides of financial support mechanisms, the analysis specifically considers research and development, education, training and information activities related to non-timber forest products. In addition, in-depth analyses of innovation processes in selected innovation examples from the region were conducted. These embedded enterprise-level case studies include the following products: game meat, Christmas trees, mountain pine essential oils, chestnuts, mushrooms, herbs and forest fruits. Some of the included cases are supported by policy programmes, marketing organisations and/or labels, for example, the LEADER+ programme, Nature Park Specialities, the Styrian Christmas tree association, Urlaub am Bauernhof (farm holidays) and Genussregion Österreich (Region of Delight Austria). The analyses include the role of actors with regard to information, financing and coordination within the innovation processes in these examples. The analyses have been conducted as part of the European research project StarTree, between 2014 and 2016.

3. Results

3.1. Characteristics of non-timber forest products in Styria, their markets and institutional framework conditions

The NTFP portfolio produced in Styrian forests covers a wide range of species from three taxonomic kingdoms including plants, animals and fungi. Apart from forest related services, which often act as a key driver for the marketing of NTFP, the most relevant product categories in terms of economics are Christmas trees, honey, game meat and forest reproductive materials (Vacik and Wolfslehner, 2009).

The main types of products NTFP are used for include food stuff, beverages and decorative items, as identified by an expert consultation on relevant taxa (i.e. single named entities), and mainly reflect a variety of traditional use forms (e.g. mushrooms, schnapps, trophies). However, various innovative approaches have emerged recently, spanning from new products out of Swiss Stone pine (Pinus cembra) to new ways of marketing game meat, guided tours, or the revival of traditional knowledge applied for the medical use of plant- or animal-based raw material.

The majority of NTFP are niche products and are subject to local or regional trade, with only some of them being distributed at national level. The share of NTFP that are internationally traded seems to be negligible, at all for NTFP that originate from Styria. Increasing activity with respect to embedded products (i.e. NTFP as an intrinsic part of a marketed service) can be recognized in the region, typical examples being homemade products marketed together with farm holidays or guided tours or similar.

Most prominent NTFP, including several game species (e.g. Cervus elaphus, Sus scrofa), wild mushrooms (e.g. Cantarellus cibarius, Boletus edulis) and berries (e.g. Vaccinium myrtillus, Rubus fruticosus), are usually harvested in the wild and thus originate from semi-natural forests. Christmas tree production is commonly executed on plantations and dominated by a single tree species (i.e. Abies nordmanniana). The number of forest owners who focus on NTFP production, either by inclusion of relevant tree species or by particular silvicultural practices, is negligible. Harvesting of NTFP is executed manually and mostly by coincidence, as they are not actively managed.

In Styria, the main legal acts in force which deal with forests are the Forest Act (Forstgesetz, 1975, on national level) and the Hunting Law (on provincial level). Besides, there are no specific laws for NTFP. Game is specifically regulated in the Styrian Hunting Law (Steirisches Jagdgesetz, 1986).

In Austria, public access to forests for recreational purpose is legally acknowledged (Forest Act, 1975, Article 33) although public access is granted by law only for walking and it may be subject to certain restrictions. The right for recreational access includes picking of mushrooms or other forest fruits for personal use as long as the forest owner does not explicitly prohibit it.

In Styria (and Austria in general) a distinction is made between use for self-consumption and commercial use of NTFPs. The Austrian Forest Act allows the collection of NTFP such as fruits, seeds, mushrooms, twigs, earth or other soil constituents in small quantities. Collection of mushrooms is legally restricted by quantity (2 kg/day/person) and collection of fruits/seeds is related to the intent of the pickers. Any commercial utilisation of these products, as well as conducting or participating in collection events, is subject to the consent of the forest owner, and is subject to a penalty when done without permission (Forest Act §174). The owner is by law allowed to exclude others from any use of NTFP or to give out licences, although this is rarely implemented.

3.2. Role of innovation in NTFP development

Non-timber products are generally poorly developed, with some exemptions that may be seen in the production and marketing of Christmas trees where the majority of the domestic market is supplied by own production, and a few food products for which small markets exist, including game meat, honey, and liquor or jam from forest berries or fruits. Swiss stone pine (*Pinus cembra*) or rowan and service tree (*Sorbus spp.*) products are specific examples which are marketed.

A common characteristic which illustrates the poor development level is the semi-professional and small-scale production, meaning that it is often home-made jam, liquor, soap, etc., produced and marketed by farmers or other small producers on farmers' markets or directly from their farms or homes. In the whole field of NTFP, only a few larger producers or trading companies exist in Styria. Direct marketing by farmers is a typical business model which implies a number of tax advantages for the producers when they do it as part of their farming business. Once the business becomes the main economic activity and builds on additional employees, these incentives are lost. An institutional hindrance can also be seen in the often weak connection between producers and land-owners as the collectors/producers are not necessarily the land-owners but there are often no formal contracts.

Emerging fields which are carried by small innovations include a renewed interest in traditional food or health products, including, for instance, chestnut (Castanea sativa), resin or herbs. Another trend seems to be what could be termed "embedded products" which are combined with experiential or tourism services. Recreational services that are directly or indirectly related to non-timber products are quite well developed in Styria, for example forest pedagogics. Tourism services such as guided tours or farm holidays are sometimes related to forest products or activities, e.g. to wild herbs, berry or mushroom picking. It is expected that all of these activities that connect to new societal demands and values have high potential in the future. The central challenge in these cases is to bring together rural and urban spheres and thinking.

3.3. Innovation policies

According to the cross-sectoral nature of NTFP, a range of policies and organisations may become relevant for supporting innovations, from public and private spheres and from various market sectors. When looking at public policies, we screened sectoral policies beyond forestry and included various innovation and development policies in our analysis. The most relevant policy documents are given in Table 1.

Table 1: Policy programmes relevant for supporting innovation in NTFP in Styria

Tabelle 1: Politische Programme, die für Innovationsförderung bei Nichtholzprodukten relevant sind

Policy field	Document Name	Type of document	Year of issue	level of the policy programme
Forestry	Federal Forest Act 1975 *(Forstgesetz 1975)*	Legal act	1975/2013	National
	Austrian Forest Dialogue *(Österreichischer Walddialog)*	Policy programme	2006	National
Hunting	Styrian Hunting Act *(Steirisches Jagdgesetz)*	Legal act	1986	Regional
Regional development	National Strategic Framework Plan STRAT.AT 2007-2013 and 2014-2020 *(Nationale Strategie STRAT.AT)*	Policy programme	2007/2014	EU/National
	European Territorial Cooperation INTERACT *(Europäische Territoriale Zusammenarbeit)*	Policy programme	2014	EU level
Rural development	Austrian Programmes for Rural Development 2007-2013 and 2014-2020 *(Österreichisches Programm für die Entwicklung des Ländlichen Raums)*	Policy programme	2007/2014	EU/National
	LEADER – Regions "Land of the Swiss Stone Pine" *(Zirbenland)* and "WoodWorld Murau" *(Holzwelt Murau)*	Policy programme	2007	EU/Local
	Rural/countryside development/local agenda21 *(Landentwicklung)*	Policy programme	Since 1996	Regional
Agriculture	Region of Delight Austria *(Genussregion Österreich)* and Region of Delight "Game from Gesäuse" *(Genuss Region Gesäuse Wild)*	Policy programme / Product Label	2003/2008	National/Local
	Farmers' direct marketing association *(Gutes vom Bauernhof)*, Farm Holidays *(Urlaub am Bauernhof)*, Domestic Christmas trees (Heimische Christbäume)	Agricultural Associations	1990s	National/ Regional
Nature Conservation /Tourism	Nature Parks Austria/Styria *(Naturparke Österreich/Steiermark)*,	Association	1996	National/ Regional
	National Park Gesäuse *(Nationalpark Gesäuse)*	Policy programme	2002	National/Local
Innovation	Wood Cluster Styria Ltd. *(Holzcluster Steiermark)*	Cluster programme	2001	Regional

There are several EU-level programmes, the European Territorial Cooperation for cross-border cooperation, the National Strategic Framework Plan with a regional development focus and the Austrian Programme for Rural Development under the EU Common Agricultural Policy which also includes the LEADER instrument. LEADER is of specific importance as it is thematically open and explicitly focused on innovation support in rural areas. In the period 1999-2015 there have been two LEADER regions in Styria which specifically focus on forest and trees, "Zirbenland – Land of the Stone Pine" and "Holzwelt Murau - Wood World Murau". While Wood World Murau aims to foster the use of wood, Zirbenland fosters cooperation and development around both wood and non-wood products from the local characteristic tree "Zirbe" (Swiss stone pine, *Pinus cembra*). The region of Zirbenland is innovative in terms of wood and related products and gains profile through regional marketing, awareness raising and networking activities. They have developed new forms of use of Swiss stone pine products in the food and non-food sectors, for instance, promoting health and wellness effects of the wood, needles and cones of this specific tree species. The provincial regional/rural development programme Landentwicklung has rather limited relevance.

The Austrian Forest Act and the Styrian Hunting Law regulate forest and wildlife management and have rather indirect effects on innovation. The Forest Act provides for several subsidies to improve the economic, ecological and social value of the Austrian forests but with a rather limited scope on innovation support.

A few agricultural associations are relevant, such as the direct marketing association on farm specialities ("Gutes vom Bauernhof") and the Austrian farm holidays association "Urlaub am Bauernhof". These specific associations under the umbrella of the Chamber of Agriculture offer important services such as joint marketing and information exchange. The only forestry-specific is the Styrian association of Christmas tree producers which offers support and advice, joint acquisition as well as a label for the marketing of Styrian Christmas trees ("Steirischer Christbaum").

"Region of Delight" is a direct marketing instrument, initiated by the Federal Agricultural Ministry and implemented in cooperation with the Chambers of Agriculture, which emphasizes the importance of regional specialties and thus contributes to attractive and future-oriented regions. One of the 17 gourmet regions in Styria is an example of a forest product: "Gesäuse Wild" is producing high quality game meat. It is located in the National Park area Gesäuse and combines tourism and marketing of local products.

With the aim of a sustainable rural development and applying an integrated nature conservation approach, nature conservation policies may contribute to the development of NTFP. The Austrian Nature Parks are active in developing forest products such as liquors, jam and herbal products. Their aims are to preserve characteristic cultural landscape types through a sustainable use of local resources and to strengthen the local and regional economy by integrated land management and adding new values to traditional land uses. They promote local specialities by their label "Naturpark-Spezialitäten" (Nature Park Specialities) and offer educational services with local products embedded, e.g. guided tours, educational trails or "cooking from the meadow".

The Styrian Wood Cluster was launched under the provincial innovation programme and may contribute to non-timber innovations, however, its current strategic plan focuses on timber only. The cluster manages also the Wood Innovation Centre Zeltweg (Holzinnovationszentrum Zeltweg) which supported the LEADER region Zirbenland.

Case analysis: LEADER-Region Zirbenland

The LEADER region Zirbenland was formed by 12 municipalities in Upper Styria with the aim to focus rural development process around wood, in particular the wood of the rare Swiss Stone Pine which is typical for the region. The region was formerly part of another larger wood-oriented LEADER region ("Holzwelt Murau") and the group of municipalities had initiated already earlier a local wood-focused innovation centre ("Holzinnovationszentrum"). The crucial event to form an own region came together with a large regional exhibition ("ZirbenLand & ZukunftsGeist") in the frame of which it became clear how strong a potential of creative actors exists in the region.

In the frame of the LEADER period 2007 to 2014, the LEADER region Zirbenland invested around 6 Mio. € from LEADER itself and mobilised another 7 Mio. € from other funding sources, mostly around projects connected with the Swiss Stone Pine. Besides the use of timber, they also developed non-timber products, first of all its essential pine needle oil as well as touristic activities. The management initiated numerous cooperations, including research partners and regional actors from various sectors. A central activity was a scientific study on the pine needle oil with the University Graz, the realisation of a pine needle oil distillery in the region, a specific online shop and the creation of a range of products from this essential oil, including health, personal care and food products. At the same time a tourism marketing campaign was initiated and led to a rise of touristic overnight stays of 30%. Although the majority of activities and budget are in the field of wood, tourism and other economic sectors, the public awareness centres more on the non-timber forest products around the pine.

Figure 1: Swiss Mountain Pine product range from LEADER Region Zirbenland (source: I. Zivojinovic)

Abbildung 1: Zirbenproduktpalette aus der LEADER-Region Zirbenland (Quelle: I. Zivojinovic)

Activities in the LEADER frame are mainly cooperation projects and information services. The following themes were covered: i) wood innovations for wood processing companies in the region, ii) energy innovations with biomass district heating plants, pilot projects and start-ups, iii) research, training and education cooperations in a "learning region", iv) pine products development and marketing, v) developing potential uses of the essential oil, vi) tourism marketing, and vii) cultural archaeological projects.

This case illustrates nicely a successful application of the LEADER method and how it can be useful for NTFP. Its innovation and bottom-up principles together with the strategic and systemic approaches are the strengths which have been fully applied here. Thus the success factors can be seen in first, the provision of not only subsidies but also personnel capacities for networking and information, and second, the flexibility and openness of the instruments towards local resources, actors and initiatives.

3.4. Innovation actors

The relevant innovation actors are often related to public policies, for instance, as being the implementing organisations, or sectoral interest groups. In certain cases, the organisations are specifically formed under a programme, for instance, in the case of associations, national parks, nature parks or LEADER regions. In the following, relevant organisations are presented according to their actor type (Table 2).

Table 2: Innovation-relevant actors in the field of NTFP in Styria

Tabelle 2: Innovationsrelevante Akteure im Bereich von Nichtholzprodukten in der Steiermark

Type of actor	**Name (English translation)**
R&D and innovation support organisations	Asamer-Handler & Co (member of ÖAR Regional Consulting Ltd.)
	Styrian government, Department for land-use planning and regional development
	Styrian government, Department for agriculture and rural development
	LEADER – *Region Land of the Stone Pine / Regional Development Association Land of the Stone Pine*
	LEADER – *Region Wood World Murau*
	LEADER – *Region Southern Styria*
	Rural network association / LEADER network
	Wood Cluster Styria Ltd. and Wood Innovation Centre (HIZ)
	Joanneum Research Ltd.
	Forest + Culture Network
Interest groups	Association of Styrian Forest Land Owners
	Styrian Chamber of Agriculture
	Styrian Forest Association
	Nature Parks Styria association
	Styrian Farm Holidays network
	Styrian association of direct marketing "Goodies from the farm gate"
	Association of Styrian Christmas tree producers
	Chestnut initiative
	Styrian hunters association
	Beekeepers association
Education and training organisations	Forestry College Bruck/Mur
	Forestry training centre Pichl, of the Styrian Chamber of Agriculture
	Agricultural vocational schools *Grottenhof-Hardt, Silberberg and Raumberg-Gumpenstein*
	University of Natural Resources and Life Sciences, Vienna
Public administration	Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management
	Styrian Forest Authority
	Styrian Hunting Authority

Research, development and innovation support actors are a quite diverse set of public and private organisations, whereby research is rather limited but regional or rural development has an important role. The LEADER network and regions are prominent, together with a few consulting companies which are most often directly linked to the LEADER management. Education and training organisations are usually semi-public actors from the field of forestry and agriculture. It seems that forestry vocational training has the ability to react to new trends and demands very flexibly as their programmes include specific courses on old forest-working skills which are not commercially relevant any more (e.g., traditional wooden fences or shingles, medicinal herbs), various non-commercial themes (e.g., bird watching, caring for ants) and new trends and skills (e.g., wood gasification, hand-made cosmetics, wilderness education, green care). Their activities are often not only education as such but also awareness raising or networking. An example is the chestnut initiative (ARGE Zukunft Edelkastanie) which organises training and knowledge exchange among chestnut growers and is supported by agricultural schools in Styria. This initiative had a great impact on the development of new chestnut plantations and a flourishing local market.

The relevant interest groups are primarily from the forestry and agricultural field as the producers of NTFP are mostly farmers. Within the framework and with the support of the Chamber of Agriculture, a number of specific associations provide important support for Christmas tree producers, direct marketers and farm holiday providers. Although farmers primarily market agricultural goods, some of them also have forest products such as forest berry jams or mushrooms in their portfolio, usually in addition to their main products. Forest products have some relevance also for farm holidays as home made products are a specific asset of those touristic activities and the farm holidays organisation uses that in marketing. It is especially the Chamber of Agriculture which is relevant and active because their members are farmers. In comparison, the Association of Styrian Forest Land Owners is not actively promoting NTFP because larger forest holdings see less business opportunities in this field but rather a conflict potential (e.g. with other pickers).

Case example: Nature Park Specialities

The Austrian Nature Parks have an interest in maintaining traditional forms of land use and offer support for producers of products from the Nature Parks with the label “Nature Park Specialities” which was developed in the Association of Austrian Nature Parks and which currently includes agricultural and handcrafted food products. As some Nature Parks are strongly shaped by woodland, the idea arose to develop wild forest products in the frame of the label. Examples are cowberries [*Vaccinium vitis-idaea*], rowanberries [*Sorbus aucuparia*] and blackthorn [*Prunus spinosa*] which are made into jams, chutneys or schnapps, other examples are wild honey, oils with herbal extracts, essential oils (Swiss pine [*Pinus cembra*], spruce [*Picea spp*]) and various bouquets garnis (partly of wild harvested material), which find a use as teas or bath additives. The producers are in most cases smallholders who process and merchandise directly on their farms, at farmers’ markets, to regional food retailers and also through service points of the Nature Parks.

Figure 2: Rowan tree in Nature Park Almenland (source: Naturpark Almenland)

Abbildung 2: Vogelbeere im Naturpark Almenland (Quelle: Naturpark Almenland)

A possibility to implement the idea was found in the framework of the European FP7 research project StarTree and in the form of action research which was implemented by the regional development consultant M. Asamer-Handler. After presenting the idea and possibility to the 48 Austrian Nature Parks, three Parks were interested to join, each with their own specific focus. Those initiatives started from the specific situations and interests of each Park and developed their own specific activities. The following two initiatives were in Styria:

1. Project "Colourful hedges and edges of woods": In the Nature Park Almenland, there existed already an initiative to promote the planting of certain local trees and shrubs such as rowanberry and blackthorn in private gardens in order to replace exotic species. In the project, this idea shall be expanded to planting the colourful trees at forest edges as the fruits can be used by farmers and small processors of the region for producing rowanberry Schnapps and other products. At the same time, the project shall make the landscape (even more) attractive and thus serve tourism.

2. Business plan for a merchandising enterprise: In the Nature Park Südsteiermark, two options for establishing a merchandising and promoting business for the local "Nature Park Specialities" were assessed in the frame of a business plan. Currently, 25 producers market their products under the label, one third being wild forest products, especially herbs. This enterprise was intended to serve as a hub for combining the scattered production. From the two options i) of establishing an own shop with an assortment of products with a long shelf life (jams, syrups, liquors, herbal teas, etc.) targeting at tourists, and ii) to supply local shops, hotels, restaurants and wineries with a variety of durable products on special shelves, the first was eventually selected because a suitable locality was available and a carrier was found to run it.

In this case example it is interesting that the initiative comes from outside the sector, namely from nature conservation which aims at an integrated sustainable development of the rural cultural landscape in the Nature Park areas. With this external impulse and the accompanied support, the local resources, traditions and creativity are bundled into innovative activities and product development. With a fairly restricted budget but a well-directed support quite significant outputs have been achieved in terms of business activities and regional value added. The success factors lie in the institutional support by the Nature Parks Association, an external consultant, and an international research project on the one side, and in the applied bottom-up approach of the consulting service on the other.

4. Discussion and conclusions

4.1. Innovation support

How are innovations in NTFP supported by innovation systems? We learn that – although the products go far beyond the forestry sector – it is still the forestry, agricultural and rural development policies which seem most relevant for non-timber innovations. Their influence, however, is limited as NTFP are not in their specific focus. The precondition for their relevance lies in their innovation-orientation and in their openness across product types and activities. We furthermore see that the relevance of policies strongly goes along with a regional or local level of implementation: it is regional level initiatives within larger level frameworks (e.g., agricultural associations of the Chamber of Agriculture) or locally or regionally implemented (national or EU) policies (e.g., LEADER regions) which have the greatest relevance.

When looking at the relevant actors, their sectoral allocation is confirmed: forestry training schools, agricultural interest groups and LEADER regions´ organisations are the most prominent ones. Many other major policies or actors from the forestry or agricultural field, however, do not have NTFP specifically in their focus: The main forestry policies, education curricula or research programmes hardly touch on them and with the exception of the Christmas trees association and the chestnut initiative, the agricultural actors have no specific awareness on products with a forest or wildland origin. Although we have found a number of policy programmes and actors which are relevant for NTFP, for the most part they do not focus on or explicitly include the forest products – these are only implicitly part of their scope. The reported case studies of the LEADER region and the Nature Park Specialities are among the rare exceptional examples.

An interesting issue is the position of the forest land owners' organisations. As they primarily represent larger forest holdings (i.e. property size >200 ha), they find themselves in an ambivalent role. Although a number of forest companies in Austria quite actively pursue non-traditional non-timber activities such as various tourism, sports or other recreational activities as well as renting out land or buildings, for many land owners non-timber activities rather mean conflicts as these are often done by other users. They are therefore hesitant with promoting such opportunities which are rather used by others than the land owners. NTFP are in fact often collected in forests without specific contracts between the pickers and the land owners. Hunting and game is an exception for hunting being a traditional forestry activity and there are always strict contracts between land-owners and hunters. In fact, many conflicts that are related to tourism or NTFP are with the hunters. Land-owners then support the hunters since they are paying for their contracts.

4.2. Institutional barriers

Besides of the supporting policies, it is difficult to determine institutional barriers because they are not so visible. An indirect barrier is found in the fact that non-timber forest products are a side-activity of any relevant sectors which leads to a "blindness" of the institutional system towards these products: a lack of statistics, specific research, education and training programmes and focussed support structures are the result. The Styrian wood cluster organisation, for instance, does not explicitly include those products into their activities. Together with a general lack of effective innovation support in the forestry sector (Rametsteiner et al. 2005), this neglect of NTFP adds to what can be called a "double blindness" of the institutional system towards the development of NTFP. The cross-sectoral characteristics of many of these products seem to be furthermore the reason for direct barriers because of a competition between the involved sectors – forestry, agriculture and nature conservation (Buttoud et al., 2011). The forestry sector seems to be hesitant in supporting activities which may benefit other groups than the land owners – these products are often for the benefit of processing companies, conservationists or the general public.

4.3. Bottom-up innovations

As a result, it can be said that there is no "one" sectoral innovation system supporting non-timber products but support is given through certain programmes from several sectoral innovation systems, including forestry (Christmas trees), agriculture (LEADER, Farm Holidays, chestnuts and the Regions of Delight) and nature conservation (Nature Park Specialities). For none of them, "non-timber forest products" are a central or significant field of activity as such which implies that no specific knowledge, instruments or promotion activities are developed and that it is not easy for interested innovators to receive support. This is only achieved, once they reach a certain institutionalisation such as with the Christmas tree association, chestnuts initiative or the LEADER region "Zirbenland" which as a whole took the Zirbe (Swiss Mountain Pine) as a trademark symbol. Non-timber innovations are typically generated from bottom-up in small, regional and often cross-sectoral "ad-hoc" networks (Kubeczko et al., 2006).

The range of Styrian examples show that despite of the lack of specific sectoral innovation systems, the institutional system still has certain structures that are able to offer support – if they are open and flexible enough to pick-up emerging demands from practice. They also show that for establishing new products beyond single firms, the innovators often have to institutionalise themselves through which the innovations gain an institutional dimension (Ludvig, Corradini et al., 2016).

The two detailed examples analysed in this paper are show-case examples where the institutional system was able to give substantial and systemic support to local creativity and capacities. Both, the product development in the Nature Park Specialities and the regional strategy development in the Zirbenland LEADER region combined a structured and expert-led process with an active involvement of local actors' needs and views. With this it becomes the ideal regional innovation system as described in Asheim's "regionally networked innovation systems" (Asheim, 1998), or Cooke's "networked regional innovation system" (Cooke, 1998).

4.4. Need for flexibility and openness in innovation support

When actors and support organisations are grouped according to types of organisations, most actors in Styria belong to interest groups, innovation support organisations and to research, education and training organisations. They are mostly regional level organisations. This observation goes along with the fact that the products are often of specific regional relevance. An important policy implication thus is that sectoral support programmes should provide for sufficient leeway to flexibly adapt to local products or other local specific needs, if not specifically focusing on new approaches and innovations as such. In order to gain more ideal type examples in the form of Asheim's "regionally networked innovation systems" as described in the two cases the model for innovation support could be regarded "top-down support for bottom-up innovations". This conclusion is supported by further case studies from other European countries, studied in the same research project (Weiss et al., forthcoming-b).

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Methodological considerations and their application for evaluation of benefits from the conversion of even-age secondary Norway spruce stands into mixed uneven-aged woodlands with a focus on the Ukrainian Carpathians

Methodologische Überlegungen und deren Anwendung zur Evaluierung von Vorteilen der Umwandlung von gleichaltrigen sekundären Fichtenbeständen in gemischte ungleichaltrige Waldbestände am Beispiel der Ukrainischen Karpaten

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Keywords: forest ecosystem services, DPSIR conceptual model, extended cascade model, Wilcoxon signed-rank test, cost-benefit analysis, impact matrix of forest conversion

Schlüsselbegriffe: Wald-Ökosystemleistungen, DPSIR-Modell, erweitertes Kaskadenmodell, Wilcoxon-Vorzeichen-Rang-Test, Kosten-Nutzen-Analyse, Wirkungsmatrix, Waldumwandlung

Summary

This paper examines the integration of three approaches towards developing a transdisciplinary framework for the evaluation of benefits from the conversion of even-aged secondary Norway spruce stands into mixed uneven-aged woodlands. To pre-

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sent a whole nexus of causal relationships in social-ecological interactions inherent for the conversion processes in a systemic and condensed way and to provide a common point of reference for decision-makers we develop a conceptual model based on the DPSIR (Driving forces – Pressures – States – Impacts – Responses) approach. The Ukrainian Carpathians are used as a case study. An extension of the cascade ecosystem service model through integration of societal processes is proposed to strengthen the functionality of the model and to make it more applicable for addressing adaptive forest management and ecosystem-based forest governance. A non-parametric analysis of the stated stakeholders' preferences with a high statistical significance shows that the flow of ecosystem services from mixed forests is considered more valuable than that from spruce monocultures. For the valuation of benefits from forest conversion we propose an impact matrix that reflects existing dichotomies both in valuation techniques and among beneficiaries. This matrix could serve as a checklist for an appraiser. We conclude that a proper integration of several methodological approaches may assist researchers to overcome limitations of a narrow disciplinary perspective, to take advantages of quantitative as well as qualitative research methods and may allow a wider involvement of stakeholders in a more participatory decision-making in order to tackle the challenge of spruce stands decline.

Zusammenfassung

Dieser Artikel untersucht die Integration von drei Ansätzen die das Ziel verfolgen eine transdisziplinäre Perspektive in den Entscheidungsfindungsprozess bezüglich der Umwandlung von gleichaltrigen sekundären Fichtenbeständen in gemischte, ungleichaltrige Waldbestände zu bringen. Im Interesse einer ganzheitlichen Betrachtung wird ein konzeptionelles DPSIR-Modell (treibende Kräfte – Belastungen – Zustände – Auswirkungen – Reaktionen) am Beispiel der ukrainischen Karpaten vorgestellt. Um Interdependenzen zwischen biophysikalischen Strukturen wie Wald / Waldlandschaften, Prozesse innerhalb dieser Strukturen, Funktionen und Dienste, die menschlichen Leistungen und Werte, sowie Komponenten von Politik und Verwaltung der analysierten sozial-ökologischen Systeme darzustellen, wird ein erweitertes Kaskadenmodell vorgeschlagen. Dieses Modell integriert Elemente, die Politikentwicklungsprozesse beschreiben, in ein Wald-Ökosystemleistungen-Kaskadenmodell. Dadurch wird die Funktionalität des Modells und seine Anwendbarkeit für die adaptive Bewirtschaftung von Waldökosystemen verbessert. Die monetäre Bewertung der Effekte einer Waldumwandlung wird im Sinne einer Kosten-Nutzen-Analyse vorgenommen. Es wird vorgeschlagen, einen Matrix-Ansatz für die Identifizierung der Vorteile des Umwandlungsprojektes anzuwenden. Die Wirkungsmatrix der Waldumwandlung basiert auf der Literatur sowie auf einer Befragung von Interessensgruppen bezüglich ihrer Wahrnehmung von Ökosystemdienstleistungen, die von gemischten bzw. von Reinbeständen bereitgestellt werden. Es erlaubt den Umfang von bestehenden Dichotomien zu erfassen. Mit Hilfe der vorgeschlagenen Kombination von Methoden kann in einer

ganzheitlichen und kompakten Weise eine Reihe von kausalen, sozial-ökologischen Beziehungen bzw. Wechselwirkungen, die den Umwandlungsprozessen inhärent sind, aufgezeigt werden. Eine derartige Integration mehrerer methodischer Ansätze kann hilfreich sein, um die Grenzen einer engen disziplinären Perspektive zu überwinden und eine stärkere Einbeziehung von Stakeholdern in die Entscheidungsfindung betreffend Waldumbau zu ermöglichen.

1. Introduction

Multifaceted challenges caused by environmental and social changes (MA, 2005) put at a threat a time-proven, traditional forest management. Recent investigation of climatic, biological and geochemical indicators of human activity impact (Waters et al., 2016) suggest that the era since the mid-20th century should be recognised as a geological epoch distinct from the Holocene. A more holistic framework instead of a narrow commercial vision has to be developed and adopted in the Anthropocene context to manage forests more effectively and efficiently in conditions of transcending planetary boundaries (Rockström et al., 2009; Steffen et al., 2015).

Mounting losses of forest ecosystems' resilience and productivity in the Ukrainian Carpathians root in transformations that occurred in the region during the 19th century, when 178000 ha of native beech (*Fagus sylvatica* L.) and mixed coniferous-broadleaved forests were converted, for commercial reasons, to Norway spruce, (*Picea abies* (L.) Karst.). Norway spruce was native to the region, but it was too intensively planted all over the place, using non-local genetic varieties (Krynytskyy and Chernyavskyy, 2014; Keeton and Crow, 2009).

Nowadays, under changing climatic conditions and increasing pressure of human praxis, such modified forest ecosystems have been rapidly losing their vitality and resistance against destructive abiotic and biotic impacts (Stoyko, 1998; Klimo et al, 2000; Spiecker et al., 2004). These changes have been undermining welfare of local communities and prosperity of the whole fragile mountain region (Krynytskyy et al., 2014; Soloviy, 2011; Soloviy and Melnykovych, 2014). At the present time a decline of secondary Norway spruce forests is made visible on the area of 19300 hectares of forest (3% of whole spruce in the Ukrainian Carpathians) with a wood volume near 6 million m^3 (Parpan et al., 2014).

Conversion of an even-aged secondary Norway spruce into uneven-aged mixed stands in the Carpathian Mountains, as in whole Central Europe, is internationally thought as a main challenge of recent mountain forest management and an effective way to tackle the abovementioned problems (Spiecker et al., 2004; Wolfslehner et al., 2005; Vacik et al., 2007; Soloviy et al., 2011; Lavnyy and Schnitzler, 2014; Krynytskyy and Chernyavskyy, 2014). Furthermore, conversion becomes internationally recognised as a necessary precondition for sustainable forest management and the well-being of forest-dependent communities (Bravo-Oviedo et al., 2013; Zahvoyska, 2015).

According to experts' estimations the conversion process induces a broad range of benefits, namely:

- Higher resilience and resistance of forest ecosystems to natural and anthropogenic disturbances and their better adaptation to climate change (Parpan et al., 2014; Soloviy et al., 2011; Roessiger et al., 2013);

- Increase of biomass productivity of forest ecosystems: in mixed stands of Norway spruce and European beech a forest stand productivity increases on average by 20% in comparison with pure stands of the same species (Piotto, 2008; Pretzsch et al., 2014);

- Better resistance to a drought (Merlin et al., 2015);

- Improved soil conditions (Brandtberg et al., 2000; Prescott, 2002);

- Reduced risk of landslides, windfalls (Schutz et al., 2006) and fires (Gonzalez et al., 2006);

- Improved hydrological regime and increased water supply (Kulchytskyy-Zhyhaylo and Kulchytska-Zhyhaylo, 2011);

- Reduced risk of pathogens' impacts (Parpan et al., 2014);

- Enhanced biodiversity and improved habitats for biodiversity (Lindenmayer and Hobbs, 2004; Carnus et al., 2006; Krynytskyy et al., 2014);

- Increased recreational value and personal perceptions of mixed forest landscapes (Grilli et al., 2014; Grilli et al., 2016) and a higher value of a neighbour real estate;

- Decreased financial risks due to forest species diversification (Hildebrandt and Knoke, 2009; Roessiger et al., 2013) etc.

However, the main difficulty associated with an assessment of benefits from the conversion process lies in the nature and features of these benefits. In a recent discourse of economic analysis of forest projects, the ecosystem services concept (MA, 2005; TEEB, 2008) is widely thought as the most relevant framework for identifying the benefits associated with a conversion project. However, the implicit nature of a significant part of forest ecosystem services (FES), non-rival and non-excludable in terms of ecological economics (Daly and Farley, 2010), causes market failures, resulting in the incapacity of a market to signal their scarcity and to provide market incentives to regulate their supply (Nijnik and Miller, 2014) or to adjust production and consumption to planetary boundaries (Steffen et al., 2015) and limited carrying capacity of the global ecosystem (Daly and Farley, 2010). This also makes it impossible to measure part of the FES value by means of traditional market instruments (Gregersen and Contreras-Hermosilla, 1992; Zahvoyska, 2014). Therefore, in the case of a market failure, economic valuation has the function to inform about all costs and benefits accruing to people now and in the future, and to enable decision-makers to reduce external costs and to maintain provisioning of public goods to the optimal extent, maximising human welfare taking into account all relevant costs and benefits (Grunewald and Bastian, 2015).

On the other hand, costs of the conversion are quite explicit. More intensive financial investments over a conversion period of around 100 years with a questionable commercial return in a long time perspective prevent a dissemination of this practice. The simulation of conversion strategies for a 62-year even-aged secondary spruce site located in Transcarpathian region of the Ukrainian Carpathians (the State Enterprise „Rakhiv forestry“) using the growth simulator SIBYLA (Fabrika, 2005) revealed, that only the conversion strategy with an intensive target-diameter harvesting for spruce and selection thinning for beech and fir allows us to obtain a target (or native) trees species composition: 70% of spruce and 30 % of beech, and fir and sycamore with a sufficient diversity in terms of height and diameter (Pelyukh et al., 2016). Conversion means significant losses in increment and standing volume. Thus a trade-off between market and non-market values and between ecosystem services themselves in a long-term perspective brings additional difficulties into forest decision-making (Nijnik et al., 2012, Martín-López et al., 2014; Mosert et al., 2009; Rößiger et al., 2011; Rößiger, 2014).

As we see from the abovementioned simulation and from the scientific literature (Hanewinkel and Pretzsch, 2000; Krynytskyy and Chernyavskyy, 2014), possibilities to obtain a rich structure diversity on an initially even-aged forest stand using only “structuring measures” are limited. A success of a conversion strategy implementation highly depends on the quality of regeneration. Conversion strategies need more skilled design and implementation as well as monitoring under climate-changed and climate-changing conditions. A highly nonlinear behaviour of (forest) ecosystems, which demonstrate a weak response until they transgress the thresholds and their collapse becomes obvious and unavoidable (Scheffer et al., 2015), aggravate uncertainty and put a conversion dilemma into the focus of adaptive forest management.

Taking these reflections into consideration, the main objective of this paper is to review and advance existing approaches to identify and evaluate benefits from the conversion of secondary even-aged Norway spruce stands into mixed uneven-aged woodlands taking the Ukrainian Carpathians as a case study. A proper integration of analytical and participatory techniques as well as visualization tools is suggested for developing a holistic transdisciplinary framework for assessing the efficiency of forest conversion projects.

2. Material and Methods

To develop a transdisciplinary framework for evaluation of benefits from the conversion of even-aged secondary Norway spruce stands into mixed uneven-aged woodlands we propose to begin with three approaches: (1) systemic and holistic DPSIR approach (Driving Forces-Pressures-States-Impacts-Responses) to understand and communicate causal relationships in social-ecological interactions related to the conversion processes; (2) the ecosystem services approach to grasp and discover the fundamental link between biophysical structures like forest ecosystems or landscapes, human wants and needs and forest governance and (3) a framework of pure economic analysis of cost and benefits of the conversion projects in order to introduce a monetary perspective. The application of these approaches should answer such questions as "What should be considered in the framework and why?" The answer will suggest us relevant approaches and methodology to be used for the evaluation.

2.1. Evaluation of benefits from the conversion process using DPSIR approach

The DPSIR framework was developed by the Organization of Economic Cooperation and Development (OECD, 1993) and the European Environmental Agency (EEA, 1995; EEA, 2007; EEA, 2013) as one of the original tools for adaptive management of social-ecological systems (Carr et al., 2007; Kagalou et al., 2012; Binder, 2013; Gari, 2015). This framework focuses on such aspects as Driving forces, Pressures, States, Impacts and Responses and postulates causal chains of links between them. Designed as a reporting framework (Eurostat 1999; Smeets and Weterings, 1999), the DPSIR approach is increasingly used as a decision-support tool to structure and condense a complex and diverse information into sets of indicators to track and analyse ongoing processes and to build quantitative models. The DPSIR model allows a researcher to reveal and understand in a holistic way the causal relationships in interactions between society and the environment and is sufficiently broad to allow a formalization of the whole procedure of decision making in the context of adaptive forest management (Chipev et al., 2008).

DPSIR indicator models serve as a reliable instrument and database for analytic hierarchical or network models for multicriteria decision-making (Wolfslehner et al., 2005; Vacik et al., 2007). In return, conceptual models usually are designed to disclose fundamental principles of processes or systems under consideration and to provide a common point of reference for model users.

Problems of secondary Norway spruce decline in the Ukrainian Carpathians are intensively examined in forestry literature (Stoyko, 1998; Kramarets and Krynytskyy, 2009; Krynytskyy and Chernyavskyy, 2014; Lavnyy and Schnitzler, 2014) whereas interdisciplinary investigations and stakeholders' involvement, essential for adaptive forest management (Holling, 1978), are weak and rare.

To fill this gap and synthesize a mosaic of disciplinary and stakeholders' perspectives into a holistic transdisciplinary view of conversion, relevant processes in social-ecological systems should be analysed integrating the DPSIR approach into the conceptual model of these systems coevolution. Such conceptual DPSIR model will explain a basic logic of social and ecological systems interaction and their interdependences, considering these processes from stakeholders' perspectives. Such model should allow an identification of driving forces, conflicts and synergies among stakeholders and facilitate their co-learning and co-search to tackle challenges in a sustainable way. To apply this model a real nexus of forestry-social-economic problems in the Ukrainian Carpathians was analysed by synthesising current knowledge and information out of dialogues with stakeholders.

2.2. Evaluation of benefits from the conversion process using the ecosystem services approach

The ecosystem services approach is increasingly applied to link biophysical structures like forest stands and landscapes with human well-being. Conceptualisation and classification of ecosystem services, originated by Costanza (1997), Daily (1997) and De Groot (2002), were enhanced in the MA (2005) and TEEB (2008) reports, further reassessed by Boyd and Banzhaf (2007), Costanza (2008), Fisher and Turner (2008), Fisher et al. (2009; 2011), Haines-Young and Potschin (2009; 2012); TEEB (2010; 2015), Gómez-Baggethun et al. (2010), Chaudhary et al. (2015), Daw et al. (2016) and many others. The value of multiple ecosystem services was conceptualised and valuation methods were analysed at appropriate scales. Knowledge of non-market valuation now has been extended (Krutilla, 1967; Gregersen et al., 1995, Hanley and Spash, 1998; TEEB, 2010; Costanza et al., 2014) and provides a solid background for operationalising ecosystem services.

However, a broad interdisciplinary scope of the ecosystem services framework predetermines a variety of their interpretations and classifications of ecosystem services per se (Daily, 1997; Costanza, 1997; 2008; MA, 2005; TEEB 2010; Fisher et al., 2009; Haines-Young and Potschin, 2009). Understanding of ecosystem services as ecosystems' contribution to human well-being (Fisher and Turner, 2008; Fisher et al., 2009; CICES, 2013) provided us with a proper framework for unambiguous identification and evaluation of the conversion process benefits. To avoid an ambiguity and a double counting in the ecosystem identification and valuation (Fisher et al., 2009; Haines-Young and Potschin, 2009) and to ensure a comparability of research we applied a trinomial hierarchical classification of ecosystem services as proposed in (CICES, 2013).

The ecosystem service cascade model (Potschin and Haines-Young, 2011; Potschin et al., 2016) serves as a comprehensive framework for the identification of the links between ecological and social systems, which co-evolve at a range of spatial and temporal scales. This model reveals how changes in biophysical structures and processes within them cascade through ecological and social systems and result in subsequent changes in multidimensional human well-being.

However, the full cycle of ecosystem services generation and management remains unrevealed in the model (Spangenberg et al., 2014). To include a variety of societal processes into the cascade model we propose a backward link in order to explain how stakeholders' knowledge, perceptions, values and the prices cascade through the decision-making process and shape environmental policy, governance and institutions, which, in turn foreshadow the ecosystems' structure and quality (Zahvoyska, 2014).

To develop adaptive management of secondary Norway spruce stands it is important to understand stakeholders' perceptions of FES generated by pure vs. mixed forest stands to be able to identify relevant synergies and conflicts. With this aim we prepared a comparative questionnaire, based on the ecosystem service framework. This questionnaire consists of three sections: the first section includes questions about professional background of a respondent; the second section is dedicated to a respondent's assessment of the FES importance; and the third section deals with a comparative evaluation of the quality of FES provided by pure vs. mixed stands. To scale these values our respondents were asked to refer to a 5-point Likert scale (the higher value means the higher importance). CICES classification of ecosystem services (CICES v. 4.3) was applied in our questionnaire because it provides a researcher with a precise interpretation of FES essence and ensures comparability of the research results.

The survey was conducted in the Ukrainian Carpathians, a part of the Eastern Carpathians, namely in Lviv and Ivano-Frankivsk regions, which are featured by a high forest cover (app. 40%). The absolute height of the mountain system ranges from 120-400 m near the foothills up to 1500-2000 m along the main ridge. There is a temperate continental climate with a relatively high level of precipitation: 500-800 mm in the foothills and up to 1600-2000 mm on the highest ridges. Altitudinal landscape differentiation is clearly expressed: from deciduous (sessile and pedunculated oak (*Quercus petraea*, *Quercus robur*), beech (*Fagus silvatica*), sycamore (*Acer pseudoplatanus*) and hornbeam (*Carpinus betulus*)) to coniferous forests (Norway spruce (*Picea abies*) and silver fir (*Abies alba*)). An average altitude of a treeline is 1376 m asl, usually it is formed by spruce and beech forests in almost equal proportions (52% and 48%, respectively) and is related mainly to human activity (Sitko and Troll, 2008).

We approached two groups of stakeholders: Scientists and Forestry enterprise employees. The Scientists group was represented by researchers from the Ukrainian Research Institute of Mountain Forestry (Ivano-Frankivsk) and the Ukrainian National Forestry University (Lviv). Both institutions are closely related and have an intensive scientific collaboration.

The Forestry enterprise employees group was represented by a staff of the State Enterprise "Skole Forestry" (Skole, Lviv region) and the Municipal forestry enterprise "Halsillis" (Pustomyty, Lviv region). Both forest enterprises are located in Lviv region, but have a bit different ecological and economic conditions. The State Enterprise "Skole Forestry" is located in a mountain area, where secondary spruce forests dominate, while the Municipal Forestry Enterprise "Halsillis" is located in plain area, where oak and pine forests are common. However, in both areas a phenomenon of spruce and pine dieback occurs. Therefore, employees from both enterprises face the necessity and have some experience in forest conversion.

From an economic point of view, both enterprises operate in strained circumstances because of long-term market and institutional transformations as well as a hybrid war, which takes place in Ukraine. However, the State Enterprise "Skole Forestry" operates in a less developed economic region than Municipal Forestry Enterprise "Halsillis". Even average salary in Skole district is approximately 15% higher. An integrated assessment which involves soft and hard indicators ranks Pustomyty district in the very top position among 20 districts of the Lviv region, whereas Skole region was placed near the end of this list at the 17th position (Lviv, 2016).

Collected data regarding stakeholders' perceptions of importance and quality of FES provided by pure vs. mixed stands were elaborated using nonparametric methods, namely the Wilcoxon signed-rank test (Lowry, 2014), to check a statistical significance of the evaluations.

2.3. Evaluation of benefits from the conversion process using the economic approach

To gain insight into the process using a monetary dimension of the conversion benefits we analysed current economic approaches, elaborated by international schools of environmental economics such as cost-effectiveness and cost-benefit analysis (CBA). Cost-effectiveness analysis is often used in the field of public goods and focuses on identifying the best alternative (the cheapest option) to achieve the goal. It avoids a valuation of benefits if this exercise is inappropriate or non-straightforward (Layard and Glaister, 1996; Callan and Thomas, 2013; Tuominen et al., 2014). Thus, this is a rather fair technique in application, but the main question of the assessment "Does the conversion process pay?" is still left unattended.

Methodology of CBA is rather sophisticated. It is theoretically well grounded and has a long history and broad scope of application (Gregersen and Contreras-Hermosilla, 1992; Layard and Glaister, 1996; Hanley and Spash, 1998; Pearce et al., 2006; Cubbage et al., 2013; Sartori et al., 2014 etc.). It is an analytical tool for discovering attractiveness of an investment decision from the investor and society perspectives by comparing costs and benefits attributable to the proposal. The logic of the economic appraisal is presented in Fig. 1.

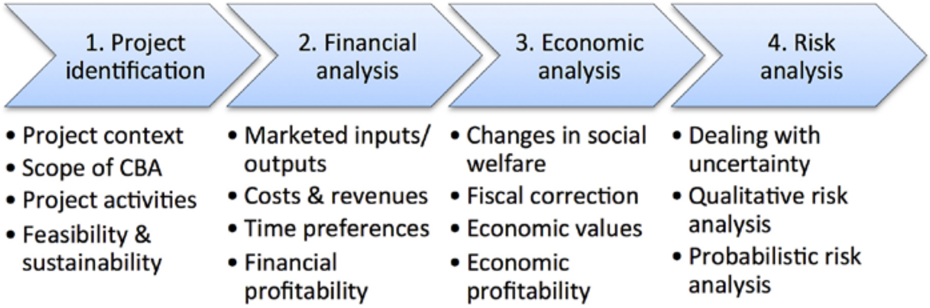

Figure 1: Main steps of cost-benefit analysis

Abbildung 1: Die wichtigsten Schritte der Kosten-Nutzen-Analyse

The analytical framework of CBA refers to a list of principal concepts as the total economic value (Krutilla, 1967) and opportunity costs, time preference rate and its social value, monetary indicators of economic performance and uncertainty. Relevant multidimensional welfare changes and associated economic values create a central focus of CBA.

Forestry projects constitute a special case of CBA because of features of forestry projects and difficulties in valuation of benefits, attributable to the proposals. These benefits often are public goods (pure or mixed), priceless but essential for human well-being. Therefore, FAO pays special attention to the economic assessment of forestry project impacts and the application of valuation methodology (Gregersen and Contreras-Hermosilla, 1992; Gregersen et al., 1995). The extensive body of literature on application of valuation techniques in forest project assessment (Gregersen et al., 1995; Hanley and Spash, 1998, Pearce et al., 2006; TEEB, 2010; Haines-Young and Potschin, 2009) proposes a variety of approaches and case studies, but at the same time stresses difficulties and pitfalls of economists' intention to assign a market price to priceless items.

A major drawback of CBA methodology is that it takes into account only those costs and benefits which have a monetary value. For long-term forest projects that have a significant impact on the environment and welfare of society, it is not easy to meet these requirements. CBA is reasonably criticised because of its fail to address multifaceted dimensions of human well-being, a whole continuum of values and the objective implications of spatio-temporal framing (Wegner and Pascual, 2011).

Over the last four decades environmental economists have taken significant steps in developing methods for the monetary valuation of benefits from improved environmental quality. Extensive databases of valuation case studies, their critical overviews and high volatility highlight the importance and complexity of the task and, as a result, raise questions about the validity of the CBA profitability indicators. For instance, recent estimations of economic damages from an additional ton of carbon dioxide emitted in 2015 varies from 37 $ worth of economic damages (US government estimation) to 220 $ according to Moore and Diaz (2015). Another example is a prediction of changes in carbon sequestration for converted mixed conifer/broadleaved stands under two models that diverge significantly (+29.4 tC ha^{-1} and –10.6 tC ha^{-1} in PICUS and 4C models respectively) (Seidl et al., 2008). Thus, an exhaustive sensitivity analysis should be conducted to reveal merits of a conversion project taking into account a specific forestry, social and economic context of a project.

Special care in CBA appraisal has discounting. Nijnik and Pajot (2014), Schiberna et al. (2012) showed that choice of a discounting rate has a significant influence on a forest decision-making, inquiring the CBA framework. A standard exercise in the financial analysis aimed in a reassessment of future values from today's perspective becomes challenging in the economic analysis: a loss of ecosystem capability and a strong reduction of ecosystem services flows suggest us a completely opposite approach and raises a question of a zero or even negative value of a social discount rate (Layard and Glaister, 1996). But such arguments have rather moral character than a practical application. Even though a relatively low interest rate of 2% cannot compete with other investment alternatives, it allows real and low-risk long-time investment attractiveness for certain types of investors and justifies forest projects with multidimensional long-term changes in human well-being. In addition, the sensitivity and risk analysis give us analytical tools for testing these assumptions and profitability indicators' sensitivity to changes in underlying hypotheses and shadow values.

Summarising these reflections, we should say that for a holistic, comprehensive evaluation of the conversion projects across different scenarios and contexts a universal framework should be developed to ensure that a whole range of impacts is considered (including positive and negative externalities), none of the stakeholders is forgotten, nothing important is omitted (TEEB, 2015). The four-capital frame of ecological economics (Daly and Farley, 2010) could serve as a reliable background for these purposes. The framework should be robust for business purposes and policy development and should be reliable for comparisons and resource allocation.

3. Results

3.1. DPSIR conceptual model of the conversion process

DPSIR conceptual model of the conversion process was developed to analyse existing interactions between social and ecological systems, namely mountain forest ecosystems in the Ukrainian Carpathians socio-economic context. Based on the literature review and dialogues with stakeholders, we identified three groups of driving forces: natural, socio-economic and institutional (Fig. 2).

Among natural drivers we stress global climate change and a complex nature of both social and ecological systems. According to Sitko and Troll (2008), in 2001 an average timberline elevation in the Carpathian Mountains was 1376 m asl, that is 47m higher than in 1933. Authors state that spruce forests reached, on average, 80 m higher than beech forests. Recent investigations of climate change in the Carpathians, conducted by Hlásny et al. (2016), predict a strong exposure of the region to climate change. One of two hot-spots, identified by these scientists for the Ukrainian Carpathians, is located in Lviv region near the border with Poland and reaches 60% of the maximum permissible change. According to the research, this change will be followed by the highest change for the whole Carpathians in a number of cumulative dry days by 42% and a decrease of precipitation during the growing season by 12%. For another hot-spot, predicted in the south-west region of the Ukrainian Carpathians, the projected changes are severe as well: 58% of the maximum permissible change, growing season length will increase by 33%, total number of days with maximum daily air temperature exceeding 30°C will increase by 26% and total precipitation decrease will reach 19%. In this water-limited and temperature-increased environment the secondary Norway spruce monocultures will lose significantly their resilience. They will be much more sensitive to destructive biotic and abiotic impacts compared to forests consisting of species better adapted to the ambient conditions (Stoyko, 1998; Klimo et al., 2000; Spiecker et al., 2004).

The synergetic nature of social and natural systems and processes within them is another decisive driving force in the systems co-evolution (Fig. 2). Synergetic systems are featured by a relatively simple behaviour of their elements compared to emergent/adaptive behaviour of the whole system they constitute (Camazine et al., 2003; Epstein and Axtell, 1996; Holling, 2001). Under constant operating conditions some relationships between the systems' elements may remain latent for a long time. Only in the case of threshold crossing these relations give rise to unexpected system behaviour that may occur as a system adaptation or self-organization, non-predicted shift to a new state, or a new way of functioning (Scheffer et al., 2015). Emergent behaviour of a synergetic system can be explained by its hierarchical organization, a positive and negative feedback, its capacity for processing information about the environment and ability to adapt to new conditions. The phenomenon of dynamic complexity of ecosystem processes (Costanza, 2008; Fisher et al., 2009) reflects our ignorance on the systems and, consequently, our limited understanding of co-evolution of social and ecological systems (Daly and Farley, 2010). Risk of approaching a deleterious tipping point should keep us in a safe operating space to avoid unwanted shifts in regimes of socio-ecological systems functioning (Rockström and Karlberg, 2010).

Considering social-economic drivers in the case of the Ukrainian Carpathians, we should first of all mention a globally-relevant misperception and underestimation of the vital role that (forest) ecosystems play in human well-being and lack of understanding of a complex nature of both systems (Fig. 2). Thus changes in a forest resource use become increasingly destructive and non-reversible. Additionally, a high unemployment rate and a low level of income per capita, especially in the mountain regions of Ukraine, force local stakeholders to non-sustainable forest practices (Soloviy and Melnykovych, 2014).

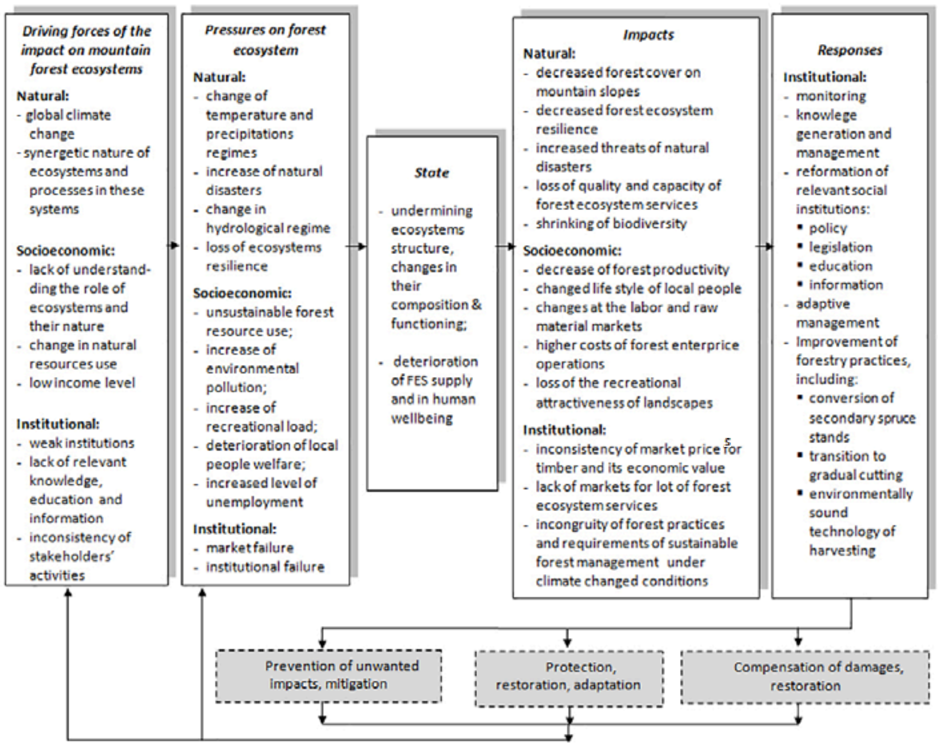

Figure 2: Conceptual DPSIR-model of interactions between society and forest ecosystems in the Ukrainian Carpathians: a conversion project perspective

Abbildung 2: Konzeptionelles DPSIR-Modell der Wechselwirkungen zwischen Gesellschaft und Bergwaldökosystemen in den ukrainischen Karpaten: eine Waldumwandlungsprojekt-Perspektive

As regards the analysis of institutional driving forces we should begin with a weakness of public society institutions, lack of transparency and a strong corruption, which push Ukraine into a low-efficiency trap. One more important, globally-relevant driver is a lack of education for sustainable development. Traditional practices are to be questioned in face of changing climatic conditions, (forest) ecosystems decline and resource scarcity. But the content of education (Farley et al., 2009) and vocational training both formal and non-formal does not tackle these challenges in a comprehensive way yet. This is especially acute to forestry education and vocational training: climate change and anthropogenic pressure demands adaptive decisions to embrace uncertainty of coming events and to disseminate a successful experience including for the conversion projects.

A strong focus on short-term financial interests of business and local stakeholders conflicts with a long-term perspective of the secondary Norway spruce conversion benefits, making them unattractive from a macroeconomic perspective of resource allocation. Gaps in communication of conversion project goals and benefits to local stakeholders fail to initiate adaptive governance in the region (Zahvoyska et al., 2015). Discrepancy and lack of coherence in stakeholders' activity, as well as financial shortage, make conversion projects (even those already initiated) difficult to complete.

In the proposed DPSIR conceptual model we pay a lot of attention to the analysis of drivers in interactions between a society and mountain forest ecosystems because understanding of the roots facilitates solving the problem in a sustainable way. As we see, global and local drivers make a complicated nexus of destructive factors which pressures forest ecosystems. These pressures, well described in the literature on secondary Norway spruce decline (Stoyko, 1998; Klimo et al, 2000; Spiecker et al., 2004; Keeton and Crow, 2009; Soloviy et al., 2011; Parpan et al., 2014), cause a worsening state of both systems: ecological – because of loss of a forest vitality and social system – because of deterioration of FES supply and related changes in human well-being.

Deeper insight into the roots provides us with a better preparedness to a response activity. We stress on proactive institutional changes in knowledge generation, education and information to change human behaviour, land and resource use. Preventive and reactive responses should complement each other to put a forest resource use, management and governance on the sustainability track.

To conclude with the DPSIR approach application we can say that the proposed DPSIR conceptual model of interactions between society and forest ecosystems in the Ukrainian Carpathians, developed from a conversion project perspective, allows us to examine how changes in institutions, forest management paradigm and practices, including the conversion processes, will weaken the destructive drivers, mitigate their pressures and affect the state of ecosystems and of the ecosystem services flows they generate. In condensed form this conceptual model reveals casual links between driving forces, pressures and impacts and facilitates stakeholders' communication and collaborative decision-making. The proposed model synthesizes forestry, socio-economic and institutional perspectives and provides a common point of reference for a further transdisciplinary research.

3.2. Evaluation of benefits from the conversion process using the ecosystem services approach

To investigate an interdependence between social and ecological systems from the FES perspective we propose to complement the ecosystem service cascade model (Potschin and Haines-Young, 2011; Potschin et al., 2016) with a backward link in order to explain how ecosystem services, their prices and stakeholders' knowledge, perceptions and values underpin forest decision-making and shape institutions, which, in turn, foreshadow the ecosystems' structure and quality (Fig. 3).

Such extended cascade ecosystem service model reveals synergies and conflicts which arise at all levels of ecosystem services provision, use, and governance from FES perspective. Institutional structures are considered to be shaped by human perceptions and values associated with FES and generate relevant policy and instruments to mitigate anthropogenic impacts on FES and biophysical structures, generating these FES. Integration of a societal perspective into the cascade ecosystem service model makes the model more realistic and operational for adaptive forest management and governance.

To understand stakeholders' perceptions of FES role, their values and preferences concerning pure or mixed forest stands, central for the proposed extended cascade ecosystem service model, we run a survey, based on the CICES classification. Our respondents – Scientists of the forest research institutions and Employees of the forest enterprises – were asked to evaluate the importance of FES, using a 5-point Likert scale. The main part of the questionnaire contained a CICES list of ecosystem services and respondents were asked to express their perceptions of these services' importance and to compare the quality of FES, provided by pure vs. mixed forest stands. We conducted twenty face to face interviews that lasted from 15 to 25 minutes each and approached two groups of stakeholders: Scientists (ten respondents) and Forestry enterprise employees (ten respondents).

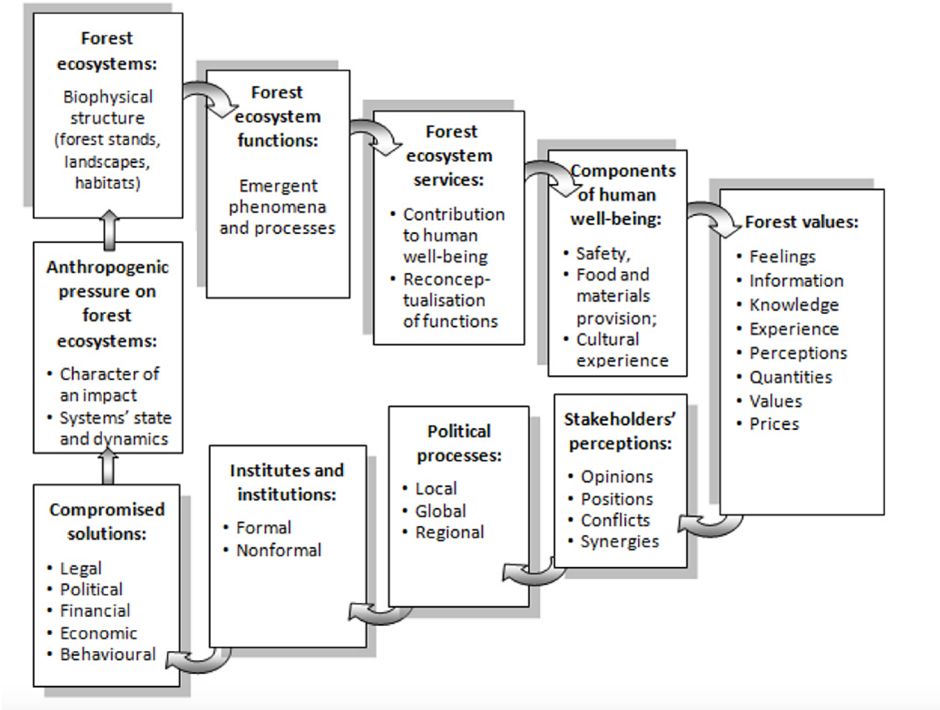

Figure 3: Extended ecosystem service cascade model: perspective of forest decision-making (proposed by Potschin and Haines-Young, 2011; modified in Zahvoyska, 2014)

Abbildung 3: Erweitertes Kaskadenmodell für die Ökosystemleistungen: Perspektive der Entscheidungsfindung im Wald (entwickelt von Potschin and Haines-Young, 2011; erweitert von Zahvoyska, 2014)

The collected data shows that respondents assess the role of FES quite high: an average range of values varies from 3.2 (Provisioning section, Energy in terms of CICES; provided by Scientists; the higher the better) to 4.5 (Regulation & Maintenance, Mediation of waste, toxics and other nuisances; Employees). Both groups of respondents give the highest values to the section Regulation & Maintenance ecosystem services with a mean value of 4.2 whereas the Provisioning section got the lowest estimation (mean 3.6). Note, that the only marketable section – Provisioning services – got the lowest rank in the stakeholders' evaluations while financial efficiency conclusions usually are based on the market values.

Generally, estimations of both groups of stakeholders are quite similar, but Scientists evaluate all divisions except Maintenance of conditions and Physical and intellectual interactions a bit lower as compared to Employees. Among provisioning section both groups of respondents stress Materials (mean value 4.0 for Employees and 3.6 for Scientists) whereas Energy division got the lowest points for both groups of stakeholders (3.5 and 3.2 respectively). Some difference in priorities is expressed in the Cultural section: Scientists consider division Physical and intellectual interactions more important (3.9) while Employees focus on Spiritual, symbolic and other interactions (with the same value 3.9).

In our poll the group Scientists was represented by researchers from the Ukrainian Research Institute of Mountain Forestry (Ivano-Frankivsk) and the Ukrainian National Forestry University (UNFU). Scientists of both institutions provide quite similar evaluations and it was not surprising: both institutions are closely related, have a common professional background from the UNFU, share a long experience of collaboration and thus no differences in the FES evaluation is to be found.

There are many similarities in the estimations provided by both forestry enterprises as well. The first of all, both rankings are similar, differences come from estimations of some items' importance. Thus, employees of both enterprises give the highest value to the second CISES section Regulation and Maintenance, in particular to the division Mediation of waste and other nuisances with the highest estimate, but employees from the Municipal Forestry Enterprise "Halsillis" estimate it a bit higher (4.7 vs. 4.4) possibly because of a higher sensitivity to the environmental pollution in the more industrialised region. Interesting, that employees from the State Enterprise "Skole Forestry", which operates in a mountain area, evaluate the division Maintenance of physical, chemical, biological conditions a bit higher as compared to employees from the Municipal Forestry Enterprise "Halsillis", that operates in a plain area: 4.2 vs. 4.0. This difference could be explained by a higher focus on a pest and disease control as well as on a climate regulation, relatively sharply revealed in mountain regions. Mediation of flows got the same estimations for both enterprises (4.1).

In the first section (Provisioning services) both enterprises give the highest value to the item 1.2 Materials, however employees of the Municipal Forestry Enterprise "Halsillis", that operates in a better economic conditions, assess this item as 0.2 point higher, then their peers (4.1 vs. 3.9). The remaining estimates are very similar.

Employees from both enterprises estimate the importance of Spiritual and other interactions as 3.9, but employees from the Municipal Forestry Enterprise "Halsillis" estimate the division Physical and intellectual interactions a bit higher than their peers (3.7 vs. 3.5). That can be explained by more intensive physical interactions with wooded landscapes from tourism and recreation.

We note that respondents from both groups with 20-25 years of professional experience evaluate the importance of FES a bit higher (0.3-0.6 points). Surprisingly, both groups of respondents prioritise the second CICES-section – Regulation & Maintenance – because a recent discourse of forest resource use is heavily focused on timber production whereas local population is considered to be more sensitive to the provision of non-timber products (ENPI EAST FLEG II, Bakkegaard, 2014; ENPI EAST FLEG II, Zhyla et al., 2014). A reasonable explanation for the observed set of values could be found in the decline of forest ecosystems and several recent floods in the Carpathian Mountains with severe consequences, which revealed a real set of priorities for the respondents. The results communicate a certain level of willingness and preparedness to a long-term wealth-creation partnership and cooperation for sustainability.

The second research question we examined using the questionnaire, dealt with a comparative assessment of FES quality provided by mixed vs. pure forest stands. According to the results a respective difference is perceived in regard to CICES divisions Materials (Provisioning section), Mediation of waste, toxics and other nuisances, Mediation of flows and Maintenance of physical, chemical and biological conditions (the whole Regulation & Maintenance section). For the rest of FES respondents estimate a bit higher or the same value for services provided by mixed forests as compared to pure stands.

While scientists come up with a more uniform evaluation of mixed FES in a range of 4.0 for Energy to 4.6 for Mediation of flows, employees' evaluations vary in an interval from 3.4 for Energy to 4.5 for Maintenance of conditions. This difference should be examined in a further research because the applied questionnaire does not allow us to collect information about respondents' reflections on the question under consideration but as we see now, this option should be provided. Also it is not clear why employees did not distinguish such FES as Spiritual, symbolic and other interactions with biota, ecosystems, and landscapes, provided by mixed vs. pure forest stands (Fig. 4), while stressed their importance whereas scientists discerned these flows but did not evaluate their importance so high as employees did.

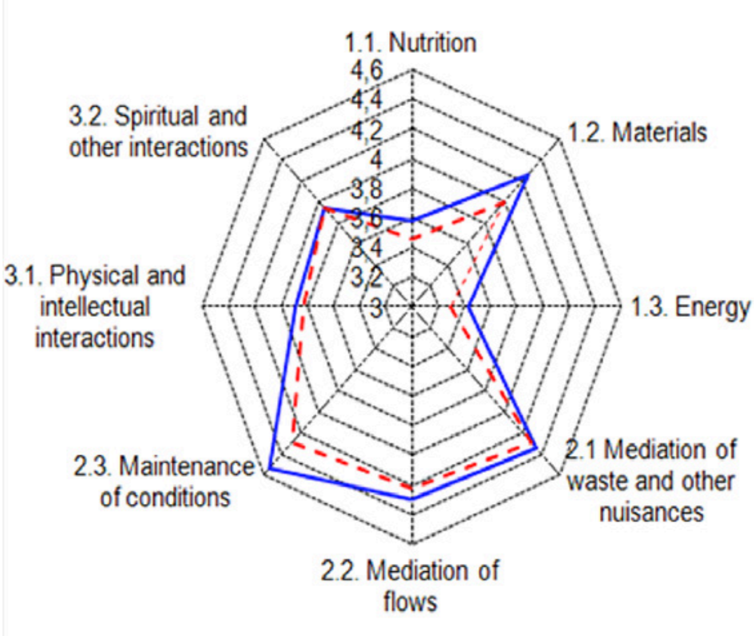

Figure 4: Comparative evaluation of forest ecosystem services provided by secondary spruce vs. mixed stands: Vision of forestry enterprises employees. CICES classification (2013) and 5-point Likert scale were used (the higher value is better).

Abbildung 4: Vergleichende Beurteilung der Wald-Ökosystemleistungen von sekundären Fichten- vs. Mischbeständen: Vision von Angestellten der Forstbetriebe. CICES-Klassifikation (2013) und 5-teilige-Likert-Skala wurden verwendet (höhere Werte sind besser).

We analysed the collected data using non-parametric statistics methods. With a probability of 99.9%, according to the Wilcoxon signed-rank test (Lowry, 2014), results of our survey demonstrate that both groups of respondents value FES of mixed stands a bit higher than FES, generated by pure secondary Norway spruce stands (Table 1). Therefore, this statistically significant difference should be considered in the economic assessment of benefits from conversion projects.

We can conclude that respondents, based on their knowledge and experience, express higher preferences to mixed forests comparing to pure secondary Norway spruce stands because they believe that FES flows, provided by mixed forests, are better and richer. Generated quantitative estimates of stakeholders' perceptions of FES should be integrated into forest decision-making aimed at sustainability. Obtained results will provide forest decision-makers and society with important information on the attractiveness and necessity of the conversion process. Hence forest conversion gains a support from stakeholders. In this context arises a question: "Do conversion projects pay?" To answer this question, we propose to apply the economic approach.

Table 1: Comparative stakeholders' evaluation of a quality of forest ecosystems services provided by mixed vs. pure forest stands. CICES classification (2013)

Tabelle 1: Vergleichende Bewertung der von den Rein- und Mischbeständen zur Verfügung gestellten Ökosystemleistungen durch die Interessengruppen. CICES –Klassifikation (2013)

Stakeholders	Number of comparisons (out of 48 services listed in CICES v. 4.3)		
	Ecosystem services, provided by mixed forest, are better	No difference in quality of ecosystem flows, generated by both forest stands	Z-ratio for the Wilcoxon signed-rank test
Scientists	31	17	4.856
Employees of forest enterprises	20	28	3.911

Critical value $z_{0.001;\ \text{two-tailed}} = 3.291$.

3.3. Evaluation of benefits from the conversion process using the economic approach

Identification of changes in social welfare and their further valuation (Fig. 1, step 3) is a crucial stage of CBA. It is especially complicated for forestry projects because a significant part of the benefits are public goods, that means that they are vital for human well-being but there are no markets for them and consequently no incentives to supply them.

To identify benefits of a conversion project we applied the ecosystem service framework and CICES classification that allow us to reveal benefits in a systemic and comprehensive way, to avoid ambiguity in identification and double counting in valuation. Analysis of existing literature on Norway spruce conversion projects, their options and consequences (Stoyko, 1998; Klimo et al., 2000; Spiecker et al., 2004; Seidl et al., 2008; Parpan et al., 2014) and stakeholders' preferences stated in abovementioned survey let us identify relevant ecosystem services to be considered in CBA of a conversion project.

To capture existing dichotomies among beneficiaries and in valuation approaches we present these benefits as matrix of a conversion project's impacts (Table 2) and position them by two axes: one axis is valuation approaches (whether or not (non-distorted) market prices exist). The other axis refers to beneficiaries (winners of a project). Dixon et al. (1997) propose to identify such relations discovering location and valuation dichotomies but this is not correct in the case of conversion projects. For instance, nonwood forest products (NWFP) appear on-site but in Ukrainian socio-economic and institutional context an investor does not care about making profit by selling them. Income from the sale of permissions for NWFP harvesting goes directly to local authorities.

Quadrant 1 of Table 2 includes conversion project outputs that the investor can sell on a market. In Quadrant 2 we present market-priced outputs that society gains from the project. The benefits in the last two quadrants are usually ignored in CBA because there are no markets for them. Quadrant 3 includes social value of business, image of the investor and other benefits that arise due to a successful run of a secondary Norway spruce conversion. Quadrant 4 contains benefits that do not have a market price, but have influence on society welfare.

Among all CICES-divisions only one division was not mentioned in the impact matrix, namely Spiritual, symbolic and other interactions with biota, ecosystems, and landscapes (Cultural section). This feature should be examined deeply because Employees stressed an importance of this division (Fig. 4), but were indifferent to type of forest whereas symbolic, sacred and/or religious, bequest and existence outputs could be strongly linked to stands with natural origin.

The proposed matrix could serve as a checklist for an appraiser and be further developed to value the benefits. Valuation techniques, such as revealed preference approaches for market outputs and stated preference approaches for nonmarket ones, developed and vetted by environmental economists during several decades of research, should be carefully used taking into account such criteria as geography, social-economic context and the applicability of certain techniques. However, the fundamental difference between values and prices, as well as between values and costs, should be articulated carefully, with a reliable evidence of relevance and correctness, keeping in mind the limited scope of CBA and relevance of financial indicators in general when it comes to multidimensional human well-being.

*Table 2: Matrix of conversion project impacts**

Tabelle 2: Matrix der Auswirkungen von Waldumwandlungsprojekten

		Beneficiary	
		Investor	**Society**
Valuation of Benefits	**Marketed**	**1** Project outcomes: - Revenue from sale of the increased timber volume *Provisioning / Materials / Biomass* - Additional revenue from sale of firewood *Provisioning / Energy / Biomass-based energy sources* - Decreased financial risks due to forest species diversification	**2** Marketed social benefits of the conversion projects that local communities obtain: - Changes in productivity of non-wood forest products *Provisioning / Nutrition / Biomass* - Taxes on revenues from sale of timber and firewood which go to local budgets (in case of clear cuttings these taxes go to the state budget) - Increased productivity of cultivated crops on sites which border sites under conversion *Provisioning / Nutrition / Biomass* - Increased supply of water for drinking *Provisioning / Nutrition / Water*
	Non-marketed	**3** Non marketed benefits of a conversion project that investor obtain: - Know-how gained by project performers - Social value of business - Image and reputation of investor - Other non-marketed benefits, that an investor gains due to successful implementation of a conversion project	**4** Non marketed benefits of a conversion project that stakeholders obtain: - Better quality of the environment *Regulation & Maintenance (R&M) / Mediation of waste, toxics and other nuisances* - Flood and storm protection *R&M / Mediation of flows / Liquid and Air flows* - Improved habitats for biodiversity *R&M / Maintenance of Conditions (M&C) / Lifecycle maintenance* - Benefits from avoided costs for biological protection of drying sites from pests *R&M / M&C / Pest and disease control* - Benefits from prevention of soil erosion *R&M / M&C / Soil formation & composition* - Benefits from climate regulation by reduction of greenhouse gas concentrations *R&M / M&C / Atmospheric composition and climate regulation* - Higher recreational / aesthetic value of forests *Cultural / Physical and intellectual interactions / Representative & intellectual interactions* - Enhanced biodiversity - Benefits from nonmarketed changes of human and natural capital derived due to a conversion project implementation

* CICES (2013) classification of ecosystem services is applied. CICES v. 4.3 categories are listed in italic.

4. Discussion and Conclusion

Such close attention to benefits of the conversion projects is explained by a high importance, uncertainty and some disadvantages, related to this activity, that are well presented in the scientific literature. From the economic point of view, we should mention first of all a higher cost of thinning and harvesting of non-mature trees (less than financial optimum maturity), as well as a significant decrease in increment and standing volume across the conversion period (Hanewinkel and Pretzsch, 2000; Roessiger et al., 2013). Higher profitability of even-aged pure spruce stands, well established markets for coniferous sawnwood and simple forest operations ensure preference of monoculture spruce sites for investments. Additional losses could come from a timber market: trees in uneven-aged stands have a longer crown compared to even-aged ones that means a worse quality of timber.

From a silvicultural perspective, conversion projects are exposed to a higher risk because of strong dependence on the success of a reforestation: in case of a lack of seed trees / years a necessity of planting could arise, that considerably increases the direct cost of reforestation. Besides, an intensive gradual cutting could pose a high risk, especially for mature even-aged stands during a time span after the cutting.

All these difficulties multiplied by an uncertainty of climate change require stronger competence, knowledge and relevant skills from forest policy-makers, scientists and forest managers. Further research and evaluations across a social-ecological gradient are needed. Forest managers should be trained to be able to design conversion projects, taking into consideration global changes, a local context and features of each site (Krynytskyy and Chernyavskyy, 2014). Conversion projects necessitate environmentally sound technology and facility for forest operations that is particularly acute for Ukrainian forestry enterprises.

To tackle these complications and obstacles relevant institutional changes are needed. First of all, it should be a holistic and long-term vision of forest management goals and tasks as well as criteria and indicators of successful activity aimed at the long-term wealth-creation partnership of forest agencies, scientific communities, business and civil society. Institutional regulations are essential to initiate and support an activity with numerous positive outcomes, that now are not considered by market transactions. Implementation of the conversion projects can induce a multiplier effect in the whole forestry cluster: development of new technologies, manufacture of equipment for a target harvesting and for beech wood processing, research programmes as well as tourism development that brings a lot of benefits to local stakeholders.

Deeper insight into the multidimensional nexus of Norway spruce monoculture conversion provides a comprehensive background for adaptive ecosystem-based forest management. To bring this perspective into a long-term forest decision-making context the whole complexity of such transformations should be holistically understood and well-presented for the stakeholders to gain their co-learning and collaboration with future generations in mind. We believe that approaches, considered in this paper, are helpful in the evaluation of efficiency of a conversion activity but none of them is universal. They complement each other and are needed to validate results and to overcome the dominance of commercial criteria in the evaluation of forest-related decision-making when implicit values and public goods are a matter of concern. These approaches can create a backbone of the framework to be applied across different policy, economic and cultural landscapes and contribute to development of a transdisciplinary, holistic and universal framework for the evaluation of conversion of even-aged secondary Norway spruce stands. It is expected that this integrated approach will contribute to the development of an evaluation framework and merits further attention of scientists, policy makers and businessmen.

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