University of Ljubljana
Biotechnical Faculty
Jamnikarjeva 101
1000 Ljubljana
Slovenia

IUFRO UNIT 4.05.00
Managerial Economics and Accounting
and
University of Ljubljana, Biotechnical Faculty,
Department of Forestry and Renewable Natural Resources, Slovenia

Collection of the presented scientific papers at the

International Symposium on

Emerging needs of society from forest ecosystems: towards the opportunities and dilemmas in forest managerial economics and accounting

University of Ljubljana, Ljubljana, Slovenia

May 22 – 24, 2008

Edited by L. Zadnik Stirn

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CONTENTS **I**

FOREWORD

With this electronic version of the proceedings of the International IUFRO 4.05.00 symposium on Emerging needs of society from forest ecosystems: towards the opportunities and dilemmas in forest managerial economics and accounting, which was held at the University of Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Natural Resources, Ljubljana, Slovenia, from May 22 to May 24, 2008, we make available the collection of the scientific papers presented at this symposium to all those who participated in the symposium and to all those who did not, but are interested in the expertise and the practical knowledge acquired at the symposium.

This electronic version of the proceedings contains the presented scientific papers at the International symposium on Emerging needs of society from forest ecosystems: towards the opportunities and dilemmas in forest managerial economics and accounting. The main issues emerging from the areas as economic opportunities and/or strong sound competition of forest amenity values for the society, forest economics and accounting of bio-energy, economics and accounting of new forest products, services and markets, as for example carbon, biodiversity, green tourism, emerging needs for forests and land use (agriculture versus forestry), forest products versus forest amenities, biomass versus niche forest production, forest development and management in the light of global changes, measuring social preferences for sustainable and society sounded forest management, improving forest-research-society communication and collaboration, etc, were presented and discussed in the symposium. We believe that 31 papers delivered at the symposium reflect the current state in forest managerial economics and accounting as well as the actual challenges. Further, we hope that the division of the presented papers into 8 sessions reflects on the one hand the variety of fields engaged, and on the other hand not separating too many subjects which could belong together. The scientific program was divided into the following sessions (the number of papers in each session is given in parentheses): New perspectives of forest management (2), Social and economic needs from forest ecosystems (4), Non-market forest goods – recreation and parks (5), Protection of the environment and forest certification (4), Accounting, statistical and economic analysis (5), Forest management practices (5), Energy planning and biomass (3), Forest technology and operations, wood technology and industry (3). The papers were written/presented by 75 authors and coauthors (see the Author index). The authors and coauthors came from Italy (13 with 4 contributions), Croatia (17 with 3 contr.), Slovenia (10 with 4 contr.), the USA (9 with 3 contr.), Germany (6 with 4 contr.), France (3 with 3 contr.), Spain (4 with 1 contr.), the Czech Rep. (1 with 1 contr.), Canada (2 with 1 contr.), Austria (1 with 1 contr.), Finland (3 with 1 contr.), Romania (1 with 1 contr.), Ukraine (2 with 1 contr.), Japan (1 with 1 contr.) and South Africa (2 with 2 contr.).

The International IUFRO 4.05.00 Symposium on Emerging needs of society from forest ecosystems was the premiere scientific event in the area of forest managerial economics and accounting, one of the traditional series of the annual international meetings organized by IUFRO Unit 4.05.00 - Managerial Economics and Accounting; and by one local organizer; this time by the University of Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Natural Resources, Ljubljana, Slovenia. At the symposium scientists, researchers and practitioners from different forest management areas dealt with forest managerial economics and accounting, land-use, forest and natural resource policy, and decision support makers, land-use planners, stakeholders, researchers and specialists of related fields came together, exchanged new developments, opinions, experience, and thus contributed to the quality and reputation of forest managerial economics and accounting. The International IUFRO 4.05.00 Symposium in 2008 in Slovenia was held under the auspices of the University of Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Natural Resources, Slovenia, IUFRO 4.05.00 and the Slovenian Research Agency. The opening address was given by Prof. Dr. Franci Štampar, the dean of Biotechnical Faculty, Prof. Dr. Dr. h.c. Niko

Torelli, the director of Slovenian Forestry Institute, Mr. Jošt Jakša, the director of Slovenia Forest Service, Assis. Prof. Dr. Janez Krč, the vice dean of Biotechnical Faculty for Forestry, Prof. Dr. Shashi Kant, the chair of IUFRO 4.05.00 and Prof. Dr. Lidija Zadnik Stirn, Biotechnical Faculty, chair of the symposium Organizing Committee.

The fundamental mission of the Biotechnical Faculty is to provide university level, advanced professional, and postgraduate education towards studying natural resources, as well as to carry out scientific research concerning the sciences of living nature, agriculture, forestry and the related production technologies. Thus, the Department of Forestry and Renewable Natural Resources, which is a part of the Biotechnical Faculty, carries out the education in forestry. The research work in forestry is performed by the Slovenian Forestry Institute which is connected with the Department of Forestry and Renewable Natural Resources. In applied research they both cooperate closely with the Slovenia Forest Service that performs public forestry service in all Slovenian forests, regardless of ownership, under the motto "Caring for forests to benefit nature and people". More details about the Slovenian forests and forestry are given in the booklet (Slovenian forests and forestry, 2004) which was enclosed to the symposium kit.

IUFRO (the International Union of Forest Research Organizations) with a long tradition dating back to 1892 is a global network for forest science cooperation. It units more than 15000 scientists in over 110 countries with the goal to strengthen the promotion and the international cooperation in scientific studies embracing the whole field of research related to forests for the well-being of forests and people that depend on them. The IUFRO 4.05.00 – Managerial Economics and Accounting - is one of the most productive IUFRO groups.

During the symposium sessions, in two days, 31 contributions were orally presented. The participants had at their disposal enough time for discussions on the main themes of the symposium and for some side meetings. The last day of the symposium was dedicated to the field trip to Panovec and Trnovski gozd in the Tolminsko forest unit to experience the practical achievements in Slovenian forest managerial economics.

We would not have succeeded in attracting so many distinguished speakers from all over the world without the engagement and the advice of active members of IUFRO 4.05.00 and several colleagues from Slovenian forestry institutions (Biotechnical Faculty, Slovenia Forest Service and Slovenian Forestry Institute). Many thanks go to them. Further, we would like to express our deepest gratitude to Mr Marko Janež, forest expert from Slovenia Forest Service, Regional Unit Tolmin for a very professional organization of the symposium field trip, Mrs Savina Terlep for technical work with symposium documents and Mr Gregor Razdrtič for taking care of the symposium web page. At last, we appreciate the authors' efforts in preparing and presenting the papers, which made the symposium valuable. The success of the appealing IUFRO scientific event and the present electronic version of the proceedings should be seen as a result of our joint efforts.

Lidija Zadnik Stirn
on behalf of the Symposium Organizing Committee

Ljubljana, November 2008

1. Program and Organizing Committee, session chairs

For the scientific and professional program of the International IUFRO 4.05.00 Symposium in 2008 in Ljubljana, Slovenia on
Emerging needs of society from forest ecosystems: towards the opportunities and dilemmas in forest managerial economics and accounting
was responsible:

***Program Committee of the symposium*:**

Prof. Dr. Hans Joebstl, chair of IUFRO 4.05.01
BOKU - University of Natural Resources and Applied Life Sciences
Vienna, Austria
hans.joebstl@boku.ac.at

Prof. Dr. Shashi Kant, chair of IUFRO 4.05.00
Faculty of Forestry, University of Toronto
Ontraio, Canada
shahi,kant@utoronto.ca

Prof. Dr. Lyudmyla Maksymiv, Director
Institute of Ecological Economics
Ukrainian National Forestry University,
Lviv , Ukraine
maksymivl@ukr.net

Prof. Dr. Bernhard Moehring, deputy of IUFRO 4.05.01
University of Goettingen, Goettingen, Germany
bmoehri@gwdg.de

Prof. Dr. Martin Moog, deputy of IUFRO 4.05.02
Institute of Forest Economics, TU Muenchen, Germany
moog@forst.tu-muenchen.de

Prof. Dr. Jean-Luc Peyron, Director, chair of IUFRO 4.05.02
ECOFOR, Paris, France
jean-luc.peyron@gip-ecofor.org

Prof. Dr. Ludek Sisak, deputy of IUFRO 4.05.02
University of Life Sciences, Prague,
Czech Republic
sisak@fle.czu.cz

Prof. Dr. Maja Jurc, chair of unit: Forest protection and wildlife ecology
University of Ljubljana, Biotechnical Faculty
Ljubljana, Slovenia
maja.jurc@bf.uni-lj.si

Assis. Prof. Dr. Janez Krč, vice-dean of Biotechnical Faculty for Forestry
University of Ljubljana, Biotechnical Faculty
Ljubljana, Slovenia
janez.krc@bf.uni-lj.si

Assis. Prof. Dr. Darij Krajčič, Director
Institute of the Republic of Slovenia for Nature Conservation
Ljubljana, Slovenia
darij.krajcic@zrsvn.si

Prof. Dr. Ksenija Šegotič,
University of Zagreb, Faculty of Forestry
Zagreb, Croatia
ksenija.segotic@sumfak.hr

Assis. Prof. Dr. Andrej Udovč, chair of unit Agricultural economics, rural sociology and rural development
University of Ljubljana, Biotechnical Faculty
Ljubljana, Slovenia
andrej.udovc@bf.uni-lj.s

Prof. Dr. Lidija Zadnik Stirn, chair of unit Applied mathematics
University of Ljubljana, Biotechnical Faculty,
Ljubljana, Slovenia
lidija.zadnik@bf.uni-lj.s

The International IUFRO 4.05.00 Symposium on Emerging needs of society from forest ecosystems: towards the opportunities and dilemmas in forest managerial economics and accounting, organized by University of Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Natural Resources, Slovenia –***local organizer*** and
IUFRO Unit 4.05.00 - Managerial Economics and Accounting; IUFRO Unit 4.05.01 - Managerial, social and environmental accounting; IUFRO Unit 4.05.02 - Managerial economics
which took place at University of Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Natural Resources, Večna pot 83, 1000 Ljubljana, Slovenia
May 22-24, 2008

was realized by the

Organizing Committee of the symposium:

Marko Janež, Slovenia Forest Service,
chair of Unit Tolmin, Tolmin, Slovenia
marko.janez@zgs.gov.si

Prof. Dr. Hans Joebstl, BOKU - University of Natural Resources
and Applied Life Sciences, Vienna, Austria
hans.joebstl@boku.ac.at

Prof. Dr. Shashi Kant, University of Toronto, Canada, shashi.kant@utoronto.ca

Assis. Prof. Dr. Janez Krč, University of Ljubljana, Biotechnical Faculty
janez.krc@bf.uni-lj.si

Matevž Mihelič, University of Ljubljana, Biotechnical Faculty
matevz.mihelic@bf.uni-lj.si

Prof. Dr. Jean-Luc Peyron, ECOFOR, Paris, France; jean-luc.peyron@gip-ecofor.org

Gregor Razdrtič, student, University of Maribor, Faculty of organizational science
gregor.razdrtic@gmail.com

Savina Terlep, University of Ljubljana, Biotechnical Faculty
savina.terlep@bf.uni-lj.si

Alenka Vozelj, student, University of Ljubljana, Faculty of Arts
alenkavozelj@yahoo.com

Prof. Dr. Lidija Zadnik Stirn,
University of Ljubljana,
Biotechnical Faculty – ***chair of symposium***
lidija.zadnik@bf.uni-lj.si

Contact:

Lidija Zadnik Stirn
lidija.zadnik@bf.uni-lj.si
symp@iufro405-08.si
web: http://www.iufro405-08.si
University of Ljubljana, Biotechnical Faculty,
Department of Forestry and Renewable Natural Resources
Večna pot 83, 1000 Ljubljana, Slovenia,
tel. 00386 1 4231161, fax 00386 1 2571169

Session chairs

Hans Joebstl, BOKU, Vienna, Austria
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Donald G. Hodges, University of Tennessee, USA
Darij Krajčič, Institute of the Republic of Slovenia for Nature Conservation, Slovenia
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Bernhard Moehring, University of Goettingen, Germany
Ludek Sisak, University of Life Sciences, Prague, Czech Republic
Janez Krč, University of Ljubljana, Slovenia

Session 1:
New perspectives of forest management

1. Forest Resource Stock Diversity and the Green Golden Rule

Shashi Kant
Faculty of Forestry, University of Toronto, Ontraio, Canada
Phone: 416-978-6196, Fax: 416-978-3834
e-mail: shashi.kant@utoronto.ca
and
Chander Shahi
Faculty of Forestry and Environment,
Lakehead University, Thunder Bay, Ontario, Canada

Abstract

The Green Golden Rule treats the total resource stock as a homogenous stock. However, the total stock consists of various stocks which have different values and different rates of transformation. Hence, the incorporation of resource-stock diversity is necessary for the determination of correct optimal conditions. The GGR is extended to incorporate the diversity of renewable resource stock: the economically optimal conditions are developed for a three-stock and an n-stock forest resource, and economics implications of these conditions are discussed. The Enhanced Green Golden Rule prescribes higher level of conservation compared to the Green Golden Rule.

Keywords: Sustainability, forest, Green Golden Rule, and optimum stock levels

JEL classification: D90

1.0 Introduction

Sustainability issues were discussed by Ciriacy-Wantrup and Krutilla even prior to the publication of *The Limits to Growth* that generated a new wave of economists' interest in sustainability. Papers included in a special issue of the Review of Economic Studies (Volume 41 (128), 1974), including Dasgupta and Heal (1974) and Stiglitz (1974), laid foundations for the future debate on sustainability. The next contribution in this sequence was Hartwick's rule (Hartwick, 1977), and all this literature has been reviewed in Pezzey and Toman (2003) and Kant and Berry (2005). The first wave of economic literature on sustainability considered utility to be a function of natural resource consumption only and used discounted utilitarian framework to address inter-generational equity.

In the next round, economists such as Krautkraemer (1985) and Beltratti et al. (1993) included "resource stock", in addition to consumption, as a source of utility. Chichilnisky (1997) proposed an axiomatic approach of sustainable development and suggested Chichilnisky's criterion to address intergenerational equity. Chichilnisky et al. (1995) extended the Golden Rule (GR) of economic growth to include environmental stock, and termed the new rule as the Green Golden Rule (GGR). The GR refers to a growth path of the highest maintainable level of consumption per capita while the GGR refers to the highest indefinitely maintainable level of instantaneous utility – which includes utility from the consumption and the stock of environmental/natural resources. The GGR is a valuable contribution to the economic literature on sustainability issues but it is insensitive to the diversity of natural resource stocks and different utilities derived from them - either by consumption or by stock. Heal (1998, p. 47) recognised this limitation by acknowledging that most ecosystems are considerably more complex than assumed in the GGR formulation, and suggested that this is a topic for further research.

We make an attempt to capture some complexity of ecosystems by incorporating the diversity of natural resource stocks and utilities from them, and propose the Enhanced Green Golden Rule (EGGR). For the sake of tractability and interpretation of results, first we develop the EGGR for an age-class-based three stocks of a forest, and later we generalize these results for a forest of n stocks. In the next section, we introduce the concepts related to structure of an age-class-based multiple stocks forest, and it is followed by the EGGR for a three stocks and n stocks forest, respectively.

2.0 The structure of an age-class-based three stocks forest

The magnitude of various products and services, provided by forests, depends on the total forest stock (generally means timber stock) as well as on the structure of the stock. Age-class distribution is the most common practice of analyzing forest stock structure, and the young, mature, and old forest stocks are the common age-classes. Young stock is generally consumed as fuel wood and pole crop, whereas mature and old stocks are used for construction material and furniture. Similarly, mature and old stocks provide recreation and habitat for big mammals whereas young stock provides habitat for small mammals. Hence, we consider a forest resource consisting of these three stocks and assume that their consumptions are not additive.

Suppose the young, mature, and old stocks are $S_1, S_2,$ and S_3, respectively, and the growth function of each stock is logistic with $S_1^*, S_2^*,$ and S_3^* as maximum stocks. As the young stock grows, some trees in the young (or mature) stock will grow but will remain in the young (or mature) stock and the remaining trees will cross over to the mature (or old) stock. We assume that no tree will move from the young stock to old stock directly. Hence, the total growth of young stock is only that growth which remains in young stock, the total growth of mature stock is the sum of its own partial growth which remains in the mature stock and partial growth of young stock that crosses over to the mature stock; and the total growth of the old stock is the sum of its own growth and the partial growth of the mature stock that crosses over to the old stock. Suppose θ_1 and θ_2 are the proportions of growth of S_1 and S_2 that remain in S_1 and S_2, respectively, $(1-\theta_1)$ is the proportion of growth of S_1 that adds to the growth of S_2; and $(1-\theta_2)$ is the proportion of growth of S_2 that adds to the growth of S_3. The growth functions of the three stocks could be represented as:

$$R^1 = \theta_1 \rho_1 S_1 (1 - \frac{S_1}{S_1^*}) \qquad \text{where, } 0 < S_1 < S_1^* \qquad (1)$$

$$R^2 = (1-\theta_1)\rho_1 S_1 (1 - \frac{S_1}{S_1^*}) + \theta_2 \rho_2 S_2 (1 - \frac{S_2}{S_2^*}) \qquad \text{where, } 0 < S_2 < S_2^* \qquad (2)$$

$$R^3 = (1-\theta_2)\rho_2 S_2 (1 - \frac{S_2}{S_2^*}) + \rho_3 S_3 (1 - \frac{S_3}{S_3^*}) \qquad \text{where, } 0 < S_3 < S_3^* \qquad (3)$$

where ρ_1, ρ_2 and ρ_3 are characteristic growth coefficients of young, mature and old stocks, respectively.

3.0 The Enhanced Green Golden Rule (EGGR) for a three-stocks forest

We modify the economic model of Chichilnisky et al. (1995) to incorporate three stocks, and assume that the consumption and levels of stocks contribute to utility. Suppose the utility function $U(C_{1t}, C_{2t}, C_{3t}, S_{1t}, S_{2t}, S_{3t})$ is a strictly concave. For succinctness, we use the notation $U(C_t, S_t)$. We also assume that the utility function is additively separable in consumptions

and stocks. Suppose the production of man-made capital K_t occurs according to the linear homogeneous production function $F(K_t, S_{1t}, S_{2t}, S_{3t})$, and capital accumulation is expressed as

$$K_t = F(K_t, S_t) - C_t \quad (4)$$

The rates of change of the three stocks of forest are expressed as:

$$\dot{S}_{1t} = R^1 - C_{1t} \quad (5)$$

$$\dot{S}_{2t} = R^2 - C_{2t} \quad (6)$$

$$\dot{S}_{3t} = R^3 - C_{3t} \quad (7)$$

Similar to the GGR, in which society is only concerned with the long-run values of the consumption and levels of forest stocks, we seek a path to maximize the long run utility, $\lim_{t\to\infty} U(C_t, S_t)$. The solution is specified by the following proposition:

Proposition 1: *There exist values of* $(\mathrm{K}^*, \mathrm{S}_1^*, \mathrm{S}_2^*, \mathrm{S}_3^*, \mathrm{C}_1^*, \mathrm{C}_2^*, \mathrm{C}_3^*)$ *characterized by*

$$\frac{U_{s_1}}{U_{c_1}} = -R^1_{s_1} - \frac{U_{c_2}}{U_{c_1}} R^2_{s_1} \ ,$$

$$\frac{U_{s_2}}{U_{c_2}} = -R^2_{s_2} - \frac{U_{c_3}}{U_{c_2}} R^3_{s_2} \text{ , and}$$

$$\frac{U_{s_3}}{U_{c_3}} = -R^3_{s_3} \ ,$$

such that

$\lim_{t\to\infty} U(K_t, C_t, S_t) = \mathrm{U}(\mathrm{K}^*, \mathrm{S}_1^*, \mathrm{S}_2^*, \mathrm{S}_3^*, \mathrm{C}_1^*, \mathrm{C}_2^*, \mathrm{C}_3^*)$ is a necessary and sufficient condition for a feasible path ($\mathrm{K_t}$, $\mathrm{C_t}$, $\mathrm{S_t}$) V t to be a solution of the problem maximize $\lim_{t\to\infty} U(K_t, C_t, S_t)$ over all feasible paths.

Proof: As indefinitely maintainable value of C_1, C_2, C_3 and S_1, S_2, S_3 satisfy $R^1 = C_1$, $R^2 = C_2$, and $R^3 = C_3$, this means that the problem Max $\lim_{t\to\infty} U(K_t, C_t, S_t)$, over feasible paths,

Reduces to Max U (C, S)

Subject to the constraints given by equations 9, 10, and 11.

$$R^1 = C_1 \quad (9)$$

$$R^2 = C_2 \quad (10)$$

$$R^3 = C_3 \quad (11)$$

Similar to the GGR, the stock of capital is not a concern because any stock of capital can be accumulated over a sufficiently long period. The set of (S, C) satisfying the constraint in (9), (10, and (11) is compact, so this problem is well-defined. Hence, the maximum is characterized by the first order conditions:

$$\frac{U_{s_1}}{U_{c_1}} = -R^1_{s_1} - \frac{U_{c_2}}{U_{c_1}} R^2_{s_1} \quad (12)$$

$$\frac{U_{s_2}}{U_{c_2}} = -R^2_{s_2} - \frac{U_{c_3}}{U_{c_2}} R^3_{s_2} \quad (13)$$

$$\frac{U_{s_3}}{U_{c_3}} = -R^3_{s_3} \quad (14)$$

This completes the proof of Proposition 1.

We term the solution provided by equations (12), (13), and (14) as the Enhanced Green Golden Rule (EGGR). The left-hand side (LHS) of each equation signifies the marginal rate of substitution (MRS) between consumption and stock-level, and the right hand side (RHS) corresponds to the marginal rate of transformation (MRT) of the respective stock. The EGGR gives the same optimality condition for the old (or terminal) stock (equation 14) as of the GGR; the MRS between consumption and stock-level is equal to the MRT of the stock with respect to itself. However, the optimality conditions for young and mature stocks (equations 12 and 13) are different than the GGR conditions. For young stock, the EGGR requires that the MRS between the consumption and stock-level is equal to the MRT of the young stock with respect to itself plus the MRT of mature stock with respect to young stock expressed in the terms of young stock (normalized by the ratio of the marginal utilities of mature stock and young stock). We call the RHS of Equation (12) as the Normalized Composite Marginal Rate of Transformation (NCMRT) (composite of the ROT of the young and mature stocks and normalized to express in the units of young stock). Hence, for young and mature stocks, the EGGR requires the equality of the MRS between consumption and stock-level with the NCMRT of the stock, and therefore, the EGGR optimal values of young and mature stocks are higher than the GGR optimal values if these two stocks were treated separately.

4.0 A Generalized EGGR for a forest of n stocks

In many cases, forest managers divide the total forest stock into more than three classes and based on features other than age such as wildlife-habitat, biodiversity, canopy, and density. Intuitively, the results of Section 3 can be generalized for n-stocks, provided the growth of each stock follows the same growth function – logistic - as assumed in Section 2. A generalized EGGR for n-stocks can be written as:

$$\frac{U_{s_1}}{U_{c_1}} = -R^1_{s_1} - \frac{U_{c_2}}{U_{c_1}} R^2_{s_1}$$

$$\frac{U_{s_2}}{U_{c_2}} = -R^2_{s_2} - \frac{U_{c_3}}{U_{c_2}} R^3_{s_2}$$

$$\downarrow$$

$$\downarrow$$

$$\frac{U_{s_{n-1}}}{U_{c_{n-1}}} = -R^n_{s_{n-1}} - \frac{U_{c_n}}{U_{c_{n-1}}} R^n_{s_{n-1}}$$

$$\frac{U_{s_n}}{U_{c_n}} = -R^n_{s_n}$$

The interpretation of these n-equations is the same as of the three equations in Section 3. In the case of terminal (nth) stock, the EGGR requires the equality of the MRS between consumption and stock-level and the MRT of the stock with respect to itself. In the case of all non-terminal stocks, the EGGR requires the equality of the MRS between consumption and stock-level of n-2 stock to the NCMRT of n-2 stock (composite of the MRT of the n-2 and n-1 stocks with respect to n-2 stock and expressed in the units of n-2 stock). Hence, for all non-terminal stocks the EGGR gives higher stock-levels than the GGR stock-levels when these stocks were treated separately

5.0 Conclusions

The paper has extended the GGR to include multiple stocks of a renewal resource, and the EGGR has all the properties of the GGR and other similar concepts discussed by Chichilnisky et al. (1995). In addition, the EGGR provides many useful results. First, the optimal stock-levels, as per the EGGR, for all non-terminal stocks are bigger than the optimal-levels by the GGR, and therefore the optimal-levels are also bigger than the maximum sustainable yield levels. Hence, the EGGR prescribes higher level of conservation of natural resources as compared to the GGR. Second, the EGGR provides optimal stock-levels of different stocks, and therefore can be used in designing management strategies for ecological sustainability such as biodiversity and habitat conservation. Third, since the marginal utilities of stock-levels and consumptions of different stocks of a forest resource will vary across communities as well as across different categories of forests, the EGGR can be used to design community-specific and forest-specific resource conservation plans.
In summary, the EGGR is more sensitive to ecological complexities of forest ecosystems, and incorporates ecological dimension of sustainability in economic decisions making. An important task for future research may be to develop specific optimal conditions for different types of utility functions and resource growth functions.

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2. The Economics of Natural Forest Resources with a Particular Insight on Dead Wood.

Jean-Luc Peyron
Ecofor, 42 rue Scheffer, 75116 Paris, France

Abstract
Preservation and development of environmental resources have often been opposed. This debate has historically been applied to landscapes such as canyons of the Colorado river in the United States (Fisher, Krutilla, Cicchettti, 1974). In the forest case, the same debate occurs between roundwood production and biological reserves, for example. This paper deals with preservation and production of forests and synthesizes two previous papers dealing one with economic challenges of forest preservation (Peyron, 2003) and the other with economic evaluation of deadwood conservation (Peyron, 2005). It is composed of four sections dealing with the costs of forest preservation, the benefits of forest preservation, some particular cost-benefit analyses and, finally, the dead wood case.
Preservation is an option that generally provides less revenue or causes bigger expenditure than current production or management. It usually consists in changing species, stand structure or infrastructure or, on the contrary, in avoiding such a change, or even in planning no more harvest. All these changes correspond to another management than the one that could have been implemented, and thus to other future net revenues than those formerly expected. According to Faustmann theory, the forest value is also changed, generally decreased, and the difference measures the costs of preservation.
However, preservation is sometimes decided because some benefits are also expected from forest preservation. These benefits are the result of environmental services that can be valued with the help of several methods among which, for example, contingent valuation.
Since Hartman (1976), the combination of production and environmental services has been studied in order to adapt Faustmann theory to the multifunctional case when forest goods and services are partly sold on the market and partly provided free of charge. Strang (1983) pointed out two interesting cases when the optimal combination between roundwood production and environmental services leads to no harvest. The first case occurs when the benefits of environmental services are much higher than the revenues from roundwood harvest. A second case may happen if the optimal rotation age has been exceedes, as it is true for old growth.
The economics of dead wood can be analyzed as an application of these theories. The balance between benefits and drawbacks incurred by dead wood depends on the weight of forest functions (production, protection of sites, conservation of biodiversity, and creation of amenities), and also on the origin of mortality, its distribution (scattered or concentrated), its position (standing or lying). The analysis of some examples shows that cases are likely to occur, for which dead wood is beneficial. In these cases, either the improvement of biodiversity doesn't harm other functions or it causes higher benefits that the opportunity cost.

Keywords: forest preservation, roundwood production, deadwood conservation, Faustman theory, costs, biodiversity

Contact: Jean-Luc Peyron, email: peyron@gip-ecofor.org

Session 2:
Social and economic needs from forest ecosystems

1. Unrevealed economic benefits from forests in Cameroon

Julius Chupezi Tieguhong and Janusz Zwolinski
Forestry, Faculty of Science & Agriculture, University of KwaZulu-Natal, P Bag X01, Scottsville 3209, South Africa. chupezi@yahoo.co.uk or 204523366@ukzn.ac.za
zwolinskij@ukzn.ac.za Tel. +27-33-2606007 Fax +27-33-2606005

Abstract
A study was established to investigate the value of forest contributions to income portfolios of local populations living in villages near the Lobeke National Park (LNP) in Cameroon. The LNP forms a part of the Sangha Trinational Park (28000 km^2), a forest conservation area established by three African countries, namely Cameroon, the Central African Republic and the Republic of Congo, with the objective of protecting the native tropical rainforests with their diverse flora and fauna. Five out of the fourteen villages located within a distance of 50 km from the LNP were randomly identified with 22-23 study households in each. Incomes (in-cash and in-kind) and other socio-economic characteristics of each household were recorded, by an enumerator, quarterly over a year-long period. Logistic regression was used to study the relationship between forest dependency (households with over 49% of income from forests) and various socio-economic variables. The results showed that the forest-derived income totaled US$ 36347 compared to the US$ 45439 for all the other income of the investigated households combined. There were significant differences between the villages, with the higher income in larger villages predominantly due to better cash generation opportunities. The income in-kind remained similar irrespective of the village size and wealth. The dependence on forest products was also not related to individual household incomes, with wealthier households remaining dependent on forest-derived products. This could indicate that the traditional link to forests cannot be easily changed through subsidies and compensations. The value of forest-derived income was the highest, significantly higher than any other source of income including the second highest income generated by agriculture. The most important forest products were wild fruits, bushmeat and fuelwood, followed by wild vegetables, medicinal plants, woven products, honey, nuts and poles. A mean forest dependency index ranged from 0,10 to 0,82 for the sample households. The logistic regression was significant and explained 90% of the variation of the forest dependency in the study area. The level of education was the only social characteristic significant in explaining the forest dependency. International efforts to prevent deforestation and degradation of forest resources in the tropics will remain ineffective unless other means of subsistence are developed for the currently forest-dependent poor. Cultural and traditional values need to be recognized to prevent any conflicting interests.

Keywords: poverty, deforestation, forest valuation, Africa

Introduction

For a long time it has been an established practice to value forests based on the price of the commercial timber they produce. Only relatively recently efforts have been made to quantify the values of their other functions such as carbon sequestration, balancing of global climates or soil conservation. Little is known, however, about their roles in providing for immediate needs of poverty stricken households in many developing and cash constrained countries. Any underestimation of such functions may impact negatively on land use policies resulting in devastating consequences, not only to forest cover but primarily to the food security and life quality of forest-dependent communities.
The second largest contiguous area of tropical rainforests is located in the Congo Basin of Central Africa. These forests extend over 228 million ha, storing 36.815 billion tons of carbon and

providing habitats for over 11000 species of plants (many of which are endemic to the area) and associated fauna, including endangered species such as gorillas and chimpanzees (FAO, 2007). Because of these attributes the local governments are under international pressures to establish forest conservation areas by restricting the harvesting of timber and other forest products.
In 2003 there were almost 80 million inhabitants in the region with 62% of them living in rural areas and deriving their livelihoods from natural resources (FAO, 2005). That number includes an estimated 500 000 Pygmies who refer to themselves as 'people of the forest' and see themselves as distinct from their settled farming neighbours whom they call the 'village people' (Abega, 1998). The Pygmies and Bantus are commonly known as Baka and Bangando or Baweke in south-eastern Cameroon and Ba'aka, Bayaka and Bilos in the south-western Central African Republic (Jackson, 2004). The various ethnic groups have different perceptions of the values associated with forests and modern society. The Pygmies are characterised with distinctive social structures and lifestyles. Their livelihood strategy is based on the continued existence of forests and their ecological functions thereof (Tieguhong and Ndoye, 2007). According to Jackson (2004), Pygmies have extensive traditional knowledge about the forests - their ecology, wildlife and plants - giving a holistic meaning to the forest and themselves as intimately connected. There are however, differences between the various groups. Compared to the Ba'aka, the Baka Pygmies in Cameroon are more inclined to send children to schools, successfully undertake employment for wages, appreciate the value of money, learn and communicate in French, and participate in community activities. They are less dependent on the forest compared to other Pygmies living in the neighbouring countries. Contrary to the Pygmies, the Bantu people transform forestlands to agriculture through slash-and-burn practices (Jackson, 2004; Abega, 1998).
The official regional GDP per capita was estimated at US$ 411 per annum (FAO, 2005). Despite a relatively low population density (20 persons/km^2), population pressures escalate not only due to a relatively high population growth (2,5%) but also due to an increasing penetration of the previously inaccessible areas by logging and mining companies as well as a desire of the locals to improve their standards of living. Despite the fact that the forest-dependencies of the people are commonly recognized, no reports have been found quantifying their scale (Tieguhong and Ndoye, 2007; Ndoye and Tieguhong, 2004; Blom, 2001; Wilkie *et al.*, 2001). Any further policy development and implementation will depend on accurate estimates of the importance of these forests to the people who depend on them for shelter, food, medicine and other critical aspects of their livelihoods (Wollenberg and Nawir, 1998). No conservation approach can be successfully implemented without addressing the well-being of the affected people (Masozera and Alavalapati, 2004; Hedge and Enters, 2000; Gunatilake, 1998). This principle has already been accepted by international funding agencies which are increasingly interested in projects with simultaneous development and conservation components (Brown, 1998).
The objective of this study was to examine the income structure of the communities living around the Lobeke National Park (Cameroon) with special reference to the income component derived from the forests of this area.

Study area and methods

The Lobeke National Park (LNP) forms a part of the Sangha Tri-National Park (TNS) established on an area of 2.8 Mha (Figure 1). The TNS is a trans-boundary park declared by the governments of Cameroon, the Central African Republic and the Republic of Congo. It is an internationally acclaimed conservation area and expected to become a model for the future protection of forests at a global level.

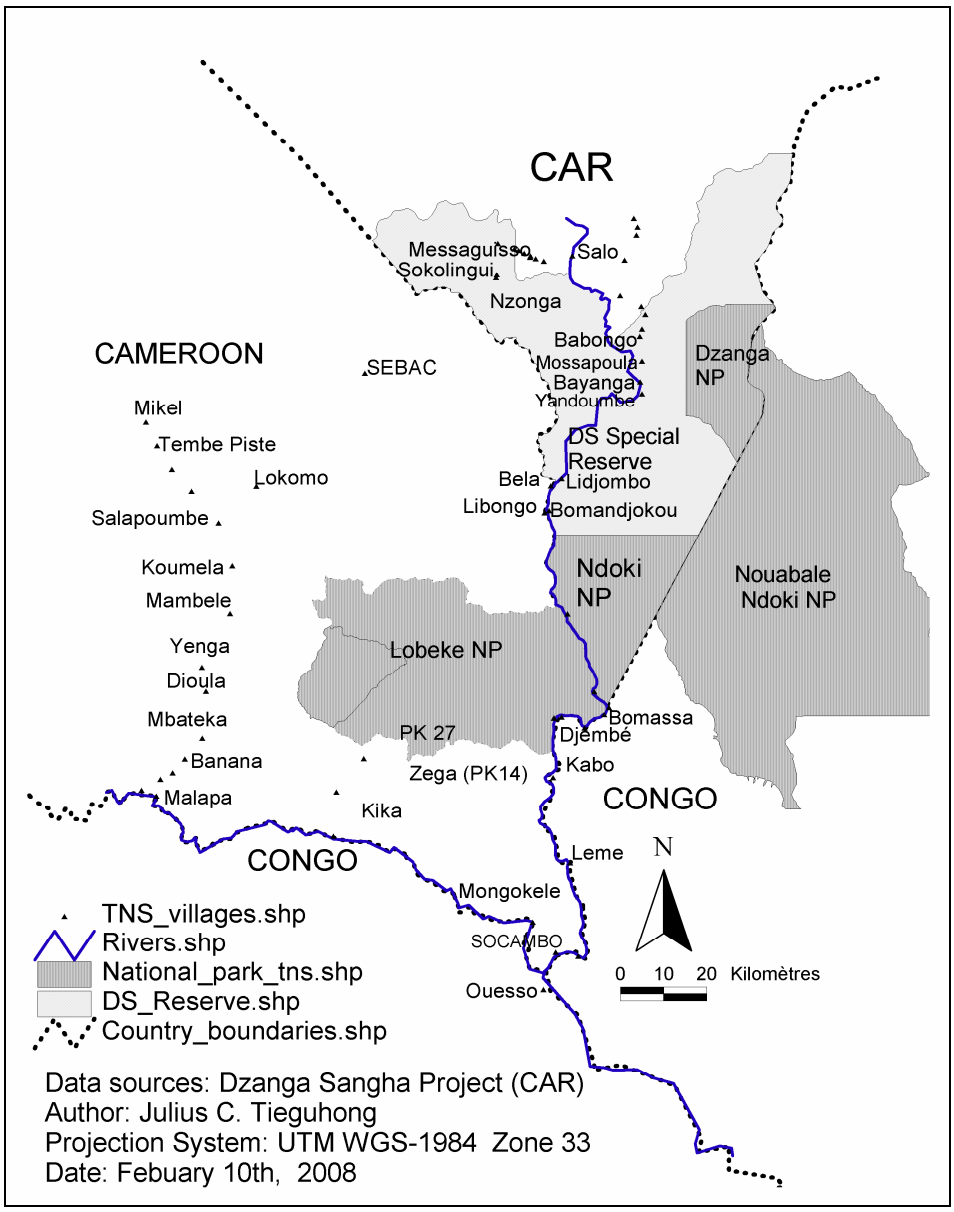

Figure 1. Components of the Sangha Tri-National Park and the location of villages around the Lobeke National Park in Cameroon.

In June 1998 the LNP was declared by the government of Cameroon in a response to international interests as a "Gift to the Earth". The LNP covers an area of 217 854 ha rich in forest resources and habitats of diverse and unique wildlife on which generations of indigenous communities have depended for millennia. This truly generous gesture is of high importance to the conservation, maintenance of biodiversity and life on Earth. However, its success will depend on finding the compromise between forest conservation and the needs of forest-dependent communities.

Five out of the existing fourteen villages located within a distance of 50 km from the LNP were randomly identified with 22-23 indiscriminant study households in each. These villages were: Koumela, Mambele, Libongo, Zega and Socambo which were inhabited by 825, 1153, 4032, 227, and 249 people, respectively. In total 111 households were investigated. Their income in cash and in-kind and other socio-economic characteristics of each household were researched in person by an enumerator after introducing the involved families to the purpose of this survey and gaining their support and cooperation. This survey was repeated quarterly over a period of 12 months based on a questionnaire translated into local languages for easy communication. Guided by some other studies (Vedeld *et al.,* 2007; Angelsen and Wunder, 2003; Campbell and Luckert, 2002; Campbell *et al.,* 2002; Luckert and Campbell, 2002; Campbell *et al*., 2000) the respondents were asked to report all

items that they collected from the forest and their quantities which they sold and consumed at a household level. This information was supplemented with the respondents' gender, education, age, duration of residence, household size and other socio-economic information, including their land ownership, crops grown on their lands and the yields (value) thereof.
The results were captured into Microsoft Access for checking and correcting thereof and later transferred by Stat-Transfer 5.0 to SPSS version 12.0 and STATA version 8 for further analysis. Microsoft Excel 2003 was also used for analysing the data, in particular to produce the descriptive statistics. A forest dependency index was calculated as a ratio between the forest-derived income and the total income. The conditions associated with the analysis of variance (normal distribution and homogeneity of variance) were investigated and since they were violated the Kruskal-Wallis test was used to study the difference of the income between the villages or income sources (SPSS User Guide, 1999). Significantly different means were separated with the Games-Howell test. This is a multiple comparison test applicable where the conditions of variance homogeneity were violated (SPSS User Guide, 1999). Finally logistic regression was used to study the relationship between forest dependency (households with over 49% of income from forests) and various other socio-economic variables.

Results and discussion

There were 693 people of diverse ethnic origin living in the 111 households studied. Household size ranged from 1 to 13 people and males were recognized as household heads in 86.5% of the households. The households were lead by married people (88.3%) and only 3.6% of the households were run by divorcees. In general the level of education was low with an average of 5.72 years of schooling whilst 11.7% of the population were without any education. Some households owned up to 14 ha of agricultural land but the average area of agricultural farms was 3.33 ha.
The results showed that the forest-derived income totaled US$ 36347 (44.4%) compared to US$ 45439 (55.6%) for the other sources of income in all the households. A mean annual income per household ranged from the smallest of US$ 567 in Socambo to the highest of US$ 1212 in Mambele (Figure 2). Agricultural farms were larger in Mambele (3.91 ha) and Koumela (3.82 ha) compared to the other villages. Mambele was also one of the largest villages what may provide for diverse employment and business opportunities. The opposite was true for the lowest income villages of Socambo and Zega. The mean total incomes of the villages differed significantly ($df=4$, $\alpha= 0.008$, $p \leq 0.05$) with Mambele, Koumela and Libongo ranked among the wealthier villages while Zega and Socambo among the poorest ones. The results (Figure 2) also showed that the poorer the village, the larger the proportion of the overall livelihood value was derived from the in-kind benefits. The difference in the total annual income was mainly due to the access to cash income.
The villagers derived their income from eight different activities: (i) consumption and sale of forest products, (ii) agriculture and food production, (iii) fishing and aquaculture, (iv) livestock rearing and animal products, (v) prospecting for gold and minerals, (vi) employment for wage income, (vii) small business enterprises, and (viii) grants and donations (Figure 3).
Clearly goods associated with shelter and food security dominated the income generated by the households with forest products being the major and the most valuable source of them. The most important forest products were wild fruits, bushmeat, woodfuels, followed by wild vegetables, medicinal plants, woven products, honey, nuts and poles (Table 1).

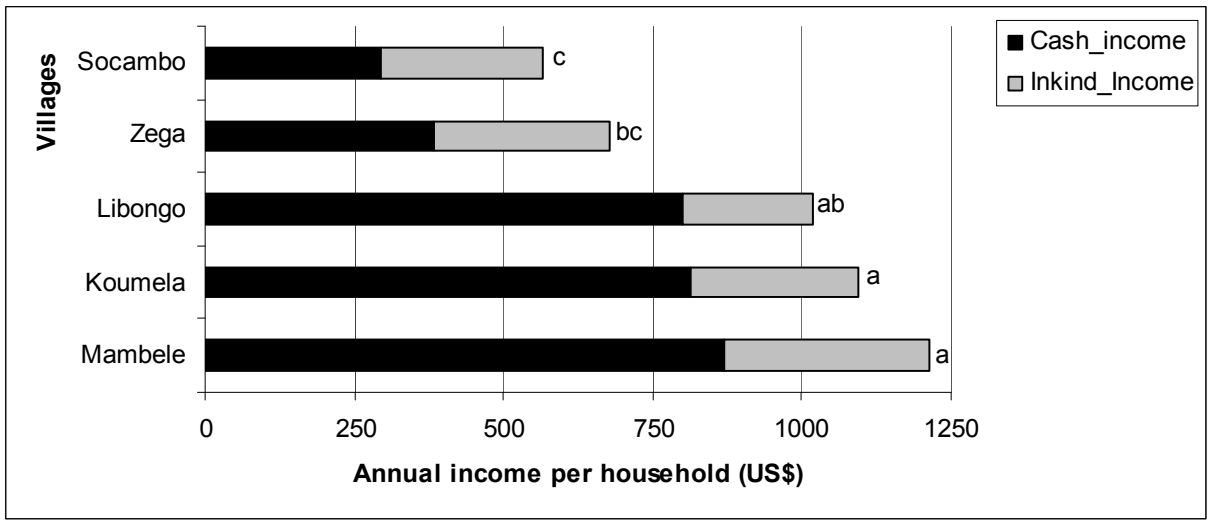

Figure 2. Mean cash and in-kind (goods) annual income per household in villages near the Lobeke National Park in Cameroon (means identified with different letter index are significantly different at $p \leq 0.05$).

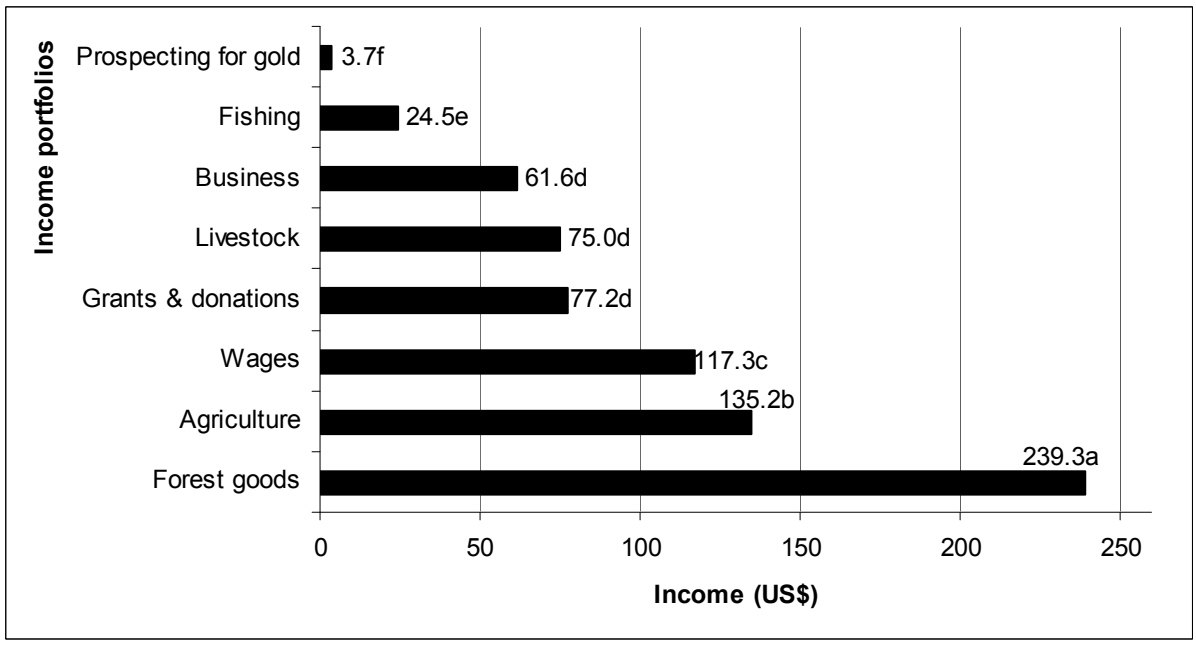

Figure 3. Mean annual household income by activities registered in villages near the Lobeke National Park in Cameroon (means identified with a different letter index are significantly different at $p \leq 0.05$).

Of all the sources of forestry-derived income (US$ 304.61 per household), the wild fruits provided the highest value to the households of the forest dwellers in the region. This combined with bushmeat and woodfuels gave the villagers 78% of all the value in the forest product category and 61% of all the income derived from the forests.

Correlation analysis showed that there was no association ($r = 0.026$, $p = 0.788$) between the values of the forest-derived products and the other types of income combined. This is an important finding, showing that, within the income range of the studied rural households, the dependence on natural forest resources cannot be easily altered by simply providing alternative means of subsistence. It is uncertain if this is due to the traditional habits and beliefs of the forest dwellers or due to an insufficient income even at higher income levels.

A mean forest dependency index ranged from 0.10 to 0.82 for the sample households (mean=0.49 and sd=0.18). The average forest dependencies were the highest (0.56) in Socambo and the lowest (0.42) in Koumela. Zega (0.50), Libongo (0.45) and Mambele (0.49) yielded intermediate values.
An attempt to explain forest dependency (forest dependency index >0.49) only with the social characteristics of the households was unsuccessful. Only when the other sources of income were incorporated, the model was significant and explained 90% of the probability of forest dependency (Table 2).

Table 1. Components of the forest-derived annual income (US$/household) in villages near the Lobeke National Park in Cameroon (means identified with different letter index were significantly different at $p \leq 0.05$).

Type	**Income (US$/household)**			
Products:	Minimum	Maximun	Mean	Std deviation
Wild fruit	0.00	310.00	82.63[a]	57.55
Bushmeat incl. insects	0.00	142.00	61.26[ab]	29.11
woodfuels	7.20	85.60	42.18[b]	13.92
Wild vegetables	0.00	24.80	7.73[c]	4.83
Medicinal plants	0.00	34.00	7.50[c]	7.09
Woven products	0.00	58.00	6.78[c]	8.84
Honey	0.00	48.00	6.32[c]	9.69
Nuts	0.00	43.00	6.22[c]	8.53
Poles	-3.80	50.00	5.01[ce]	6.08
Bamboo	0.00	29.00	3.83[e]	7.13
Rattan	0.00	30.00	3.63[e]	5.88
Mushroom	0.00	16.30	2.84[e]	3.16
Maranthaceae leaves	0.00	27.40	1.78[e]	3.27
Roots and tubers	0.00	18.00	1.26[e]	3.44
Sub total 1	85.80	581.60	238.96	80.30
Source of wages:				
Timber various	0.00	672.00	35.62[a]	94.97
Timber processing	0.00	490.00	28.57[b]	88.84
Timber logging	0.00	75.00	0.68[c]	7.12
Timber transport	0.00	18.00	0.16[c]	1.71
Sub-total 2	0.00	672.00	65.03	130.02

Table 2. Coefficients and elasticity of the significant ($p \leq 0.05$) independent variables in logistic regression of forest dependency among households neighbouring the Lobeke National Park in Cameroon.

Independent variables	**Coefficient**	**Elasticity**
Education	0.423	0.106
Income from fishing	-0.033	-0.008
Prospecting for gold & minerals	-0.053	-0.013
Non forest wage income	-0.016	-0.004
Business income	-0.015	-0.004
Agricultural income	-0.017	-0.004
Income from livestock	-0.016	-0.004
Other non-forest income	-0.014	-0.003
Constant	6.452	

The following variables were insignificant in explaining forest dependency of the households: duration of residence, ethnicity, household size, age and gender of household head, area of land owned, memberships of forest user groups. It is possible that the households were too homogenous and insufficient social differences existed as some of the variables, e.g. the ethnicity, was expected to be significant. Only "education" was significant and included in the final model. It is possible that the educated people were more successful in attracting income. This being due to their higher mobility and efficiency in generating income from the collection and trade in forest products as well as from forestry services and employment. Obviously the higher the income from the other sources the lower the chance of a household becoming forest dependent. Therefore all the respective coefficients were negative. The elasticity index indicates the percentage change in the probability of forest dependency at 1% change of the respective value (e.g. income). For instance, 1% increase (or decrease) in the income from fishing (US$ 25/household/annum) will decrease (or increase) the probability of a household forest dependency by 0.008%.

Conclusions

In 2004, the International Fund for Agricultural Development (IFAD) asserted that about 80% of the population in developing countries uses forest products on a daily basis and about 75% of poor people that live in rural areas depend on forests for subsistence (IFAD, 2004). According to Dubois (2003) over 1.6 billion people of the world depend heavily on forest resources for their livelihoods. In this study the 693 people were found to be dependent on forest resources and services valued at US$ 36347 per annum, i.e. 52.45 US$/person/annum. With 80 million people in the Congo Basin and 62% of them living in forest-dependent communities, this can translate to 2602 million US$ of generally unaccounted contribution of forests to rural livelihoods. These results clearly demonstrate the level of poverty in this region and therefore the dependence of the rural communities on forest products for survival.
International efforts to prevent deforestation and the degradation of forest resources in the tropics will remain ineffective unless other means of subsistence are developed for the currently forest-dependent poor. These actions must take into account traditional value systems.

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2. *Ecosystem Service Provision on the Cumberland Plateau, USA: Landowner Motivation and Alternative Incentive Mechanisms*

Donald G. Hodges and Neelam C. Poudyal
Professor and Graduate Research Assistant, The University of Tennessee
Natural Resource Policy Center, Department of Forestry, Wildlife and Fisheries
274 Ellington PSB; Knoxville, TN 37996-4563 USA
Tel. +1 865 974 2706, FAX: +1 865 974 4714
dhodges2@utk.edu

Abstract
Ecosystem services offer an added value of forest land that could entice individuals in rapidly developing areas to maintain their lands in forest cover – if landowners are able to capture this value via the market or other incentives. This paper explores the feasibility of using ecosystem services to encourage landowners in a region experiencing substantial changes in land use patterns to maintain their forests. The first portion will describe a preliminary study that segments private forest landowners in the region according to their level of interest in providing selected ecosystem services and evaluates landowner preferences for different types of financial incentives. The results reveal that there is notable variation among landowners in terms of their interest in provision of ecosystem services and preference for incentive structure. The second portion will review the potential for alternative incentives to encourage ecosystem service provision within a regional context.

Keywords: Ecosystem Services; Land Use Change, Non-Market Valuation; Parcelization

Introduction

Forests have been considered primarily as a source of timber and other wood products historically. Conversely, ecosystem services that forests provide remained under supplied, if not ignored, until recently. Forests provide a wide range of benefits that have environmental, economic, and aesthetic value for society, including biodiversity preservation, carbon sequestration, water and air quality protection, recreational opportunities, endangered species protection, and aesthetic beauty. The supply of forest ecosystem services in the United States is compounded because the majority of the nation's forests are privately owned. Moreover, most of the private forestland management in the U.S. is focused on traditional forest products such as timber and other wood products for which markets exist. The USDA Forest Service estimates that over 17.8 million hectares of private forests, 11 percent of the total area, are at risk of conversion to development within the next two decades (Stein et al. 2005).

The sustainable supply of ecosystem services from U.S. forests will depend on private forest landowners' interest in managing their land for those services. A few existing federal programs have provided payments to encourage landowners to adopt conservation practices, indirectly enhancing ecosystem service provision. In addition, private markets have been emerging for some of the forest ecosystem services such as carbon sequestration and water quality (Pagioloa et al. 2002). Establishing formal markets will not only promote good stewardship but also increase landowner returns to their land. Private forest landowners may be willing sellers of such services, provided financial incentives are provided. Identifying landowners who are interested in managing their forest for non-timber benefits will be critical if effective strategies are to be developed to encourage landowners to supply the desired ecosystem services. While previous studies regarding ecosystem services have been focused on estimating the total economic value of all or a portion of

such services (Costanza et al., 1997; Loomis et al. 2000; Knoche and Lupi, 2007), none of the studies with some notable exceptions (Olenick et al., 2005; Church and Ravenscroft, 2008) have examined the landowner's perspectives on providing the services.

This paper explores two aspects of ecosystem services from private forestlands in the United States. First, we assess landowner willingness to manage for specific ecosystem services. We also examined landowner interest in different financial incentive mechanisms, and land use restriction issues that might affect landowner willingness to accept such incentives. To achieve these objectives, we first segmented the landowners according to their level of interest in providing the selected ecosystem services, and then examined the characteristics and perspectives of landowners in each segment. The second aspect we explore in the paper involves the feasibility of alternative incentive mechanisms to foster collaboration among landowners in ecosystem service provision,

Methods

Involved surveying nonindustrial, private forest (NIPF) landowners to assess interest in and barriers to managing for ecosystem services on the Plateau. The study was conducted among NIPF landowners on the Cumberland Plateau of Tennessee. The Plateau is one of the world's "largest, temperate hardwood plateau systems" and has remained remote and largely undeveloped until recently because of the rugged terrain (TNC, 2008). The Nature Conservancy (TNC) (2008) estimates that the Plateau supports more than 2000 species of plants and the largest number of cave invertebrates in the world. Recent studies revealed that some Plateau counties experienced growth in retiree populations as large as 28 percent between 1990 and 2000 (US Census Bureau, 2000). As the area is being developed as a prime retirement destination, the future of forest areas, especially those under private ownership, is uncertain. Hence, the production and supply of ecosystem services from the Plateau depend on the interests of numerous landowners in the area.

The landowner survey was mailed to more than 1600 private forest landowners in the region who owned at least 16 hectares. Survey questions addressed ownership objectives and management characteristics, level of interest in managing for selected ecosystem services, preferences for different financial incentive mechanisms and land use restrictions, and demographics. Of the original survey population, 246 names were eliminated due to bad addresses, death, or having sold the land. A total of 695 completed surveys were returned, for an overall return rate of 39 percent. Because some of the surveys contained incomplete information for this analysis, a total of 592 surveys were used in the analysis.

Following Salmon et al. (2006), we segmented the respondents using K-means cluster analysis. K-means cluster analysis uses a classification algorithm to classify individual observations into meaningful groups. It allows one to specify the number of clusters (K), and the algorithm classifies individual observations into these clusters (Weinstein, 1987). Cases of similar response patterns are grouped in one cluster whereas dissimilar responses are used to create new cluster. Since our purpose of cluster analysis was to distinguish landowners according to their interest in providing ecosystem services, six variables representing landowner's level of interest in providing different ecosystem services were used to detect the clusters or segments. The ecosystem services included in these variables were enhancing wildlife habitat for hunting, protecting water quality, storing carbon, maintaining forest cover for aesthetics, protecting endangered species, and enhancing habitat for birds. Since, these are among the major services produced in forest ecosystems (Notman et al. 2006), we believe those are enough to solicit landowners' general response to provision of ecosystem services. It should also be noted that many of these services could be produced jointly as well.

Results and Discussion

While selecting the *a priori* number of clusters is rather subjective, a 3-means clustering produced the clearest division between three different segments of landowners. The average responses of landowners in each segment are presented in Table 1. The first segment included 255 landowners (43 percent) who had the highest level of interest in managing their forest for all types of ecosystem services. This segment was defined as 'probable managers' because the probability of managing land for selected ecosystem services was high. The second segment included 244 landowners (41 percent), who expressed some interest in all ecosystem services, but did not indicate strong interest in any specific service, and hence was defined as 'potential managers'. The third segment included 93 landowners (16 percent), whose levels of interest were little or none, and hence defined as 'unlikely managers'. Landowners indicating a strong interest (interest level=4) in those services were separated as a percentage of the segment population and tabulated (Table 2).

Landowners with a strong interest in managing their forestland for selected ecosystem services dominated the probable managers segment. However, there was a within the cluster variation in terms of their strong interest in particular services. For example, approximately 90 percent of the landowners in this segment were strongly interested in managing their land for protecting water quality, whereas only 51 percent were interested in enhancing wildlife habitat for hunting and recreation purposes. Similarly, more than 80 percent of the landowners expressed a strong interest in managing their land for storing carbon, maintaining aesthetic beauty, protecting endangered species, or enhancing habitat for birds. In the 'potential managers' segment, the proportion of landowners indicating a high level of interest was significantly less than in the 'probable managers' segment. However, 39 percent of the 'probable managers' indicated a high level of interest in managing their land for water quality protection. Landowners in the 'unlikely managers' segment did not express a high interest for any type of ecosystem service, with the exception of 10 percent who expressed an interest in managing land for water quality. This reveals an overwhelming interest of landowners in the area in protecting water quality.

Although many of the ecosystem services included in the study could be produced jointly, most landowners were more interested in ecosystem services such as water quality or carbon storage than utilitarian services such as wildlife hunting (Table 2). Overall, water quality protection as an ecosystem service was the most common ecosystem service cited by all three groups. Still a significant number of landowners in two of the three categories were strongly interested in managing for ecosystem services.

The landowners did not differ substantially across segments with regard to demographic and personal characteristics, although some characteristics were dominant in particular clusters (Table 3). Landowners did not differ significantly in age and occupation. Probable and potential manager segments contained a higher proportion of white-collar jobs compared to unlikely managers. Slightly more than one-half of the probable and potential managers indicated that their forestland was their primary residence, compared to slightly less than one-half of the unlikely managers. Among those who lived away from their forest, probable and potential managers on average lived further from their forests than the average non-resident unlikely manager. A notable variation in income level was evident among the segments, as unlikely managers were more likely to have lower incomes than probable or potential managers.

Landowners did not differ dramatically across segments in terms of area owned (Table 4). Interestingly, landowners in the potential managers segment were more likely to control forests larger than 40.5 hectares. While the landowner's enrollment in government cost-share programs is not very common among NIPF landowners of Cumberland Plateau area, probable managers (9 percent) were more likely to have enrolled in some kind of program, compared with potential (5 percent) and unlikely managers (2 percent).

The survey asked respondents to indicate their preference for three different types of incentives: property tax incentives, payments from private individuals or companies, and payments from government. The results reveal a consistent preference of landowners for these three types of

incentives, regardless of their level of interest in providing ecosystem services. The largest number of landowners in all three segments ranked the property tax incentive first, followed by payments from the government and payments from the private individuals and companies. This might be attributed to the fact that a property tax incentive is the simplest and most easily administered payment mechanism, and one in which most landowners are familiar. Landowners preferred payments from government to private individuals, perhaps due to the uncertainty and legal and liability issues they might experience in private transactions. Compared with other segments, the unlikely managers segment had a higher proportion of landowners indicating that all of those incentives would be not or only slightly useful.

Landowners also were questioned regarding their willingness to accept land use restrictions associated with incentives. Examples include government cost share programs to protect water quality preventing property development, and a carbon offset contract with a private company limiting timber removals. Landowners responded differently by segment to the questions regarding restrictions. The majority of landowners (nearly 75 percent) in each segment indicated that allowing public access to their land would prevent them from accepting incentives. This is consistent with our observation in landowners' segmentation (Table 2) that relatively fewer probable or potential managers were interested in providing hunting, which requires access to the property. The results reveal that overall landowners are less likely to participate in ecosystem services schemes that would require public access to their land or prohibit new construction in their land. Compared to the other two segments, probable managers were more likely to accept restrictions that limit development opportunities (31 percent) and harvesting (40 percent). Roughly the same proportion of landowners in all segments was unsure about the impact of restrictions.

Alternative Incentive Mechanisms

The findings of the landowner interest survey have been used to inform the second wave of the study which will examine landowner interest in alternative incentive mechanisms to enhance ecosystem provision. As described in the introduction and the discussion of the results, the bulk of forest area in the region is controlled by nonindustrial, private forest landowners, most of whom have not utilized public cost-share programs in the past. The key, then, is to determine how to identify those landowners most likely to enroll in such programs, the program characteristics most attractive to landowners, and the type of incentives that will achieve the objectives of ecosystem service provision. The results of our survey and recent research can address the first two factors. Kaetzel (2008) assessed the factors related to prior use of cost share programs for conservation. These included landowners with larger land holdings, prior contact with professional resource managers or agencies, and possessing management objectives related to financial returns. The results of our survey reveal that the landowners most interested in ecosystem service provision, the "probable managers" do not necessarily own the largest tracts, on average, of the three landowner segments. However, they are more than twice as likely to have prior experience with cost chare programs.

The current study also provides some insights into the type of incentive that would be preferred by the majority of landowners. Specifically, landowners in all three segments were more likely to opt for an incentive tied to property taxes than direct payments by governmental or private entities. The use of property tax incentives could pose problems logistically, as most ecosystem service program are being initiated by private organizations or state governments, while property taxes are collected by local governments for which these taxes are the major source of revenue. Such issues could be resolved, however, with fund transfers from the state to local governments to replace the lost revenue a proactive that has been utilized in the past to fund state initiatives.

The primary issue remaining is to identify the incentive mechanisms that will achieve the objectives of enhanced ecosystem service provision. A number of papers have been published recently describing and evaluating some potential incentives (Koskela et al. 2007, Parkhurst and

Shogren 2007, Bergman and Bliss 2004, Parkhurst et al. 2002, Rickenbach and Reed 2002, Heal et al. 2001). Goldman et al. (2007) provide an overview of three primary types of cross-boundary incentive structures that could be employed in a region such as the Cumberland Plateau in which ecosystem services must be managed over a large number of forested tracts with multiple owners. The first incentive, an agglomeration or cooperation bonus, encourages cross-boundary provision of ecosystem services or conservation by providing a 'bonus' for enrolling land adjacent to other landowners' land that has been enrolled in the program. Landowners could receive a reduced property tax burden for enrolling their forest in an ecosystem service program, for example, but receive a larger reduction for enrolling areas that border other landowners' land enrolled in the program. A major advantage of the agglomeration bonus is that it encourages cross-boundary provision of ecosystem services without requiring direct cooperation among neighboring landowners, thereby reducing transactions costs substantially. Parkhurst and Shogren (2007) have demonstrated using economic experiments that the bonus is effective, after the subjects have become familiar with its structure.

The second mechanism requires an increasing level of cooperation among landowners. The entrepreneur incentive allows landowners to act upon information regarding potential ecosystem service provided by a government agency or other organization to identify the "landscape that is both feasible and effective for ecosystem service provision," The group could then receive a total payment for the project to be allocated based on land area enrolled by individual landowners or the effectiveness of providing ecosystem services (Goldman et al. 2007). The authors state that this incentive has not been applied to ecosystem services to date, but an ongoing effort in the Cumberland Plateau to establish a Habitat Conservation Plan (HCP) for multiple federally listed endangered species offers a similar structure. An HCP requires landowners to agree upon appropriate management practices that they can employ to achieve their management objectives and protect the habitat of the target species. Rather than receiving a payment for applying these practices, however, landowners simply are allowed to apply these practices after approved by the U.S. Fish and Wildlife Service without fear of violating the Endangered Species Act and facing civil or criminal penalties. The Cumberland Plateau HCP process is progressing in the region, primarily through the efforts of several local governments.

The final incentive mechanism, ecosystem service districts, entails a more formal, legalistic structure than the first two alternatives. This approach involves both incentives and regulations and once the majority of landowners in the area vote to form a district, all landowners are required to participate. The primary disadvantages are the obvious large transaction costs and the difficulty of applying the concept to ecosystem services in a heterogeneous landscape (Goldman et al. 2007). It does hold the potential, if developed correctly, to encourage the management of common-pool resources effectively (Wagner and Kreuter 2004).

Conclusion

Based on a survey of forest landowners on the Cumberland Plateau of Tennessee, the study assessed the landowner perspective on managing for selected ecosystem services. The findings from this study have several implications in forestry, land use planning, and ecosystem management. First, only a specific group of landowners were interested in managing their land for ecosystem services. While several ecosystem services could be jointly produced in a forestland, landowners were more interested in certain type of services than others. Moreover, our study identified three distinct segments of forest landowners, according to their level of interest. Landowners of the probable manager segment were overwhelmingly interested in managing their land for any type of ecosystem services, and could be approached by the professionals interested in promoting the supply of particular services. Similarly, potential managers could be the targets of a second stage. Raising the interest of landowners of this segment would be important in the long-run, because the

perpetual supply of ecosystem services would require a landscape approach, where a vast number of landowners protect a sizable amount of forests to produce various ecosystem services.

Second, property tax breaks were the preferred financial incentive to landowners. Additionally, landowners preferred payments for ecosystem services from the government to that from private individuals. Third, landowner willingness to supply ecosystem services is influenced by the type of land use restrictions they would face under various incentives. In particular, not many landowners would be inclined to manage for ecosystem services if it required public access to their property or prohibited new buildings on their land. Conversely, the majority of owners would accept incentives to produced ecosystem services even if it limits timber harvesting or prevents them from developing their land. With this in mind, the area might experience a limited supply of certain ecosystem services such as wildland recreation or hunting, which requires public access, but a comparatively better supply of services such as carbon storage and water quality protection.

The results also lead to the next phase of the study which involves developing appropriate mechanisms to encourage enhanced ecosystem service provision. Recent work has identified at least three alternative structures that vary in terms of the level of landowner cooperation required, transaction costs, and possible effectiveness. For the Cumberland Plateau, the most likely determinants of success will include the degree to which a landowner population that is growing in numbers and diversity can cooperate across property boundaries, the source of funding, and the ecosystem services targeted. The Plateau forests have been transformed from a region characterized by large, contiguous tracts of single commodity-oriented ownerships to a mosaic of smaller holdings whose owners purchased the land for a diversity of non-commodity purposes. Any program to encourage ecosystem service must take this diversity into account. The region also can be characterized by a history of mistrust of government and external party efforts. Thus any incentive mechanism must be transparent in terms of funding sources, landowner requirements, and program objectives. Another issue that must be addressed is the potential conflict between ecosystem services. Caparros and Jacquemont (2003), for example, discuss the conflicts between programs aimed at carbon sequestration and biodiversity. Even among the multiple habitat efforts on the Plateau, conflicts could arise between managing for game species reliant on early successional stages and migratory neotropical songbirds requiring large, contiguous tracts of mature hardwood forests.

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Table 1: Landowner interest in managing for ecosystem services by landowners segments

Ecosystem services	Landowners segments		
	Probable Managers	Potential Managers	Unlikely Managers
Enhancing wildlife habitat for hunting	3	3	1
Protecting water quality	4	3	2
Storing carbon to reduce global warming	4	3	2
Maintaining forest cover for aesthetics	4	3	2
Protecting rare and endangered species	4	3	1
Enhancing habitat for birds	4	3	2

1 = no interest, 2 = slight interest, 3 = some interest, 4 = high interest

Table 2: Percentage of landowners with a high level of interest in managing for selected ecosystem services by segment.

	Probable Managers (percent)	Potential Managers (percent)	Unlikely Managers (percent)
Enhancing wildlife habitat for hunting	51	22	0
Protecting water quality	90	39	10
Storing carbon to reduce global warming	79	11	1
Maintaining forest cover for aesthetics	79	25	1
Protecting rare and endangered species	83	8	0
Enhancing wildlife habitat for hunting	86	14	3

Table 3: Demographic characteristics of forest landowners by segment

	Probable Managers	Potential Managers	Unlikely Managers
Education			
High school or less (percent)	27	25	43
Some college or Vo-tech training (percent)	28	30	28
College graduate or advanced degree (percent)	44	45	30
Age (years)	60	59	61
Occupation			
White collar (percent)	25	23	19
Blue collar (percent)	6	12	5
Farmer (percent)	6	7	7
Retiree (percent)	30	29	35
Others (percent)	33	29	34
Primary residence			
Forestland in Cumberland (percent)	53	45	54
Away from forestland (mile)	238	171	104
Gross Annual Income	291	216	158
Less than $ 25,000 (percent)	17	12	21
$25,000 - $ 75,000 (percent)	47	44	59
More than $ 75,000 (percent)	36	43	20

Table 4: Forest ownership and management characteristics by segment

	Probable Managers	Potential Managers	Unlikely Managers
Forest area owned			
Less than 4.5 hectares (percent)	2	3	2
4.5 – 20 hectares (percent)	54	45	58
21 - 40.5 hectares (percent)	23	23	20
More than 40.5 hectares (percent)	21	30	20
Own multiple tracts on Cumberland Plateau (percent)	22	33	15
Enrollment in government cost-share program (percent)	9	5	2
Tenure			
Less than 10 years (percent)	27	31	25
10 - 25 years (percent)	27	21	20
26 - 50 years (percent)	19	22	30
More than 50 years (percent)	28	26	25
Lost tree from Southern pine beetle epidemic (percent)	48	47	39
Harvest plan in near future (percent)	27	38	28

3. Segmentation as a tool to adjust forest management to its social context

Dr. Nevenka Bogataj
Andragoški center Slovenije, Šmartinska 134 a, 1000 Ljubljana
T: (+386) (0)1 5842 579, E: nevenka.bogataj@acs.si

Abstract
Multifunctional forest management calls for R&D engagement in - up to now more or less neglected field of sustainable development – its social pillar. We present a method of segmentation which has not been used in Slovenian forestry up to now. It was used as a structuring method in a sample of Slovenian public regarding its relation to the forest. Segmentation is a two step clustering analysis of quantitative and qualitative data gathered among study circles participants as a sample. It consists of three key working phases and is generally known in marketing. We see potential and the role of segmentation method for forestry in rationalisation of forest management on different levels by recognising the diverse structure of society and by addressing priorities of its segments.

Keywords: segmentation, forestry, Slovenia, method, structure of society, learning, sustainable development

Introduction

Traditionally Slovenian forestry is focused on forest use, protection and management. As interpretation of forest state, trends and other measures is people based, public relation is also extremely important for forestry.

Plural society is dependent primarily on knowledge and information flow; therefore it is called information society or knowledge society. The background consists of the lifelong learning concept. Information/knowledge flow can only occur among people; therefore learning is crucial while its object is forest, its management, forest user's behaviour, roles, structure etc. As forest covers such a huge share of Slovenian surface it is hard to find someone who is not a forest user in some way. Even foresters we are an important public therefore internal information infrastructure has been developed during the last decade. It consists at least of:

- Regular professsional meetings (e.g. forest study days) with occasional accent on sociability (e.g. meeting of Forestry Service staff),
- Media infrastructure (List, intranet) including professional periodical papers (Zbornik gozdarstva in lesarstva, Gozdarski vestnik),
- Occasional EU projects (e.g. Lifelonglearning programs/e.g. Leonardo da Vinci, Erasmus) and
- Informal individual meetings.

Communication with general public is organised through diverse events, usually of educational and/or developmental nature where motivated participants are mobilised, while less motivated public is adressed by mass events and media (e.g. Forest Week, Earth Day). Events cited are yearly listed in a Forestry Service report. An important communication channel has proven to be personal contacts of local foresters with forest owners and/or local environment, including written orders/provisions of forest measures.

Grounded and rational communication of profession with forest users calls for more data on forest users e.g. on the general publics´ opinion. Slovenia only has a decade old general data on this issue

(Šinko and Malnar, 2000) and several case studies (comp. Oršanič 2005), among which forest owners are the most studied part of population (Medved 1994, 1997, 2002). Along the National forest programme debate in 2006 we got more general picture of »motivated part of public« (Golob 2008).

The question is who presents the »non-motivated part«of the public? Does it prevail or not? Who can we count on as a partner in our efforts if we hypotesise that "partners" have positive attitudes towards forest/forestry and/or at least some knowledge about it? What do we know about attitudes of general public toward forest/forestry? Who do we intend to communicate primarily with - partners or conflict makers? Can we imagine as partners young urban inhabitants, ICT litterate but without forest related experience and low interest in forest/forestry issues or we prefer older rural inhabitants, who cut and manage their forests by their own, and are on the other side of the »digital barrier«? Quantitative description of such (speculative) divisions might illustrate complexity of the question and urgent need for both quantitative and qualitative data on forest owners, forest users and society in general.

The focus of this text is a method of general public stratification in order to support forestry in its dealing with demographic and social changes, characterised by lower coherence of European society and its relatively high material welfare (comp. Rosling 2004). As plural, uncohesive environment supports subjectivity of individual perceptions (comp. Luckmann 1966 cit. in Luckmann 2007), measuring methods of forest related behaviour, standpoints and values gain role and deserve attention.

We tested the method on the study circle participants´ (non-representative) sample.

> **Study circles** are an organised form of intentional community learning for adults and a key reference reference of non-formal adult learning in Slovenia (see data on http://www.sk.acs.si). Study circles participants represent occasional structured public as a study circle has no legal status and is dependent on motivation of people and ground basis for their work (some room, material, financial norms). Forestry Service offer study circles as well. Even more, their educational role is upgraded by promotion of forestr-related topics and by systematic communication with public on local development and other actual issues.

Measurable indicators we used were:
- Social structure (age, education lenght, the number of family members, income, etc.) and
- Subjective perceptions of forest and forest management.

The basic question was: is it possible to structure study circle participants according to the non-classical indicators which define their relation towards forest?

Literature review

Structural changes of society until recently have simply not been »forestry field of work«. Forestry profession status amongst the general public decreases and is – at least in Slovenia - poorly visible. European authors introduce sociological studies quite dispersed (Nyskanen 2001, Elands and Wiersum 2001, 2003, 2004, Slee, 2003, Rametsteiner and Kraxner 2003). Rural studies and bibliography on gender issue in forestry seem important (Lidestav and Sjölander 2007) as they give a clear message about overcoming of physical distance between people and forest and an insight to our own functioning. As rural inhabitants generally have stronger ties with forest, they might be our most important partners; however their complex relationship with forest/forestry is still poorly understood (comp. Bogataj 2007). Social structure of Slovenian rural population (51% of inhabitants) is colourful and characterised by low formal education of farmers (Korošec, 2002, Kovačič et. al., 2006, Jelenc Krašovec and Kump 2007), changed women role (Černič-Istenič et al., 2003), poorly developed lifelong and lifewide learning (Gougoulakis and Bogataj, 2007) and weak cooperation of sectors (Lampič, 2005; Klemenčič et al., 2005). Studying of key (general) learning

motives has shown that they are forest related just in a limited scale, while for example interest to cope with digital litteracy is high in all target publics. We lack of levers for intentional communication (management) of target groups, as they have not been identified in a structural manner. Slovenian PR is not data rooted (e.g. on forest users needs) but on strenght of decision makers on different levels, their knowledge on this field and quality of their link with users. Monitoring and respect of individual person through the dialog with her/him is the first step suggested and its continuation with acknowledging of the discourse and gathering of the data. Our approach was a test of a marketing method, segmentation which followed to triangulation of methods for better general understanding of the population studied as segmentation variables definition depends on population characteristics. Detailed sample description and context of research is presented in Bogataj 2007. As segmentation results are not strictly delimited categories we put attention to our approach and not results – they are meant as an illustration only. Our main message therefore rises out of method description and interpretation of its potential role in forestry.

Method description

Segmentation is a densification and delineation of dispersed characteristics on the basis of their equity and their presentation. The choice of a sample roots in several reasons:
- Study circles, leaded by menthors, represent informational channels in diverse local environments all over Slovenia. Therefore they are a potential for inclusion of socially excluded, non-interested target groups and those who are difficult to access;
- It was possible to monitor them for several years in the context of the Slovenian study circles network. Mentors are forest professionals with special training for educational work in groups. Their local origin and housing aquaint them well with the local informal information flow;
- It was possible to gather data rationally and thus carefully define the segmentatin variables.

Variables were both quantitative and qualitative characteristics of study circle participants: their age, education lenght, elements of their lifestyle and parts of their biographies. Special care was given to the questions of individual link to the forest, him/her knowledge and learning about it and his/her personal attitude to the forest.

There were three phases of segmentation:

1. Monitoring of the basic sample characteristics (its geography, demography, pschyology, socio-cultural aspects, behavioural typics) and defining of criteria for units inclusion into the sample,
2. Analysis and its elements:
    - Decision for the data analysis method (in advance or post hoc); we decided for the two step post hoc cluster analysis, as it enables large datatsets and analyses numerical and categorical data at the same time;
        i. We have sent inquiries to all the study circles in 2003 and got filled them up back in a two week period from 354 participants.
    - Defining of variables and omitting of those which were connected;
    - The questionnarie consisted from 80 questions;
    - Sample definition
        i. Study circle participants
    - Data collection;
    - Data analysis (SPSS programme).

    Two step cluster method takes a minimal distance among individual units as a clustering criteria. It groups individual data around cores of the group and than makes a draft Cluster Feature Tree. The number of clusters was defined automatically according to the Bayes infromational criteria (BIC) as we omitted defining the number of clusters in advance (AIC

criteria). Individual data were then adjusted to the cluster according to the distance of their centre by searching of the maximum distance between the closest clusters at every hierarchical phase. The distance measure was Log Likelihood distance, as variables were nominal and ordinal at the same time.

CFT (cluster feature tree) has more nodes. New facts enter through the leaves, nodes without leaves serve for directing to the right node with leave. An entrance is defined by the cluster tree, described with the number of unites, average and variance for numerical variables and number of categorical variables. If the unit is within the distance of the closest entrance, it absorbs it while the entrance is defined once again. If there is no room for the new entrance on the node, the node is divided into two ones, its content is delineated between them according the same procedure while the most different data are used as seeds. In case, da of maximum CFT growth, a new CFT is being made with rising of criterial distance.

CFT growth is dependent on data entering; therefore we entered the data occasionally. Data, not included into any of the groups, are understood as extremes, if there are less than 25 % of the largest leave entrances.

3. Defining of segment profiles and their description
    - Segments were definable, measurable, accesible (for eventual communication), responsive (to eventual offer) and relativly stable (in order to lower the costs). Weaknesses of data gathering were identified (one of the segments was defined by questionnaries with several unanswered questions; we had to exclude the segment with the statistically non-representative size). Profile was defined for the three segments. They were titled with their typical characteristic.

Stratification of the target group into segments has an important characteristic: segment is defined with the *prevailing* characteristic of its units. Therefore segment are not exclusive and they include unspecific indivudual units. Differences among segment are relative, dependent on the average of the sample. Legitimity of $\chi 2$ might therefore be partly questionalbe as the sample is not representative, but the strenght of relation is documented by Pearson´ and Spearman´coeficient.

Results of observation, inquiry and segmentation

Relation to forest was according to our observation and inquiry results extremely positive. Slovenian forest is according to our data crucial for free time and accomodation, while one fifth of the sample sees its importance for work and income as well (figure 1).

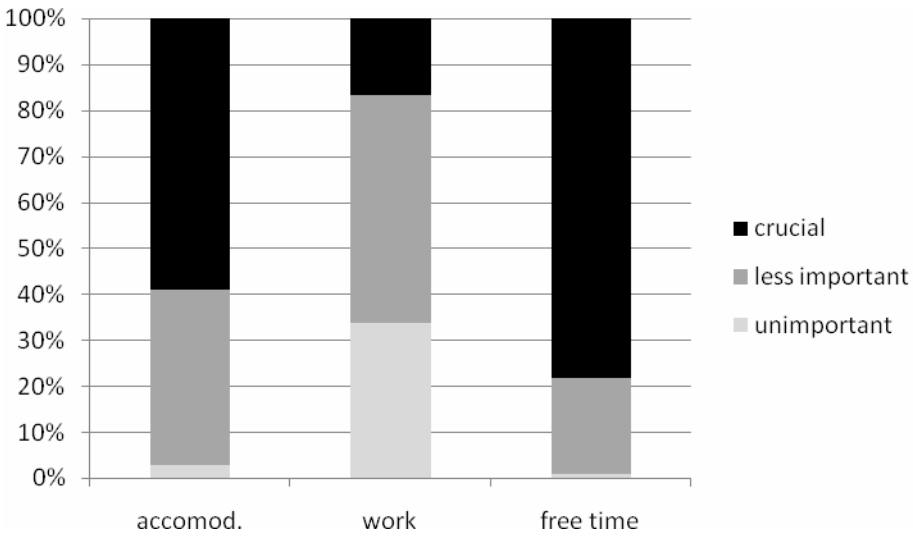

Figure 1: The role of forest for the daily life, work and free-time

Individual relation to forest depends on individual situation and subjective forest role perceptions. They are defined by both: measurable quantitative categories (age, educational and occupational status, income etc.) and qualitative categories as raising, experience, self-conscious, ties with the local people etc. As the latter is extremely difficult to measure and define - even the basic term »forest« can be at least in Slovenia understood very different and can stimulate diverse perceptions - data from inquiries are complex and subjective in particular. It is therefore not by chance than that we got as a result different expectations on different locations.

The most colourful and evenly distributed data of inquiry were forest related expectations for the »homeplace« (home surrounding) (figure 2).

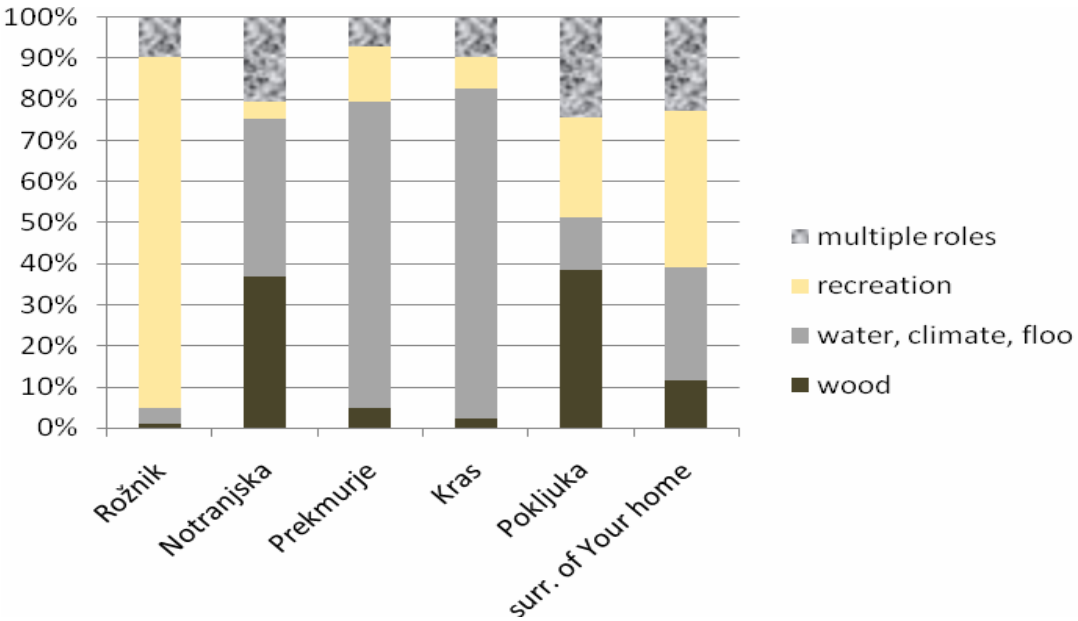

Figure 2: Forest role expectation for typical slovenian locations and »homeplace«

Inquiry includes several subjectivity sources: individual perception of basic terms, weak inquiry questions. Clustering may add subjectively defined clustering indicators. Therefore we carefully observed and studied population and gathered periodical data on its activity. Crosstables enabled us to sketch the general clustering of forest roles perceptions. Later procedure of (independent) segmentation very well confirmed these results.

Table 1: What do study circle participants who feel as »rural« expect from forest – the case for Notranjska region ($\chi 2 = 0.018$)

Percent on the level of sample and segment		Expectation from forest in Notranjska region				Sum sample
		Wood	Forest floor, water, climate	Recreation	More roles	
Who am I?	Rural inhabitant	54,40 %	42,90 %	54,50 %	26,70 %	44,10 %
	Urban inhabitant	24,30 %	25,90 %	36,40 %	41,70 %	29,00 %
	Both	21,40 %	31,30 %	9,10 %	31,70 %	26,90 %
Sum		100,00 %	100,00 %	100,00 %	100,00 %	100,00 %

Expectations of those, who feell urban identity, are (for the sample and the observed year) statistically different than for those, who feel rural identity. In the segmentation procedure the two step cluster analysis has densed the answers according to their distance/comparability. Segmentation resulted in five groups-segments, which were at the end reduced into three for the sake of numerical and content representativity. These segments were titled as segment 2 (intermediate segment), segment 3 (study circle participants with the pro-natural characteristics) and segment 5 (study circle participants without the pro-natural characteristics) (table 2).

Table 2: Result of a two-step clustering of intervieweed

Segment analysis units		Number of units	Share of units in the sample (%)	Share of valid units %
Accountable	1 (segment 1)	53	15,0	15,4
	2 (segment 2)	***49***	*13,8*	*14,2*
	3 (segment 3)	***143***	*40,4*	*41,4*
	5 (segment 5)	***100***	*28,2*	*29,0*
	Sum_valid	345	97,4	100,0
Excluded	Ekstrem value	1	,3	
	4 (segment 4)	8	2,3	
	Sum_excluded	9	2,5	
All units		354	100,0	

These characteristics were the background for the segment titling.

- Study circle participants from the segment no. 3 are called »pro-natural«. There are more men than woman (30% while in the sample 23% only), average age in this segment is 47,7 years, its unites are active in their local settlement, usually they help without payment, feel rural identity and feel deprivileged in comparison with other people.
- Segment no. 2 is smaller and is defined by higher average age (54,8 years), its units do not differ statistically from the other two segments while they feel the same identity than the segment no. 3.
- Segment no. 5 is defined by urban identity, the lowest average age (42,4 let), developmental passivity, lack of ties among people and relative absence of feelings

of being depriviledge. Proportion of women is higher than in other two segments (89% while in the sample this share is 78%).

Some characteristics about segment units´relation to forest are illustrated in the table 3:

Table 3: Selected characteristics of the three key groups of study circle participants e.g. segments associated with forest (more in Bogataj 2007)

Inquiry question	Segment 3 STUDY CIRCLE PARTICIPANTS WITH CO-NATURAL CHARACTERISTICS	Segment 2 INTERMEDIATE GROUP	Segment 5 STUDY CIRCLE PARTICIPANTS WITHOUT CO-NATURAL CHARACTERISTICS
Whom with have You **talked about** forest the most?	With friends, with local people	With forest management holders	With nobody
Have You ever intentionally **learned about forest**?	Yes	Yes-no	No
Self-evaluation of knowledge about forest (according to school grades) is …	Quite some 4 – a lot 5	Some 3–Quite some 4	A little 2
Have You ever **admired** forest (through the window)?	Usually	Usually	Seldom-no
Are You **aware of any forest related conflicts?** (α 0.000)	yes (Segment **69,** average 56 %)	Segment has no typical structure for this indicator	no (segm. **62,** Average 44 %)
Have You ever **attended public presentation of Forest Management Plan**?	Yes	No	No
Are You annoyed by **forest visitors**? (α 0.009)	Yes (segment **20** Sample 14 %)	Segment has no typical structure for this indicator	No (segment **94** Sample 86 %)

Discussion

Heterogeneous social structures can be dealt with in a rationalised manner – segmentation is such a tool for better understanding of society at any level. The process is comparable to structuring of forest stands to optimise forest management (comp. http://www.cek.ef.uni-lj.si/u_diplome/sekavcnik1733.pdf). Segmentation is based on several subjective decisions (e.g. variables, methods of analysis), therefore we have to know population quite well, choose large samples and triangulate sources, data and methods, all done in segmentation presented. It enables us to choose communication channels, educational offer, information forms etc. even if does not represent the »end definition« of target publics (as it is always a part of the context therefore of broader research work). It enables us also to enter new analyses e.g. logistic regression. We used it as a non-typical indicators identifying tool. Its use and possible further development might contribute to strenghtening of European and Slovenian forestry role and its communication culture therefore as a contribution to the social pillar of forestry which gains importance.

Ambition of this text was to overcome traditional approach to "forestry role changes" from its consequences to its causes. For diverse reasons, described in Bogataj 2007, we have chosen to test non-formal education form from the forest relation point of view. We structured participants of study circles according to their attitude to the forest. Study circles as intermediary bodies are between massive and individual approach, therefore useful to put in force plural society with its colourful livingstyles palette. Our segmentation results - despite they were gathered on a non

representative sample - confirm general results recently gathered along the process for gaining the National Forest Programme (NFP) (Golob 2008). In general pluralisation and individualisation of society leads to diversification of values and lack of authorities, institutional as well (Luckmann 1966 cit. in Luckmann 2007). This is what should we count on when we study expectations to forest, their articulation and use of knowledge infrastructure .

Conclusions

Forest use is not only a result of forest characterstics but also - maybe even mostly - a result of society and its key groups´ interests. In knowledge society information/knowledge and skills flow is crucial. At least two consequences are therefore obvious: 1. Forest professionals have an important oportunity to engage all, who care for forest, to make this knowledge flow; 2. Response of participants is an indicator of quality of their relation to the public.

Decision makers have social power which in plural and democratical society needs empowerment by partnership e.g. of "allies". Our "allies" might primarily become those who gain direct forest benefits e.g. men and older rural inhabitants in case of wood production, urban inhabitants in case of recreation and the whole public in case of environmental goods. For the sake of free acces in Slovenia, forest is used and visited by all of them. Usually identifiable target groups are poorly known despite we have several dispersed data on this issue. In cases of landuse conflicts irreversible consequences might be important imperative for further research and professional work and communication with social structures. Stratification presented was just one of steps to this direction. Unfortunately staff, finances and R&D support is weak on this field of Slovenian forestry.

A method presented strives for the

1. Acknowledging and activation of the
    a. Leading (numerically or by its role) part of the public,
    b. Pallete of smaller groups, usually neglected for the sake of the minority or lack of their organised public presentation; they can be an important partner for forestry/forest management if they are fond of forest or its management in general or potential conflict, if it is the opposite;
2. Broadening of the set of indicators which define public and target groups from quantitative (age, educational elvel, e-accesibility) to new, qualitative indicators e.g. expectations (from forest), responsibility of personal impact on the forest, participation in the public life – active citizenship, information channels, perception of professional measures and responsibility on them.

Opening of forestry to its social field might enforce forestry with »added value« without fear for its traditional roles. We understand our example as a contribution to the social pillar of sustainability, well confirmed with own experience, data and recent results of NFP - request for information, education and research on this field.

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4. Assessment of factors which influence forest owners to join associations

Krč Janez, Pezdevšek Malovrh Špela, Mihelič Matevž, Zadnik Stirn Lidija
University of Ljubljana, Biotechnical Faculty, Department of forestry and renewable natural resources, Večna pot 83, 1000 Ljubljana, **Slovenia**,
Tel. 00386 1 423111, fax: 00386 1 2571169
e-mail: janez.krc@bf.uni-lj.si; malovrh.spela@bf.uni-lj.si; matevz.mihelic@bf.uni-lj.si; lidija.zadnik@bf.uni-lj.si

Abstract
The paper is related to social and institutional problems of sustainable and multiple-use forest management. It deals with the problem of small and fragmented forest property distributed among a large number of forest owners and co-owners what makes the private forest management ineffective and non-competitive.
With the aim of making progress in private forest management, many owners have decided to establish associations of private forest owners. But before a forest owner becomes a member of an association he/she wishes to know the advantages and disadvantages of factors (alternatives) which influence his/her decision to join the association. In the paper, two multi-criteria decision making methods, AHP and DEXi, are employed to establish which factors are more important for private forest owners in making their decision whether to become a member of a private forest owners association or not. A real-life example from the Mirna Valley, where private forest owners formed an association, is presented. The size of forest is also taken into account.
In the second part of the paper we investigate the influence of two institutions (the Chamber of Agriculture and Forestry of Slovenia, and Slovenia Forest Service) on private forest management. Both institutions offer professional support to forest owners. The strength, weakness, opportunity and threat factors of these organizations in relation to the private forest management are determined and by the use of SWOT and AHP analysis it is studied which factors are more important for private forest owners.

Keywords: private forest owners, associations, institutional influence, multicriteria decision making, SWOT, AHP, DEXi method

1. Introduction

In forest management it is indispensable to create equilibrium of economic, ecological and social objectives, while taking into account the sustainability and multiple-use of forest ecosystems. Following this guideline, on one hand, the new ecosystem management paradigms and a very broad range of problems on a time and on a spatial scale and from organizational perspective are emerging. On the other hand, the forest ecosystem management decisions are influenced by forest experts, institutions and forest owners who should maintain and use the forest and want to maximize the expected profit from the forests, and the public as a whole who desires the benefits from the amenity values of those forests. In this paper we discuss only one segment of the extensive category of forest ecosystem management problems. In the first part of the paper we investigate the problem of small and fragmented forest property, and with it connected demands and needs of private forest owners to join an association. In the second part, however, the paper deals with the influence of institutions (two of them) on private forest management.
Small and fragmented forest property distributed among a large number of forest owners and co-owners is one of the main reasons for the low efficiency and a non-competitive position of private

forest management. This problem is a typical characteristic of Slovenian forestry and also of many other countries. This is why many owners have decided to establish associations of private forest owners. But before a forest owner becomes a member of an association he/she wishes to know the advantages and disadvantages of factors (alternatives, attributes) which influence his/her decision to join the association (Pezdevšek Malovrh and Krč, 2006). Undoubtedly, alternatives differ in their importance to private forest owners, and it is often difficult to ascertain how much more important one alternative is from the another. So, we are associated with a multi-criteria decision making problem. This problem, as such, has precipitated the development of interdisciplinary decision support models to determine the optimal multi-objective (multiattribute) private forest management decisions. Thus, in order to get the answer to how important is a particular alternative (factor) for the private forest owner, we generated a multicriteria model (Manrai, 1995). The model is based on multi-objective decision making methods and on private owners/institutions survey results (Zadnik, 2006a). Since, it is a well-known fact that the size of the property influences the reasons for joining the owners' association (Medved and Pezdevšek Malovrh, 2006), in the model, we have first used cluster analysis (Zadnik, 2005) to split the private forest owners into four groups with regard to the size of the estate: private forest owners with 1-5 ha of forest, private forest owners with 5-10 ha of forest, private forest owners with 10-25 ha of forest and private forest owners with more then 25 ha of forest. Then the factors, like education, joint purchase of machinery, etc., which influence the owner whether he/she joins the association or not, are determined (Pezdevšek Malovrh, 2005b). By the use of AHP (Saaty, 1994) and DEXi (Špendl et al., 1996) methods we found out which factors are more important for the private forest owner and have a decisive influence on joining the association. The input data for AHP and DEXi were obtained by carrying out surveys with private forest owners. Through surveys the forest owners expressed their preferences on the determined influential factors. As an application of the model, a real-life example of private forest owners from the Mirna Valley is presented (Pezdevšek Malovrh, 2005a).
In the second part of the paper we investigate the influence of two institutions on private forest management. Both institutions offer professional support to forest owners. First the SWOT (strength, weakness, opportunity and threat) factors for such a support were established (Mihelič, 2007). Employees of both institutions working in forest sector were interviewed. We generated two surveys for this interview, one in which the employees expressed their opinion about the given SWOT factors, and one by which they were asked to make a pairwise comparison of SWOT factors. In this way we obtained the data which were then analyzed by the use of AHP analysis. The results explain which factors used by considered institutions to support the management of private forests are more important for private forest owners. The application of the presented methodology was completed for two institutions: the Chamber of Agriculture and Forestry of Slovenia, and Slovenia Forest Service.

2. Methodology used

The methods employed within this paper are AHP, DEXi and SWOT. All these methods are procedures used to analyze the multicriteria problems which can be presented in a hierarchical structure.

2.1. Multicriteria decision making

Decision making is an important area of managing any system. It deals with strategies (decisions, alternative paths, alternatives, different projects,…) and objectives (goals) in the perspective of a changing environment. Further, it requires careful consideration and evaluation of the external and internal factors. Equally important is the assessment of opportunities, threats, strengths and weaknesses of the strategic paths under consideration. Thus, the decision making process involves the following steps:

being conscious of opportunity. The decision makers must be fully equipped with all relevant facts, figures, and data. They must be aware of the present and of future opportunities of strategies under consideration, and of their strengths and weaknesses in relation to competitive alternatives;
establishing objectives. After being aware of the environment in which the strategy should be undertaken, objectives of the strategy are to be established;
evaluating alternative strategies. The opportunities and threats, and strengths and weaknesses of each strategy are to be properly evaluated and their relative advantage is to be analyzed;
selecting the optimal alternative and course of action. After careful evaluation of various possible alternatives, the alternative which suits the objectives best and is practically possible to implement is to be selected.
Taking into consideration the steps of a decision making process, it is proclaimed that this process, as such, presents a multiple criteria problem.
Multi-criteria decision making is based on the fact that the choice of a solution is affected by numerous criteria, the importance of which varies and which are of hierarchical structure, i.e., they can be presented at different levels (Špendl et al., 1996). A decision making problem is thus broken down into smaller subordinate problems (parameters, criteria, attributes), and these are then assessed separately for each parameter. The final assessment is obtained by means of a specific combining procedure (Figure 1).

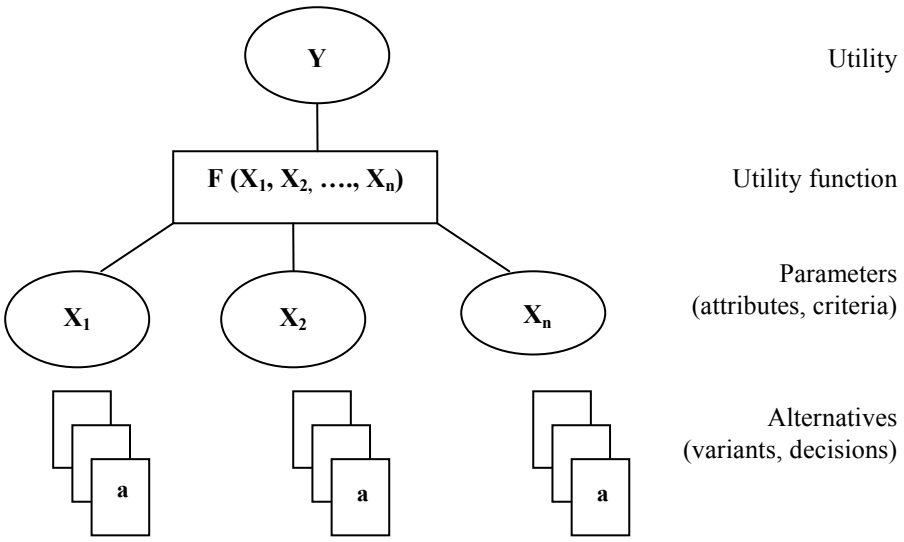


Figure 1: The multi-criteria decision making model (Špendl et al., 1996).

As evident from Figure 1, the model is formed by means of parameters (attributes), X_i. These are variables which represent subordinate problems of a decision making process (attributes which define the quality of alternatives). Utility function F is a rule according to which the values of individual parameters are combined to form variable Y, which represents a final assessment of usefulness of alternatives. Alternatives are described according to basic parameters by values a_i. On the basis of these values, the utility function provides a final assessment of each alternative.
In the case of multi-criteria decision making, two notions are encountered:
preferential relation S; $x_1 S\ x_2$; i.e. x_1 is preferred to x_2
utility function - $F(x_i)$, which determines the degree of suitability (preference, priority) of parameter x_i.
In actual cases we know what we prefer, but we are unable to assign a certain value to a solution (the utility function is not known). What is needed, then, is a procedure which converts preference relation into utility function. One of the procedures which make this possible is the AHP method.

2.2. Analytic hierarchy process (AHP)

In problems dealing with multiple and conflictive objectives (goals, factors) of the alternatives, and above all with objectives of different importance Saaty's analytic hierarchy process, assigned as AHP method is employed to determine the best alternative. AHP can incorporate mixed data that may include both qualitative and quantitative judgments, and is capable of analyzing multiple factors (parameters, attributes, criteria). AHP is based on a gradual mutual comparison of two objectives (pairwise comparison) at the same level. A scale from 1 to 9 is used for making the comparison, where, for example, 1 means that two objectives are of equal importance, 3 means that judgments slightly favor one objective over another, ….., 9 means that favouring one objective over another is of the highest possible order of affirmation, 2, 4, 6 and 8 are intermediate values, while the reciprocals of these values tell that if objective k has one of reasonable assumptions of the above nonzero numbers assigned to it when compared with objective j, then j has the reciprocal value when compared with k (Saaty, 1994, Saaty, 2005).
Comparisons between individual objectives are gathered in a pairwise comparison matrix A. Each objective k is associated with a weight w_k. The weights ratio of the objectives k and j is written as intensity of importance:

$$a_{kj} = \frac{w_k}{w_j} \qquad (1)$$

The matrix A = [a_{kj}], (k = 1, 2, ... K, j = 1, 2, ... K) if there are K objectives. By entering the estimated values a_{kj} into the matrix we get the pairwise comparison matrix A. The pairwise comparison matrix A is a square, positive and reciprocal matrix, its diagonal values equal 1 and symmetrical values are inverse: $a_{kj} = \frac{1}{a_{jk}}$.

$$A = [A] = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1K} \\ \vdots & & & \vdots \\ a_{K1} & a_{K2} & \cdots & a_{KK} \end{bmatrix} = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_K} \\ \vdots & & & \vdots \\ \frac{w_K}{w_1} & \frac{w_K}{w_2} & \cdots & \frac{w_K}{w_K} \end{bmatrix} \qquad (2)$$

Since, in practice, we never encounter perfectly consistent estimations (Saaty, 2005), we proved the consistency as described in Winston (1994), using the consistency index. Further, the vector of weights w = (w_1, w_2, …, w_K) is calculated with multiple squaring of matrix A to the satisfactory exponent, i.e., A, A^2, $(A^2)^2$, etc. and then the lines are summed up and the values normalized (Winston, 1994). The vector of weights w = (w_1, w_2,…,w_K) is therefore scaled between 0 and 1, $\sum w_k = 1$, and calculated by the following equation:

$$w_k = \frac{\sum_{j=1}^{K} a_{kj}}{\sum_{k=1}^{K}\left(\sum_{j=1}^{K} a_{kj}\right)} \qquad (3)$$

Utility vector *w* can also be obtained by searching for eigenvalues λ of matrix A: $Aw = \lambda_{max} w$, where λ_{max} is the maximum eigenvalue of matrix A and *w* is the corresponding eigenvector. In practical cases, this tends to be a complex calculation procedure. The eigenvector which belongs to the maximum eigenvalues of positive reciprocal matrices can be obtained in various ways:
method of powers – the matrix is put to a sufficiently high power, the values are then added and normalized by lines
normalization – the matrix is normalized so that the sum according to columns is 1, and the average element in the line is calculated.

The eigenvalues which correspond to the eigenvector are obtained as:

$$\lambda_{\max} = \frac{1}{K}\sum_{i=1}^{K}\frac{(Aw)_i}{w_i} \quad (4)$$

The measure of inconsistency is defined by the difference ($\lambda_{\max}$ - K). It is expressed by the consistency index CI: CI = ($\lambda_{\max}$ - K) / (K – 1). (5)

A random index is then introduced, which is given in tabular form (Winston, 1994)

K	1	2	3	4	5	6	7	8	9	10
RI	0	0	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,51

and inconsistency (CR quotient) is calculated as: CR = CI / RI. If CR < 0.1, the matrix is sufficiently consistent. In the opposite case, the matrix should be corrected; otherwise the results will not be correct. For the purpose of this paper we used AHP as implemented in the program Expert Choice.

2.3. DEXi

DEXi is a multi-criteria decision method which is based on the construction of a decision problem in a hierarchical structure of attributes. In contrast with AHP, DEXi uses qualitative attributes. Each attribute in hierarchy is defined as a discrete variable which can take its values from a set of symbols. These symbols need to be defined for each attribute separately and typically consist of words like not important, very important … In DEXi, the use of a qualitative attribute requires a different approach to aggregation than AHP. As opposed to using weights, the aggregation is carried out by decision rules. These are simple "if-then" rules defined by the designer, with which the utility function is expressed point-by-point for all possible combinations of alternative values. For the purpose of this paper we used DEXi as implemented in the program DEXi (Špendl et al., 1996).

2.4. SWOT analysis

SWOT analysis means analysis and assessment of comparative strengths and weaknesses of a strategy in relation to competitive strategies, and environmental opportunities and threats which the strategy under consideration may face. SWOT analysis is, as such, a systematic study and identification of those aspects of the strategy that best suit, in our case, sustainability, maximal expected profit, refers to ecological objectives, and respects the forest owner's acceptance of the examined alternatives. SWOT should be based on logic and relational thinking such that the selected strategy improves the strategy's strength and opportunities and at the same time reduces the weaknesses and threats.

Strength is a distinct superiority (competitive advantage) of technical knowledge, financial resources, skill of the people, image of products and services, access to best network, of discipline and morale. Weakness is the incapability, limitation and deficiency in resources such as technical, financial, manpower, skills, image and distribution patterns of the alternative under examination. It refers to constraints and obstacles of the alternative. Corporate weaknesses and strengths are a matter of how the alternative can achieve best results compared to other, similar competitive alternatives. Weaknesses and strengths of the alternative present internal forces and factors required to be studied and assessed with the goal to evaluate and rank the alternatives under consideration.

Opportunities and threats are the external factors of the examined strategies. These factors are changing with the change of governmental, industrial, monetary and market policy, including the changes of legal and social environment. Environmental opportunity is an area in which the particular strategy would enjoy a competitive advantage. Proper analysis of the environment, identification of new market, new and improved customer groups and new relationship could present opportunity for the strategy. Threat is an unfavorable environment for the strategy. Increased bargaining power of users and suppliers, quick change of government policy, rules and regulations may pose a serious threat to the strategy undertaken.

SWOT analysis is nowadays very important for decision making. Such analysis can be undertaken effectively through brainstorming session with participation of experts and users of the environment, land, firm, etc. involved in the strategy. SWOT analysis has many advantages. Within SWOT internal and external factors are analyzed and summarized in order to attain a systematic decision situation. There are also several shortcomings of using SWOT. SWOT results in listing and quantitative examination of internal and external factors, and groups the factors in strength, weakness, opportunity and threat groups, but it is not able to identify or analytically determine the most significant factor or group in relation to the examined strategy. In order to get a qualitative information, to yield analytically determined priorities for the factors and groups included in SWOT analysis and to make them commensurable we have integrated SWOT analysis with AHP when measuring the institutional influence on private forest management (Zadnik, 2006b). The problem is organized in a hierarchical structure around the concept of objectives (in our case SWOT groups: strengths, weaknesses, opportunities, threats), and attributes (in our case SWOT factors), within a two level hierarchy (Figure 2). The first level is viewed as objective/group level. These groups are not directly measurable by themselves, but are presented by factors which are found at the second level. The factors define the effect of the SWOT group.

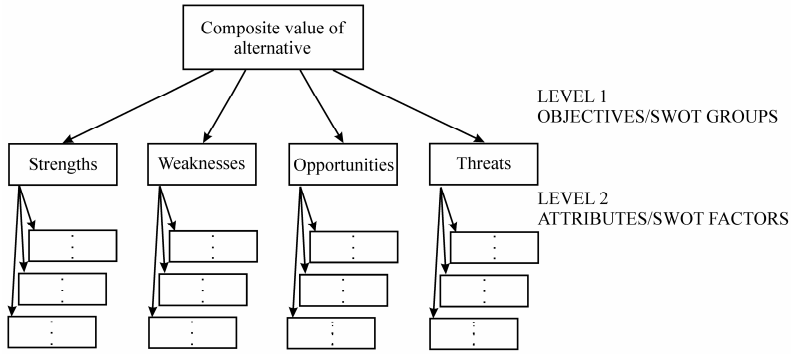


Figure 2: Factor's and group's hierarchy for composite value of institutions in SWOT (Zadnik, 2006b)

3. Application 1: Assessment of factors which influence the forest owners in the Mirna Valley to join associations

Private forest owners of the Mirna Valley, Slovenia decided to join a forest owner association, aiming to improve competitiveness of the private forestry sector. But every new member wants to know which alternatives are important for his decision to join the association. A survey was carried out on the pattern of 40 members. With the information obtained from the interviewed members of the association, mutual comparisons were assessed and a pairwise comparison matrix was formed for each level of the decision tree. The data are found in Pezdevšek Malovrh, 2005b).

The private forest owners were split into four groups according to the size of the estate and the alternatives, i.e., the reasons why private forest owners became members of the association: education, counseling, cooperation in elaboration of forest management plans, conclusion of timber sale contracts, joint purchase of machinery, equipment and literature are shown in a hierarchical way in Figure 3. The analysis which we made with the AHP method in the program Expert Choice (results are given in Figure 3) showed that for the private forest owners the most rewarding alternative regarding the criteria was education; counseling took second place, followed by cooperation in elaboration of forest management plans, then came conclusion of timber sale contracts, while joint purchase of machinery, equipment and literature were stated as the least important for the owner's decision to join the association.

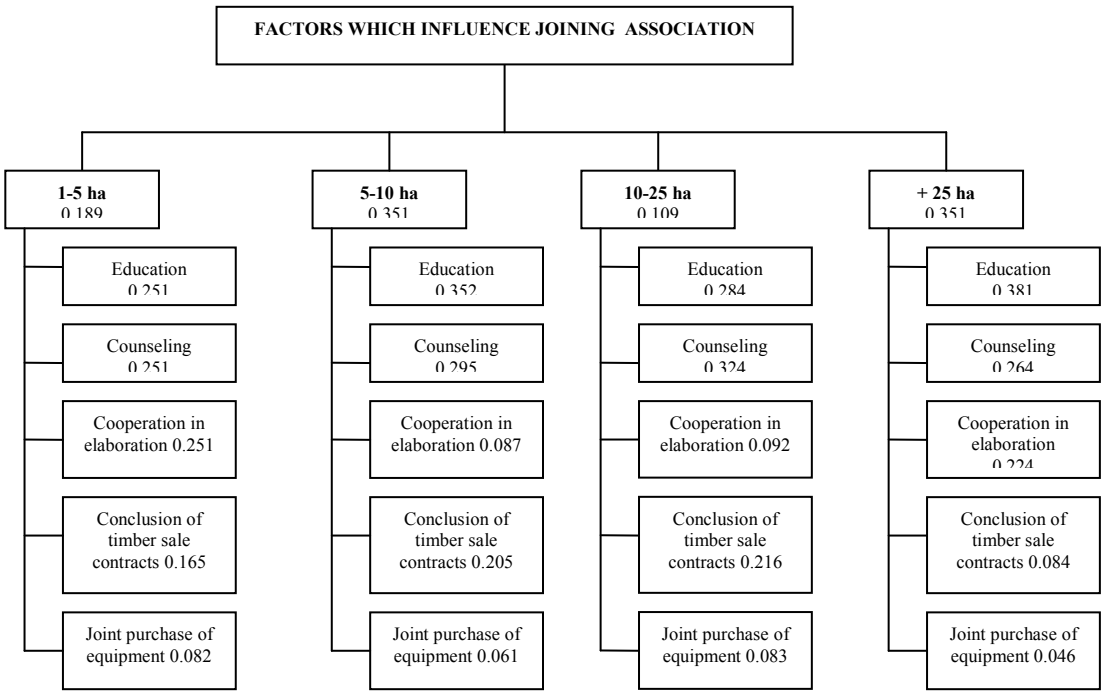
When we compared the private forest owners by property size we discovered that there were only minor differences between them. The most important factor why owners became members of the

association was education, since private forest owners wish to improve their knowledge on safe work in the forest and on silviculture, and become acquainted with new technologies. The second factor that was important for all of the owners was receiving counseling about the timber market and being informed about the best contractors.

The difference between owners with regard to the size of the property was obvious with respect to the following two factors: cooperation in elaboration of forest management plans and conclusion of timber sale contracts. For small (1-5 ha) and for big (+25ha) forest owners cooperation in the elaboration of forest management plans was more important than for the other owners.

Concluding timber sale contracts was more important to all small proprietors than to the biggest ones (+25 ha). A joint purchase of machinery, equipment and literature was the least important for all proprietors regardless of the size of the property.

Further we made with the data of the same alternatives and owners, an evaluation analysis by the use of DEXi. The results (Figure 4) show that the most important alternatives for private forest owners are education and counseling, less important is conclusion of timber sale contracts and not important for the owners are cooperation in elaboration of forest management plans and a joint purchase of machinery, equipment and literature.



	1- 5 ha	5-10 ha	10-25 ha	+ 25 ha		Attributes		Result
Education	0.251	0.352	0.284	0.381		0.189		0.336
Counseling	0.251	0.295	0.324	0.264		0.351		0.279
Cooperation in elaboration	0.251	0.087	0.092	0.224	·	0.109	=	0.167
Conclusion of timber sale contracts	0.165	0.205	0.216	0.084		0.351		0.156
Joint purchase of equipment	0.082	0.061	0.083	0.046				0.062

Figure 3: Results of evaluation with AHP (Pezdevšek malovrh, 2005b)

	Education	Counseling	Cooperation in elaboration	Conclusion of timber sale contracts	Joint purchase of equipment
Factors	very important	very important	not important	less important	not important
1- 5 ha	less important	very important	not important	less important	not important
5 - 10 ha	very important	very important	not important	not important	not important
10 - 25 ha	less important	very important	not important	not important	not important
+ 25 ha	very important	less important	not important	very important	not important

Figure 4: Results of evaluation with DEXi (Pezdevšek Malovrh, 2005b)

If we compare private forest owners with regard to property size we see that education and counseling are important for all owners. Conclusion of timber sale contracts is only important for owners with property sized 1-5 ha and for those with the largest property (+ 25 ha). For small proprietors the conclusion of timber sale contracts is important because they carry out tree felling in longer time intervals and thus have only scant information about the timber market. But this factor is also important for big proprietors (+ 25 ha) because they sell timber during the whole year and need to get a fair price during this whole period. Cooperation in elaboration of forest management plans and a joint purchase of machinery, equipment and literature are not important for private forest owners.

4. Application 2: Assessment of factors which influence the two institutions in Slovenia in supporting the private forest management

We investigate the influence of the Chamber of Agriculture and Forestry of Slovenia, and Slovenia Forest Service) on private forest management. Both institutions offer professional support to forest owners. The main goal of both organizations is to help and give advice to the owners. Most of the employees in these two organizations primary work with farmers (more than 200). Just some of them are specialized in forestry and give support to private forest owners regarding the sustainable and multiple-use forest management. The survey included all employees specialized in forestry.
Through the personal interview conducted with these employees and some other experts (Mihelič, 2007) we determined which SWOT (strength, weakness, opportunity and threat) factors are present in these organizations in relation to the private forest management. These factors are given in Figure 5 in the SWOT factor boxes.

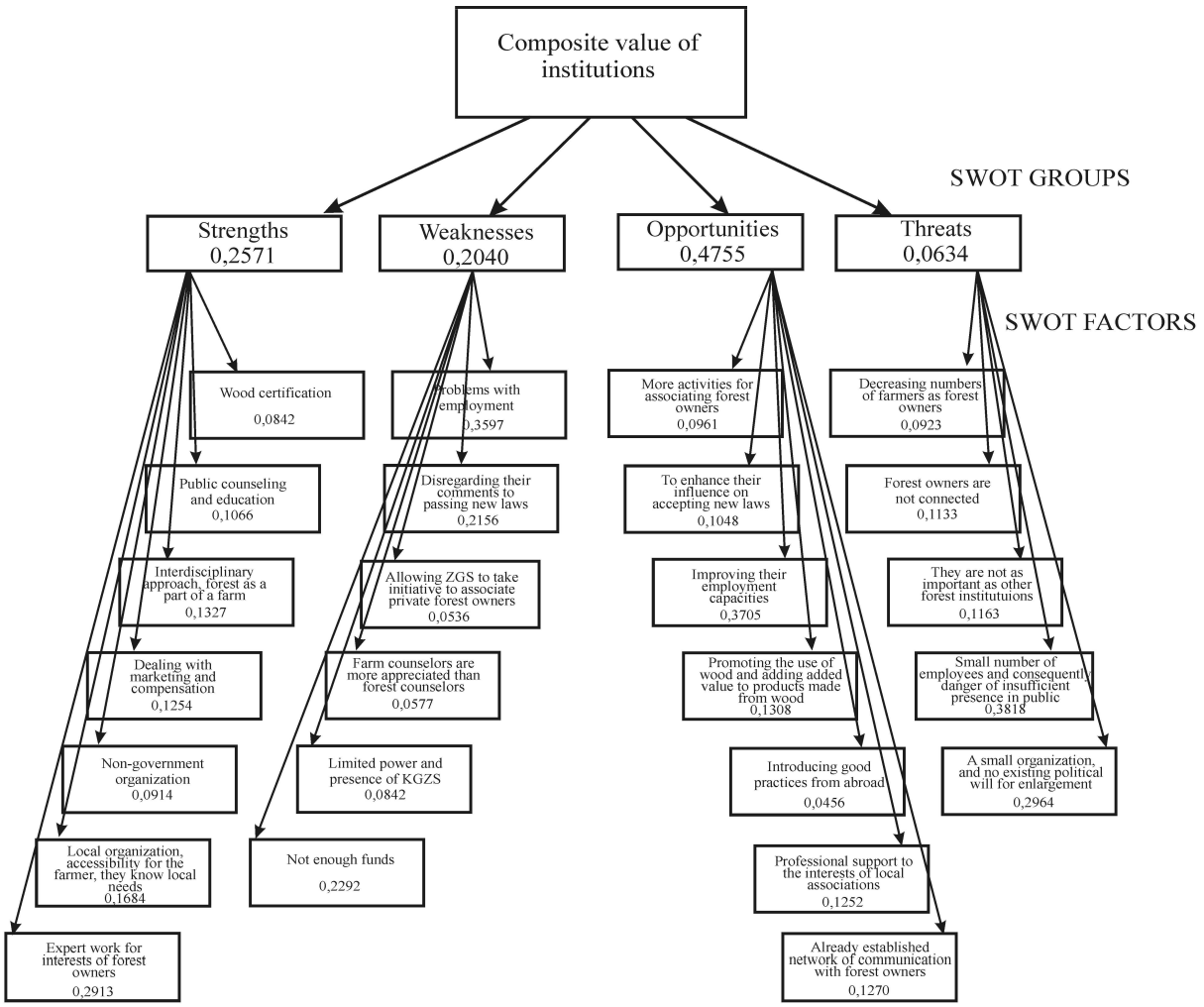


Figure 5: SWOT factors and SWOT groups with their relative importance obtained by AHP method

In order to assess the SWOT factors by SWOT/AHP model the employees of the organizations skilled in forestry were asked to make their judgements via pairwise comparisons between four SWOT groups, and within SWOT factors, i.e., pairwise comparisons of seven factors of strengths, pairwise comparisons of six factors of weaknesses, pairwise comparisons of seven factors of opportunities, and pairwise comparisons of five factors of threats. The estimates from their pairwise comparisons are given in matrices (Mihelič, 2007). Here we show only the matrix of pairwise comparisons between four SWOT groups, where group strengths is assigned as S, weaknesses as W, opportunities as O, threats as T.

$$\begin{array}{c} \\ S \\ W \\ O \\ T \end{array}\begin{array}{c} \begin{array}{cccc} S & W & O & T \end{array} \\ \begin{bmatrix} 1 & 2 & 1/3 & 4 \\ 1/2 & 1 & 1/2 & 5 \\ 3 & 2 & 1 & 6 \\ 1/4 & 1/5 & 1/6 & 1 \end{bmatrix} \end{array} \rightarrow \cdots \rightarrow \begin{bmatrix} 0{,}2571 \\ 0{,}2040 \\ 0{,}4755 \\ 0{,}0634 \end{bmatrix}$$

All other data and calculations are similar. Calculations were made by the use of Expert choice program. The results are gathered in the relevant boxes in Figure 5.

The most important strength for the organizations is expert work for forest owners, followed by local organization, which must be accessible to farmers. Here we have to emphasize that it is hard to distinguish between farmers and forest owners since farmers usually also have forests. Due to this fact, interdisciplinary approach, i.e. forest is a part of a farm, is also important, because forests

are in these two organizations treated as an integral part of a farm. Important strength of the organizations is also wood certification, which was an important project running for several years and is now in its implementation phase. Many employees consider public counseling, especially in marketing and compensation important.
The main weakness is employment. There are not enough people employed in forestry sector in order to support the forest owners in forest management and to initiate forest owners associations. Employees of these two organizations also put a lot of energy in proposals of new laws, but their ideas are almost always overlooked, which causes considerable apathy and frustration among the employees. Because of a lack of funds forest counselors are not regarded as important as their farm counterparts. Because of the lack of employees everyone has to do everything. They help each other and thus, their work is not specialized. They work on everything from dealing with wood certification and education of forest owners to lobbying for new legislation.
Enhancing the influence on accepting new laws and increasing the number of employees are seen as very important opportunities. The organization considers the influence on legislation as an important assignment. They hope to expand their tasks and gain more money by taking an active role in policy making. The expansion of these organizations depends on new laws that give more weight on forest owners' associations. Thus, in the future the organizations are focused on activities for associating forest owners, on promotion of wood and on introducing good practices from abroad. Professional support to the interests of local associations is a task that is very important and also very demanding, as there is needed considerable communication with forest owners and a lot of paper work. In this sense, the already established network of communication with forest owners is an important factor.
The main threats to organizations are posed by the size of the organization. A very important threat to organizations is bad relations between forest owners and a decreasing number of farmers as forest owners. Forest owners are very weakly connected, some do not want to be connected, some have bad experience from the past and others just do not care about their forest. There is a prevalent opinion, that farmers are very good forest owners, because they are connected to the forest and can work in it with their existing equipment. The forest is also an important part of the farm, and farmers see it as a kind of a long-term investment.

4. Conclusions

The presented approach is new for this kind of social problems in private forest management. From the methodological point of view it encompasses a combination of SWOT analysis, analytic hierarchy process, DEXi and analysis of the surveys. These methods are of great assistance with almost all decision making problems. Some methods considered are rather old and simple, like SWOT analysis, but can provide us with insight into problems. When using SWOT analysis we are being forced to think creatively, to look at problems from different angles and to come up with creative and thought-out solutions to a specific problem.
Methods like AHP and DEXi give us the possibility to take problems, think about them, compare alternatives and together with other people try to determine, which of the given alternatives is best, most important, or most desired. Out of a large pool of data obtained in the interviews with decision makers, through calculations the optimal alternatives are determined. We must however emphasize that with mathematical modeling a lot of attention has to be given to content, analysis and critical evaluation of the criteria used.
Both AHP and DEXi use hierarchical decomposition for developing decision models. The structure of attributes is identical, but the methodologies use different techniques for describing the options and aggregating the values of input attributes into the final result. The AHP uses comparison matrices, while DEXi is based on decision rules that aggregate qualitative values. When comparing the results of evaluation, DEXi gives very comprehensible symbolic results, while AHP produces a numeric evaluation. So the DEXi method evaluates several factors with the same values, while AHP

determines a unique value for every project. The results of evaluation with both methodologies were almost the same, excluding cooperation in elaboration of forest management plans. DEXi with its qualitative values is suitable for modeling problems that are by their nature qualitative and would be difficult to describe with numbers.

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Session 3:
Non-market forest goods – recreation and parks

1. Estimating the demand for urban recreation parks

Neelam C. Poudyal, Graduate Research Assistant
Department of Forestry, Wildlife and Fisheries, The University of Tennessee

Donald G. Hodges, Professor and Director
Natural Resource Policy Center, The University of Tennessee, Corresponding author contact information: 274 Ellington Plant Science Bldg.; Knoxville, TN 37996, USA;
Tel. +1 865 974 2706; FAX: +1 865 974 4714; dhodges2@utk.edu

Christopher D. Merrett, Professor and Director
Illinois Institute of Rural Affairs, Western Illinois University

Abstract

We employed a typical hedonic price method, which confirmed that the urban recreation park acres increase the nearby property values. Subsequently, the demand and benefit of urban park acreage were estimated for the City of Roanoke, Virginia. The demand was inelastic in price and income; and the size of recreation parks was a substitute for living space and proximity to the park. The estimated amenity benefits of urban recreation park will be useful in urban land use planning and open space preservation.

Keywords: Hedonic model, Urban recreation parks; Demand; Open space

Introduction

Open spaces and public recreation lands enhance the economy and quality of life in cities by improving the air quality, providing the recreational opportunities and aesthetic values, among many other benefits (Nowak and McPherson, 1993). However, as cities grow, open spaces are paved over to make room for new buildings and roads. McPherson (2006) pointed out that one of the likely constraints in North American urban forestry is the overuse of recreation parks in urban areas. The sizes of open spaces not only affect the recreational potential and aesthetic values, but also determine the environmental benefits (Metropolitan Design Center, 2004).

The demand for urban parks and open space is likely to grow in future with citizen awareness of environmental issues and demand for ecosystem services. Effective urban land use planning and supplying additional acreage of such parks will require a clear understanding of its amenity values and demand in our society. However, our current knowledge on economic value of such parks, especially the welfare effect to the community is limited. For example, one of the major 6 strategic goals of the National Research Plan for Urban Forestry, 2005-2015 is focused on properly estimating the economic benefits and real estate value added by the enhanced neighborhood quality from such parks (Clark et al., 2007). This paper attempts to estimate the demand for recreation park acreages in urban neighborhood using a two stage hedonic framework. It will also assess how the supply of additional acreage of land in such park will increase the welfare in our society.

Most of the studies focused on either the distance to the urban parks or the proportion of open spaces in some defined level of neighborhood to measure their amenity values in dollar terms. With some notable exceptions (e.g. Bolitzen and Netusil 2000), most of them have ignored the acreage effect of the urban parks on property values. In other words, little information is available on how increasing acreage of urban recreational park will be capitalized in the real estate market and local property tax base.

Most of the previous studies relied on data from multiple markets or metropolitan area to identity the demand (Taylor, 2003), and ignored the existence of submarkets within a single city (Palmquist, 2005). However, submarkets exist even within a single city (Bourassa et al., 1999). Recent studies utilized some statistical clustering techniques to identify such submarkets (Bourassa et al., 1999). Estimating the second stage demand function to evaluate the urban parks or open space has not been a focus of previous studies. This study aims to fill this gap by evaluating the amenity value of urban recreation park and estimates the demand for park acreage based on a second-stage hedonic demand. It also evaluated the welfare effects from non-marginal changes in park size.

Study Area

The study was carried out in the City of Roanoke, Virginia. Roanoke was chosen because it is the biggest and fastest growing urban area in the southwestern Virginia region. In addition, the city contains several urban recreation parks of varying size, uniformly distributed throughout the city area and hence provides an ideal place for the study of urban park benefits. In addition to green open space and urban trees, these parks are supplemented with additional man-made attractions such as greenways and playgrounds.

Hedonic model

This study used a typical hedonic equation of housing price in a semi-logarithmic form, where the price of a house is explained as a function of structure variable of house, neighborhood characteristics and urban recreation park variables. A White test of heteroscedasticity was used to test for the heteroscedasticity, which if found present, consistent estimates of the standard errors were obtained using White's approach of robust standard error (White, 1980). Variance Inflation Factor (VIF) was used to test for multicollinearity among the covariates (Greene, 2003). Included among the recreation park variables were the size of the nearest park and the distance from the house to the park. A positive and significant effect of the size of urban parks was expected. That means the larger (smaller) the size of the park, the larger (smaller) the sales price of nearby houses. In addition, distance to the park was expected to have a significant and negative effect.

In order to identify the demand, the above-discussed hedonic model was estimated for different submarkets. Following McGarigal et al. (2000), and Strong and Jacobson (2005); this study used Two Step Clustering techniques to identify the optimum number of submarkets within the city of Roanoke. ANOVA test was performed to compare the statistical difference among the submarket properties based on sample means and variances (Moore and McCabe, 2003), whereas a series of Chow tests were used to confirm the existence of submarkets by checking whether the hedonic price functions among those clusters differed significantly (Day, 2003). The partial derivative of the estimated hedonic equation with respect to the attribute of interest (i.e. size of urban forest park) was used to calculate the implicit price of the park per acre.

Demand for Urban Recreation Park

The implicit prices of different attributes estimated from separate hedonic regressions for individual submarkets were combined to estimate a citywide-pooled model. Following Palmquist (1984); Boyle et al. (1999); Brasington and Hite (2005); we estimated a semi-log demand model, in which the log of acres of urban park was modeled as a function of the implicit price of park acres, implicit price for substitutes and/or complements and a vector of exogenous demographic and economic factors that are related to tastes and preference of the residents and are expected to influence the demand. Following Boyle et al. (1999), implicit prices of living areas and proximity to

the park were used to control for the price of substitutes/complements. The exogenous demand shifters (income, age, race, education) were taken from the corresponding census block group information. Endogeneity of income of the home owners (Palmquist, 1984) was addressed using instrumental variables in a Two Stage Least Square approach. Estimated demand functions were later used to compute the welfare effect due to change in acres of urban recreation park.

The Data

Housing prices and their structural characteristics were obtained from the Geographic Information System (GIS) database of the real estate department at City of Roanoke, Virginia. A total of 11,125 single-family houses, those were sold from 1997 to 2006, and had complete information were used. Using the local area's housing price index (OFHEO 2006), all the housing prices were adjusted to year 2000 dollars. Since the month in which sales occurred was also recorded along with the transaction price, the month of sales was used to create a season of sale dummy variable. The GIS files of spatial location of parcels, regional airport, *public bus routes, schools, railroad, rivers, urban parks, central business districts were obtained from the city as well. Distances from each house to those features were computed in ArcGIS 9.3. The neighborhood data on socioeconomic information were obtained from the census block group level data of US Census Bureau data in 2000 (US Census, 2000).*

Results

Hedonic Model

A White test of heteroscedasticity rejected the null hypothesis of homoscedasticity at *the 1% le*vel in citywide hedonic regression (Chi-square Statistic = 1434.61, critical value of 135.81). Computed values of VIF did not exceed the threshold value of 10 except for age and square of age. Conventional adjusted R-square (0.64) reveals a relatively good fit of the date to the specified model. Coefficients on most of the variables (22 out of 24) were statistically significant at the 1% or better level and most of them had the expected signs.

Most of the structural and neighborhood variables were significant at 5% level, and had expected signs. More importantly, the variables associated with the urban forest park, which also is the focus of this study were significant and had expected sign. The size of the nearest urban park was significant at the 1% level and was positively related to house price. This finding confirms that the size of the nearby urban forest parks has a small but significant and positive relationship to property price. Likewise, the distance to the nearest urban forest was negatively related to house price at the 1% level, corroborating the finding of earlier studies (Bolitzer and Netusil, 2000; Tyrvainen and Miettinen, 2000).

Demand Model

Two Step Cluster analyses yielded four distinct submarkets within the city of Roanoke. The *P*-values of F Statistic in ANOVA tests indicated that the property characteristics varied significantly among submarkets, suggesting a clear distinction between those submarkets. In addition, a series of Chow tests showed that F-Statistic were significant at 1% level for each submarket combination, rejecting the null hypothesis of equivalency of hedonic price functions between those submarkets. These evidences confirmed that Roanoke contains four distinct submarkets, which were utilized to identify the demand. In the estimated demand model, most variables were significant and possessed the expected sign. The own implicit price, price of substitutes, and exogenous demand shifters explained most of the variation in quantity demanded.

As expected, the own price was negatively related to the acres of park demanded and was significant at the1% level. The elasticity value of -0.84 reveals that a 1% increase in the implicit price of park acres decreased the demand by 0.84%, ceteris paribus. This indicates that the demand for urban recreation park acres is inelastic, corroborating the findings of Kristrom and Riera, (1996). Following Boyle et al. (1999), the demand function was evaluated for various levels of park size and using a grand constant which contained all variables other than own price in their current mean values. It revealed a clear downward sloping demand curve for park acres with respect to its hedonic price change.

The coefficient of implicit prices of living area was positively and significantly related to demand for park acreage at the 1% level, confirming that the house was a substitute for the size of nearby parks. Similarly, the median household income of the purchaser was positively and significantly related to demand. Although, the demand was inelastic on income ($\gamma = 0.43$), it is still the most important predictor of demand for park acres after the price of the amenity itself.

Following Boyle et al. (1999), and Brasington and Hite (2005), we estimated consumer surplus per household from a policy that provides more urban acreages under recreation parks. Increasing the current average size of the urban recreation park (35.13 acre) in the city by 20% (42.15 acre) resulted in an increase in consumer surplus of $ 160 per household. Even though there are no other studies on urban park demand to compare our results, the estimated figures do not dramatically differ from other related open space studies.

Conclusion

Using a two stage hedonic model, this study estimated the amenity value of and demand for urban recreation park acres in Roanoke, Virginia. Our analysis suggests that both the proximity to and size of the urban recreation parks have a small but significant positive effect on property values. Further, the hedonic price of an urban park acre was negatively related to the park size. A fairly inelastic demand was derived with an elasticity of -0.84. Our analysis revealed that the demand for urban park size increases as the cost of living space increase. This might be a useful implication in land use planning and urban sprawl management because preserving public open spaces could encourage high-density development and help discourage sprawl. Similarly, residents prefer the residential locations by trading the size of the urban recreation parks with the proximity of those parks.

Welfare analysis in this study also suggests that increasing the current mean size of urban forest acres by 20% in Roanoke will increase the per household consumer surplus by $160. This estimated welfare impact might be helpful in justifying investment on open space preservation and park management, and may provide guidance in open space preservation or park management. Results from this study will have several policy implications in real estate design, land use planning, and urban park management. Given that the federal and local government are attempting to preserve more open spaces in urbanizing communities, this study provides useful guidance to understand how the residents respond to different level of open space acres; and to ensure proposed investment for new acquisitions will be justified by the anticipated welfare gains.

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2. Recreational services economic evaluation and responsible management of protected areas: a case study in the Plitvice National Park (Croatia)

Davide Pettenella, , Tiziano Tempesta, Mara Thiene and Anna Zangirolami,
Dipartimento Territorio e Sistemi Agro-Forestali, Agripolis - Università di Padova, Via dell'Università 16 - 35020 Legnaro PD, **Italy**

Stjepan Posavec
Faculty of Forestry, University of Zagreb, Svetosimunska 25, 10 000 Zagreb, **Croatia**

Krešimir Čulinović
National Park "Plitvička jezera", 53231 Plitvička jezera, **Croatia**

Summary
The Plitvice National Park in Croatia is one of the richest in biodiversity and most appreciated protected areas in the world, with some 0.9 million visitors every year, mostly concentrated along a limited areas surrounding the lakes.
The paper presents the results of an analysis of the recreational and biodiversity protection functions of the National Park based on a Contingent Valuation approach.
A parallel survey has been carried out on the distribution of the visitors and on the marketing tools employed by the National Park authorities to optimize the use of the land resources, with the aim of increasing the number of visitors, reducing their concentration on the most known and appreciated areas, and protecting the most vulnerable and valuable resources, like the tracks of virgin forests.
In the conclusions the paper explores the trade off among these conflicting objectives and planning instruments available to optimize the sustainable use of the National Park resources.

Key words: forest economics, evaluation, recreational services, National Park

Introduction

National park „Plitvička jezera" is the oldest and the most famous Croatian National park, Proclamed in 1949 and entered on UNESCO List of World's cultural and natural heritage in 1979. The park extend over an area of 294,82 km². According to the IUCN classification NP Plitvice is in the second category. A National Park (NP) is an area of relevant biodiversity conservation value managed for multipurpose objective under the constraint of preserving and, if possible, enhancing its environmental protection role. For the most attractive NPs a common problem is the assessment of the carrying capacity in terms of visitors, their optimal distribution along the year and in the various location of the Park. For a NP a sustainable number of visitors is a key organisational factor also in relation to the role that tourism may have for the local economies in the nearby areas and, ultimately, on the support by the local inhabitants to the implementation of the NP's objectives. When an entrance fee is defined by the NP's authorities, the presence of visitors may have a direct impact on the budget available for the Park management and protection; the proper marketing of the NP's attractions may thus result not only in a more effective tourist, recreational and educational service, but also in larger investment in biodiversity conservation.
All these issues are of particular importance in the case of the Croatian National Park of the Plitvice Lakes. For this reason a cooperative research programme between the Faculty of Forestry of Zagreb University and the Faculty of Agriculture of the University of Padova has been set up in 2007. The research programme is aimed to analyse the economic value of the recreational and biodiversity protection functions of the National Park through a Contingent Valuation approach and to define the

marketing tools to be employed by the National Park authorities to optimize the use of the land resources.

Area description

The Plitvice Lakes National Park is Croatia's most popular tourist attraction, was granted UNESCO World Heritage status in 1979. Located roughly halfway between capital city Zagreb and Zadar on the coast (see map), the NP's relevance lies in its sixteen lakes, inter-connected by a series of waterfalls, and set in deep woodland populated by deer, bears, wolves, boars and rare bird species. The NP covers a total area of 300 square kilometres, whilst the lakes join together over a distance of eight kilometres. There's also quite an altitude difference - the highest point is at 1,280m, the lowest at 380m - although the total height difference between the lakes themselves is only 135m. The Park is open daily all year round, with longer opening hours during summer (usually 8am to 7pm). There is an entrance fee, which acts as a contribution to the Park's upkeep and protection: for adults it's 55 Kunas in November - April; 110 in the other months (full ticket); for children (7 -18 years old) it's 40 Kunas in November - April; 55 in the other months (reduced ticket) (1 Croatian Kuna = 0.1376 Euro – May 2008).

Research methodology

Study carried out in the The Plitvice Lakes National Park was based on a survey by means of questionnaires collected through an on-face interview. Data collection took place between October 1st and 15th 2007.

221 questionnaires have been collected. Considering the relevant number of visitors within the year (around nine thousand visitors have been estimated in 2006) and the limited period of time in which the survey took place, it is clear that results cannot be considered fully representative of the phenomenon, hence they need to be taken into account as preliminary data.

Questionnaires were translated and handed out into four languages: Croatian, English, German and Italian. In the first section one would fill socio-economic information, whereas in the second part interviewed were asked to provide information about the length of the holiday, transport, the number of trips taken, and so on. Subsequently, other economic questions were asked and a final question asked to report a satisfaction index regarding different aspects of the NP.

Specifically, the economic section would be on questions concerning the contingent valuation (CV) approach. This is a valuation method based on the elicitation by the respondent of the value associated to the environmental good within a hypothetic scenario (Mitchell and Carson, 1989).

Respondents are usually asked to provide the individual demand function aiming at create a hypothetical market as much close as possible to a real market, in order to allow the estimation.

Moreover, by means of the contingent market one seeks to persuade respondents to elicit their willingness to pay (*WTP*) for the preservation and/or the improvement of the investigated environmental resource.

The questionnaire used in the survey is reported in Annex 1.

Contingent valuation has both the advantages that it can be implemented in every context and it is relatively easy in terms of empirical and analytical approach. Nevertheless, the reliability of the method strictly depends on both the willingness of the respondent to provide accurate answers and on the care and accuracy adopted in the description of the environmental good and the payment vehicle. However, in general, when dealing with use value, CV can be considered a viable and reliable method (Arrow et al. 1993).

Results

Primary data collected during the field survey have been elaborated to have a preliminary understanding of the social structure, composition, and economic behaviour of the visitors.
As reported in table 1, visitors to the NP are coming from a large range of countries (21). Approximately one quarter of visitors comes from Croatia, and 35% comes from other four European countries (Germany, Italy, Switzerland and Austria). The table 1 supports the idea that the Plitvice National Park is an area of international importance from the naturalistic, recreational and cultural point of view that can attract visitors from the entire world.
Respondents belong to all age classes with people in the age class 20-40 and over 50 years slightly prevailing (table 2). In general, however, visitors are quite young: about 57% are under 40 years.
Almost 62% of the interviewed persons have high level of qualification (university degree) (table 3), an indicator of the main interests of the visitors: probably environmental education and not only general tourist interests are among the motivation of large number of visitors.
The two mentioned aspects (middle age and well educated visitors) are relevant factors to be considered in organising a costumer oriented offer of information services.

Table 1 – Visitors to the National Park by country of origin and Willingness To Pay (WTP, Euro)

Country	No. visitors	%	Average WTP (full ticket)	Average WTP (reduced ticket)
Australia	8	3,6	20.5	11.40
Austria	9	4,1	17.1	10.68
Belgium	6	2,7	18.3	9.38
Brazil	1	0,5	20.6	10.29
Canada	2	0,9	20.6	10.29
China	2	0,9	23.3	11.66
Croatia	58	26,2	16.6	8.45
Finland	3	1,4	27.4	13.72
France	10	4,5	16.1	9.70
Germany	38	17,2	18.3	9.87
Hungary	2	0,9	17.8	10.63
Ireland	2	0,9	32.2	15.09
Israel	12	5,4	19.3	10.98
Italy	20	9,0	22.0	12.26
Netherlands	1	0,5	0.0	0.00
New Zealand	5	2,3	17.6	8.51
Poland	2	0,9	20.6	10.29
Slovenia	2	0,9	0.0	0.00
Spain	4	1,8	17.2	8.58
Switzerland	12	5,4	14.7	8.92
United Kingdom	3	1,4	16.0	8.00
USA	19	8,6	17.9	10.16
Total	221	100,0	18.2	9.82

Table 2 - Visitors to the National Park by age and Willingness To Pay (WTP, Euro)

Age class	No. visitors	%	Average WTP (full ticket)	Average WTP (reduced ticket)
less than 20	17	7,7	15.0	8.4
from 20 to 30	58	26,2	17.2	9.2
from 30 to 40	55	24,9	19.0	9.9
from 40 to 50	39	17,6	18.1	9.7
more than 50.	52	23,5	19.6	11.2
Total	221	100,0	18.2	9.8

Table 3 - Visitors to the National Park by qualification and Willingness To Pay (WTP, Euro)

Qualification	No. visitors	%	Average WTP (full ticket)	Average WTP (reduced ticket)
Junior School	5	2,3	18.2	11.4
High Junior school	14	6,3	18.3	11.5
High school	58	26,2	16.7	9.1
Graduation	137	62,0	18.7	9.9
No answer	7	3,2	21.1	10.8
Total	221	100,0	18.1	9.8

Most of the visitors have decided to visit the NP thanks to the information provided by friends and tourist operators. Quite a large number of interviewees (37%) have been already in the NP in the last five years, a very appropriate indicator of the positive evaluation of the experience done in the past and of the richness of the protected area (table 4). However this figure is mainly due to visitors coming from Croatia and it involves only part of the foreign tourists.
As mentioned, the NP is not located close to the coast or other valuable tourist attractions; about 63% of the interviewees have planned their visit to the NP as a complementary activity in a tour to Croatian cities and other tourist attractions (table 5). 71 % of the visitors are using a car to reach the NP. Short visits are common: 53% of the interviewees are spending in the NP's surroundings (hotels and B&B) one or two nights. In fact, usually the visit to the NP covers no more than one day (82%) (table 6).

Table 4 - Visitors to the National Park by number of visits during the last 5 years and Willingness To Pay (WTP, Euro)

No. visits	No. visitors	%	Average WTP (full ticket)	Average WTP (reduced ticket)
0	138	62,4	17.9	9.8
1	53	24,0	18.9	9.9
2	19	8,6	17.0	8.8
3	6	2,7	21.0	11.4
4	2	0,9	20.6	10.3
5 or more	3	1,4	16.5	9.4
Total	221	100,0	18.2	9.8

Table 5 – Interviewees that visited other Parks or Croatian Cities during the travel and Willingness To Pay (WTP, Euro)

Visit to other parks or cities	No. visitors	%	Average WTP (full ticket)	Average WTP (reduced ticket)
No	82	37,1	16.7	8.7
Yes	139	62,9	18.9	10.4
Total	221	100,0	18.2	9.8

Table 6 - Visitors to the National Park by their intention to stay more days and Willingness To Pay (WTP, Euro)

	No. visitors	%	Average WTP (full ticket)	Average WTP (reduced ticket)
Only one day	179	81,0	17.7	9.6
More than one day	38	17,2	19.8	10.7
No answer	4	1,8	23.8	12.3
Total	221	100,0	18.2	9.8

In spite of the expectations, a non negligible part of the interviewees didn't visit the NP for strictly naturalistic purposes (table 7): 20% declared only a moderate naturalistic interest.
Visitors' satisfaction related to the environmental aspects of the NP is very positive, as well as the overall evaluation of the infrastructures and services provided by the NP's authorities (footpath's maintenance, bus and electric boats, etc.). Only information services on the environmental aspects, of the NP (flor, fauna, geology, etc.) should be improved in the opinion of the interviewees. On the whole, respondents seem to have been satisfied with the experience they had in the NP (table 8).

Table 7 – Influence of the naturalistic interests on the choice to visit of the National Park by and Willingness To Pay (WTP, Euro)

Naturalistic interests importance	No. visitors	%	Average WTP (full ticket)	Average WTP (reduced ticket)
Not at all	20	9,0	16.8	9.8
A bit	25	11,3	15.8	8.2
Quite enough	30	13,6	18.8	9.8
A lot	49	22,2	19.1	10.2
Very much	91	41,2	18.5	10.2
No answer	6	2,7	17.4	9.8
Total	221	100,0	18.2	9.8

Table 8 - Enjoyment of the visit to the National Park and Willingness To Pay (WTP, Euro)

Did you enjoy your visit to the park?	No. visitors	%	Average WTP (full ticket)	Average WTP (reduced ticket)
Not at all	0	0,0	-	-
Not too much	2	0,9	14.4	8.6
Quite a lot	6	2,7	16.8	9.9
A lot	64	29,0	17.7	9.6
Very much	147	66,5	18.5	9.9
No answer	2	0,9	17.2	9.9
Total	221	100,0	18.2	9.8

As far as the visitors' opinion on the entrance fee is concerned, 60% of the interviewees think that the price is fair (table 9). It is relatively high the number of people who think that the entrance fee is quite expensive (23%) or too expensive (10%).
The average willingness to pay (WTP) equals to 18.2 euro for the full ticket and to 9.8 euro for the reduced ones. It's interesting to point out that some interviewees declared a WTP lower than the ticket. Considering that the ticket paid was equal to 15.5 and 7.5 euro respectively for the adults and the children, the consumer surplus equals to 3.1 euro and to 2.2 euro per visit. These figures are comparable with the recreational benefits estimated in other European natural parks (Marangon et al., 2002). Note however, that the amount of the benefits enjoyed is equal to the declared WTP.

Obviously the Park subtracts a part of the benefits in order to pay the maintenance and management costs.
There are a lot of factors affecting the WTP. As one can see in table 1, the WTP changes deeply according to the nationality of the interviewees. This seems to depend on the average national income and on the distance travelled in order to reach the park. People motivated by naturalistic interests have in general greater WTP. Finally it's interesting to note that the opinion about the entrance fee is strictly related to the WTP (table 9).

Table 9 - Visitors to the National Park by their opinion on the entrance fee price and Willingness To Pay (WTP, Euro)

	No. visitors	**%**	**Average WTP (full ticket)**	**Average WTP (reduced ticket)**
Very cheap	2	0,9	27.4	15.1
Cheap	12	5,4	19.4	10.5
Fair	132	59,7	20.1	11.0
Quite expensive	51	23,1	15.7	8.3
Too expensive	22	10,0	11.5	6.3
No answer	2	0,9	15.1	8.2
Total	221	100,0	18.2	9.8

Analysing the WTP it's possible to estimate the demand function of the NP and to verify if the entrance fee amount is correct in order to maximise the Park revenue. From an economic point of view in fact the entrance fee can't exceed the price that maximize the profit of the pure monopolist. It is well known that the profit maximisation condition under a pure monopoly is: MC = MR that is, the marginal cost has to be equal to the marginal revenue. If the average costs are constant, this condition can be rewritten as MR=0. So, also without knowing the cost function of the NP, it's possible to find the maximum price at the above condition (Marangon and Tempesta, 1998).
Considering only the full ticket, we estimated two different demand functions: the first one for the Croatian visitors and the second one for people coming from abroad:

Croatian demand function:

$$WTP = -6{,}3435 \ln(x) + 39{,}591 \qquad r^2 = 0{,}9406 \qquad [1]$$

Other visitors demand function

$$WTP = -8{,}8497 \ln(x) + 51{,}519 \qquad r^2 = 0{,}9550 \qquad [2]$$

In order to make comparable the two demand functions the number of visitors (x) was expressed as the percentage of the interviewees that were willing to pay any WTP amount.
Calculating the entrance fee that maximises the NP revenue the subsequent conditions were found:

Croatian: entrance fee = 6,4 euro number of visitors: 88% more than the current ones

Other visitors: entrance fee = 8,8 euro number of visitors: 24% more than the current ones

There is a remarkable difference between the current tickets and the revenue maximising tickets. This is especially true for the Croatian. In fact, considering the presence of not negligible variable costs, one can suppose that the actual entrance fees are closed to the profit maximising condition for the people coming from abroad, but they are probably too high for the Croatian.

Conclusions

Forests are a renewable natural resource whose value is expressed by their ecological, sociological and commercial functions. The concept of non-wood forest services embraces a multitude of diverse benefits that people obtain from forests. These benefits result from spontaneous effects of forests on the living environment and from activities of man and nature in the field of production and services. These services belong to all members of the society and nobody can purchase them for their sole use.

In this study we investigated correlation between Croatian and other visitors demand function. Amongst the forest attributes with a strong effect in WTP we find that presence of a nature reserve and the recreational quality play a relevant role. Regarding socio-demographic profile among visitors, international tourists prevail, especially in Plitvice lakes NP.

Main motive for visiting the park is to enjoy the natural beauty of the area and a desire to simply visit the park, although rest and relaxation is also common. Most visitors arrive to the park while in transit followed by the targeted visit to the park from a place where they are spending holiday. Some visitors made a targeted visit from their permanent place of residence or visit the park on an organized tour. Most visitors arrive to the park by their own vehicles, and most stay in the park for a day. 66.5% visitors are very much satisfied with the visit. 59.7% of visitors are fairly satisfied with the ticket price.

This research points to a growing demand for indirect, optional and future values of forests in the Republic of Croatia, as well as to increased awareness of multiple values and uses of this renewable natural resource. One of the main management goals regarding forests is on the basis of observation of forest ecosystem condition, to ensure preservation and improvement of ecological and sociological functions of forests, which are of crucial importance for biodiversity and existence of lakes. The National Park Plitvička Jezera is, and will be an extraordinary valuable World Natural Heritage Site, where priority is given to the conservation of the unique biodynamic process of travertine building and the creation of lakes. Uniting all specialities of ecosystems, cultural heritage, spiritual values as well as contemporary sustainable developement in cooperation with the local population, together with education on all levels assures a complete experience of special beauty and thus supports the developement of the broader region.

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Annex 1 – The questionnaire used in the survey

University of Zagabria University of Padova
Plitvice National Park

Personal data:
City _____Province/District_____

Nation _____ Age _____ □ Male □ Female (0)

Number of people of your family _____

Job:
□ Agriculture □ Industry □ Handicraft □ Commerce □ Services □ Public Employment □ Not working

Employment:
□ Self-employed □ Dependent □ Freelancer □ Businessman □ Student □ Housewife/ Retired

Qualification:
□ Junior School □ High Junior school □ High school □ Graduation

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1) How many times did you visit the Park during the last 5 years?
□ never □once □ twice □ three times □ four times □ five times or more

2) The visit of the park was realized: □ By leaving home □ By leaving from an holiday facilities
If you are on holiday, please indicate your holiday Place_____
Nation _____

3) Means of transport used in order to reach the park: □ Car □ Motorcycle □ Camper □ Bus
□ Else (specify) _____

Number of participants that used the same means of transport (excluding the interviewed) _____

4) Number of people on holiday _____ Holiday's length (days) _____

5) During your holiday did you visit other parks or Croatian cities? □ YES □ NO (0)
If YES, please specify which cities, parks or other
_____
_____

6) Fee entrance to the Park: Full price, number _____ Reduced price, number _____ Free entrance, number_____

7) Please, could you provide an approximately estimate of the total cost of the visit (average per participant) (including the cost of the journey costs, the overnight stay, lunch, entrance tickets, fee for the organized trip, etc.)
_____ Kuna per person

8) How do you evaluate the cost of admission fee?:
□ Too expensive □ Quite expensive □ Fair □ Cheap □ Very cheap
Could you justify an eventual choice of Cheap/Very Cheap?

The admission fee is entirely spent by the administration to maintain the good conditions of the park. Imagine that, due to the high cost of administration, the park had to raise the cost of the entrance in order to guarantee the public opening. In this situation, what would be the maximum amount of the ticket that you will be willing to pay to visit the park?
Full ticket _____ Kuna (1 Kuna = 0,1372 euro)
Reduced ticket_____ Kuna

9) Kilometres to reach the park from home or your holiday place (just one way): km _____ Time needed to reach the park _____arrival time at the park (hour) _____ exit time from the park (hour) _____

10) Will you visit the park some more days? □ YES □ NO (0) If YES, how many days _____

11) Did you sleep nearby the park? □ YES □ NO (0)
If YES, in which facilities? □Hotel □ Camping (tent) □Camper □ Bungalow, roulotte □Private room
□Other (specify) _____

12) The visit at the park was made :
□ with the family □ with a group of friends/families □ with an organized trip with a tour operator or else □ with a friend/boyfriend □ alone

13) How did you know the Plitvice National Park? □ Tourist guide □Tour operator □Travel bureau of your holiday place □Friends □ Internet □ Specialized magazines

14) How much your visit was influenced by the environmental interest?
□ Very much □A lot □ Quite enough □ A bit □ Not at all

15) Inside the park you avail of:
- the service of the electric boats? □ YES □ NO (0)
- the service of transportation bus? □ YES □ NO (0)

16) What is your assessment?
- Electric boats: □ Very worthy □ Efficient □ Not very efficient □ Inadequate
- Transportation bus: □ Very worthy □ Efficient □ Not very efficient □ Inadequate

17) How could you evaluate the whole information given by the park in order to understand the characteristics of the natural environment?: □ Very good □ Good □ Quite good □ Insufficient □Very insufficient

18) How do you consider the internal systems of signs of the park?
□ Very good □ Good □ Quite good □ Insufficient □Very insufficient

19) How do you consider the maintenance of the trails web?
□ Very good □ Good □ Quite good □ Insufficient □Very insufficient

20) How do you judge your visit to the park, did you enjoy it?
□ Very much □ A lot □ Quite a lot □ Not too much □ Not at all

3. *Economic issues of incentive contracts for a free access and recreation of the public in private forests: a case of risk management*

Juliette Gadaud, PhD. candidate
CEMAGREF Bordeaux- Unité Aménités et dynamiques de l'espace rural
GRETHA -Université Montesquieu Bordeaux IV
50, avenue de Verdun 33612 Cestas, France
Tel : (33) 05 57 89 26 94 – fax : (33) 05 57 89 08 01
e-mail : juliette.gadaud@bordeaux.cemagref.fr

Abstract:
The aim of this paper is to analyse the economic issues of the incentive contracts conclude between public authorities and landowners permitting free access and recreation of public in private forests.
The majority of foresters are non-industrial private forest owners (NIPF), so they are confronted with problems of the joint production timber and amenities. Their forest management is getting complicated with the access of public in their forest that can have consequences for their income, for their utility and for an increase of fire risk probability. In order to answer to recreational demand, the French forest law of 2001 requires private forest owners to provide recreational activities and it encourages the implementation of financial incentive schemes to integrate better the supply of recreation services with the other functions of forest and woodlands, as productive as non-productive ones.
We first analyse an example of conventions that tend to resolve the problem of the increasing fire risk generated by the public by proposing a free insurance. This convention has been implemented in the Landes department of France, which is a high fire risk area. The proposition of the public authorities meets refusals, so we develop a model of insurance in order to know if the refusal can be explained by a too low indemnity for risk covering or by a too much strict coverage. We conclude that these contracts are largely generous and they can go beyond risk management. That is the reason why we present, in a second part, different facilities that can be used to propose a recreation supply. These facilities imply constraints and costs for the landowners. Finally, in a third part, we value the landowner's willingness to accept for each constraint and cost knowing that increasing fire risk can modify their willingness to accept. The analysis lean on data stemming from a contingent valuation design led in 2006 in the department of Landes. We conclude that the perception of increasing fire risk is fundamental because there is an ambiguity on the probability and the degree of ambiguity influences the choice to contract or not.

Keywords: private forest, recreational activities, willingness to accept, risk

Introduction

Leisure and recreation in forests and woodlands remain very popular in France (Peyron et al., 2002; Dobré et al., 2005). The National Forest Inventory (NFI) values the monetary equivalent of forest recreation at two billion euros per year, at the national level and with an average of two hours per household per visit. With 70% of French forests being privately owned and with the increase in outdoor recreational activities, the free access to private forests by the general public and its consequences have become very important issues. However, many others European countries are concerned with this problem (Janse and Ottitsch, 2005; Church and Ravenscroft, 2008). A few surveys of forest owners show that peri-urban forests know more pressure from the public (Schlumberger, 2001). And even if forest owners allow some recreational activities which are not dangerous for their forests, the majority are against the opening their forests to free access for public recreation.

The latest forest law of 2001 changes the organisation of recreational activities. It asks private forest owners to provide recreational activities. It then encourages the implementation of financial incentive schemes to better integrate the supply of recreational services with the others functions of the forests and woodlands, both productive and non-productive. The new focus is to adequately compensate landowners for inconveniences and supply of recreational services.

The supply of non-market recreational services in private forests is not yet addressed by the economic literature. The main reason is that recreational activities are mainly practiced in public forests, benefiting from free access and considered as a public service provided by public authorities. On the contrary, outdoor recreational activities in private forests depend on private law. We can note that it exists many differences between countries. For example, in German, Norway and Finland, the law allows the public to access private forests whereas in France and Holland, the access to private properties is being prohibited.

So, the development of recreational activities as bicycling, jogging, walking, hiking, picnicking, driving for pleasure, visiting nature sites, are rival and excludable goods, subject to congestion. These sorts of activities are being developed in public places but the issue is now how to extend these activities to private forests. This development forces us to examine, firstly, the compatibility between the recreational activities in forests and timber producing areas; and secondly the financial incentive schemes to integrate the supply of recreational services.

After six years of existence of the law, few conventions have been enacted. We have analysed why this law is a quasi failure. Our conclusions reveal two impediments to the development of such contracts.

The first difficulty concerns an anticipation of an increasing fire risk induced by public access: forest owners manage their forests in a risky background and all agree to say that the opening to free access public recreation increases fire and damage risks.

The second difficulty lies in the lack of information at the disposal of public authorities and landowners on which to base their negotiations of the contractual terms. In fact, they do not know the different constraints generated by the public recreational use. In other words, there exists a vagueness about the definition of the supply recreational services and about the cost thereof.

The aim of this paper is therefore to analyse these two difficulties and determine how they can possibly be resolved. Concerning the fire risk, we rely on an example of conventions that implement a financial incentive scheme by proposing a free insurance for the increase in fire risk generated by the public. This convention has been implemented in the Landes department of France, which is a high fire risk area. We place the emphasis on the indemnification for risk covering proposed in this contract by the public authorities and we compare it to a forest owners' willingness to accept (WTA) an increasing risk when they allow public access to their forests. We conclude that incentive contracts for opening private forests to the public must go beyond increasing the risk covering management (part I). We assume that it is necessary to take into account others constraints generated by a free access to private forests. This assumption leads us to analyse the second difficulties lying in the definition of a contract of recreational services, thus the different constraints generated by the public recreational use (part II). After concluding that the creation of contract to recreational use in private forests which only take into account the risk of fire is not the good solution, and that recreational use leads to numerous constraints, we analyse the consequences of the perception of fire risk and of the degree of ambiguity on the financial compensation of the constraints negotiated by the contractual terms (part III).

I- Economic analysis of a covenant of rights of passage in private forests with financial compensation in case of damage generated by public

The covenants of rights of passage have been implemented to develop hiking trails in each French department. The landowners generally contract with the public authorities to allow a free hiking trail in their forests, the authorities paying for the alteration works and upkeep costs. The contract is valid for 3 years. Concerning the civil liability, landowners are advised to insure themselves because, if a hiker has an accident because of a tree, the forest owner can be liable. Nevertheless, if

a hiker causes a fire or a damage, he would be liable. These covenants might be interpreted as a free rental contract for public authorities.
Now, with the new covenant signed between the public authorities of the Landes department and its forest owners, a financial compensation is being proposed to landowners by public authorities if a fire risk with an unknown origin should occur. The financial compensation is 1018 euros per hectare for the financial loss and 1018 euros per hectare for reforestation. This measure is applicable to within 100 metres on each side of the trail. So, we can interpret the covenant as a free insurance contract to cover increasing risks induced by a public access to private forests.
We can generally define an insurance contract by the insurance premium paid by the insured person and the indemnity (equal here to 2036 euros). In our case, the premium is explicitly equal to zero, even if landowners endure costs when they permit free access and recreation of public in their forests. So, these costs can be considered as being the implicit insurance premium.
Despite the financial compensations, landowners refuse this incentive contract in the Landes department. We have been interested in the economic reasons for this refusal and we have wanted to know if they can be explained by a too low indemnity for increasing risk covering. In order to verify this hypothesis, we develop a model of insurance demand as introduced by Mossin (1968) and, using a static analysis, we define the theoretical indemnity claimed by the landowners to support an increasing risk. In fact, it amounts to calculating their willingness to accept (WTA) for an increasing risk according to several levels of risk probability and indemnity. Then, we estimate their WTA in the situation of the Landes department; that is to say, we adapt the probability and the indemnity. Afterwards, we compare the estimated WTA and the real financial compensation supplied by the public authorities. We make this comparison when a NIPF undertakes self-protection actions and does not. To perform this analysis, we define a landowner's expected utility when he wants to insure himself without self-protection actions (1) and with self protection actions (2). The landowner is assumed to be a non-industrial private forest owner (NIPF), meaning that he owns forest but his initial wealth W (W>0) is composed to timber income R which is under risk and a non-risk income W_0. Thus,

$$W = W_0 + R$$

The loss rate is X, $X \in [0,1]$ and the indemnity rate is α with $\alpha \in [0,1[$. To avoid any ambiguity case, we only take into account the contracts with $\alpha < 1$. The insurance loading factor is λ, $\lambda \in [0,1]$. XR is the loss and αXR the indemnification paid by the insurer. NIPF[1]'s preferences are represented by the twice continuously differentiable von Neumann-Morgenstern utility function, U(.). And p is the probability of fire risk.
When a NIPF takes self-protection actions q ($q > 0$), the cost of self-protection is $c.q$. The losses are dependent to self-protection actions: $X(q).R$ ($X' < 0$ et $X'' > 0$). The risk premium $P = p\alpha XR(1+\lambda)$ is interpreted as the amount of money the individual is willing to give up in order to obtain with certainty the mathematical expectation of the lottery (Eeckhould, Godfroid, Gollier, 1997). Thus,

$$EU(W) = pU[W_0 + R - XR + \alpha XR - p\alpha XR(1+\lambda)] + (1-p)U[W_0 + R - p\alpha XR(1+\lambda)] \quad (1)$$

And

$$EU(W') = pU[W_0 + R - X(q).R + \alpha X(q).R - c.q - p.\alpha.X(q).R.(1+\lambda)] + (1-p)U[W_0 + R - c.q - p.\alpha.X(q).R.(1+\lambda)] \quad (2)$$

In order to define the landowner's WTA for an increasing risk, it's necessary to differentiate the expected utility by the non risky income W_0 and the probability of risk p:

[1] We consider a NIPF as a risk-averse agent.

$$dEU(W) = \frac{\partial EU(W)}{\partial p} dp + \frac{\partial EU(W)}{\partial W_0} dW_0 = 0$$

thus :

$$CAR = \frac{dW_0}{dp} = -\frac{\partial EU(W) \big/ \partial p}{\partial EU(W) \big/ \partial W_0}$$

Next, we estimate the WTA of a NIPF from the Landes department. To do so, we make a numerical simulation of the forest owners' willingness to accept within different scenarios. The data for this simulation stem from forest owners characteristics in the Landes department. Afterwards, we compare simulated values of the WTA with the contract-based indemnification supplied by the public authorities, i.e. the expectation of indemnification (p * αXR) with αXR = 2036 euros in the covenant for the Landes department.

The difficulty of this analysis results in the estimation of the increased risk probability when the public has a free access to private forests. We have two estimations of the risk probability in a normal situation (without the opening of private forests). The "protection of forests against fires" (DFCI) association works to prevent the risk of fires in the Landes forest and estimates the risk probability at 0.2% in a normal situation, whereas an insurance organization specialized in insurances for forest owners estimates the risk probability at 0.5%. When private forests are in free access, the insurance organization assumes that the risk probability is doubled but this is not justified by statistics.

Finally, we can compare the simulated WTA and the expectation of indemnification for different probabilities in the case of a free access to private forests. When the WTA is superior to the expectation of indemnification, the NIPF should refuse the insurance-contract, defined before. This case is valid when a NIPF does not develop any self-protection and for an estimation of risk probability defined by DFCI. This situation represents a minority of landowners because many of them use at least one self-protection action. So, the majority of the NIPFs are in the other situation which means they should accept the insurance-contract because the estimated WTA is inferior to the expectation of indemnification: the estimated financial compensation for accepting an increasing risk generated by the public is inferior to the probability of indemnification supplied by the contract.

We can conclude that the indemnification supplied by the public authorities is rather generous and the financial compensation amounts can not be detrimental to an expansion of the contract.

Even if we had overvalued the increased risk probability, relations between the simulated WTA and the expectation of indemnity should not change.

Finally, the risk covering seems to be an important consideration but this is not enough for landowners to allow free access and recreation of the public in private forests. The management of the opening of private forests to the public includes not only the risk management but also the management of free access recreational activities and the consequences for landowners' income and their utility of owning a forest. Indeed, the NIPFs have to bear costs when they open their forests. These costs depend on the development of the recreational setting characteristics (creation of outdoor recreational activities, improvement of the landscape), upkeep of the forests (trash collection), free access adjustment and the consequences on their utility. For example, hunting is widely practiced in the Landes department and can be hampered by a free access of the public. In this situation, when we value the landowners' WTA, we must integrate these different constraints generated by the public recreational use as said in the latest forest law of 2001. Moreover, we have to take into account the impact of increasing risk on the choice to accept or not a contract.

In what follows, we attempt to define a contract for recreational services and, thus, the different constraints generated by public recreational use. Afterwards, we evaluate the NIPFs willingness to accept different contracts which match the constraints defined earlier.

II- Contracts for recreational services: definition and conditions of supply of recreational services

The extension of public recreation to private forest by the forest law points out to the compatibility between timber production and amenities production and thus, an incentive financial compensation to accept the joint production. However, let us first define recreation supply.

1) Definition of recreation supply

Economic literature of outdoor recreational activities considers that it is the consumer who produces the service himself and who derives a certain satisfaction in using it. McConnel (1985) considers an outdoor activity as a service produced and consumed by someone, jointly with a natural resource. Therefore, the measurement of the results concerning the management of recreational activities is arduous. We can perform a supply analysis, meaning that we adopt the point of view of the production and thus we are interested in the characteristics of recreational services whereas, if we chose a demand analysis, we are interested in the social benefits of the management. For example, the results of management could be measured by the amount of visits. The production function of attendance in private forests could integrate natural, human or material factors (Dehez, 2002). Obviously, in this case we assume that we have an objective and reliable measurement of attendance.
In the contrary, with a supply analysis, outdoor recreation cannot really be supplied. What is supplied is the opportunity to consume the service (Robinson, 1967). This opportunity exists when we have two necessary factors: activities and settings. Because of the nature of the recreational service, the supply consists in offering these two factors and the management will depend on the cost of supplying the recreational services. For illustrative purposes, the results of a survey about the forest users around Paris (conducted by CREDOC, the Research Centre for the Study and Monitoring of Living Standards) indicate that users visit a forest because they enjoy the scenery of natural areas and landscape (calm, aesthetical environment) and because of the quality of recreational development (picnic areas).
Nevertheless, in order to know how to supply the recreational services, it seems better to adopt a supply analysis.
We have said that the recreation supply is a combination of the natural settings and the recreational development. Therefore, if we want to compensate landowners who supply them, it's necessary to explore the recreational supplying conditions.

2) Recreational supplying conditions

Forests have a multifunctional characteristic because they are a jointure between a timber production and amenities. If the NIPFs want to propose a recreational supply, this would have consequences on the timber production. For example, the main objective of a NIPF is to determine the optimal rotation length, given a set of parameters. If parameters change, as amenities are more considered, the optimal length will change, Hartman (1976) describes why and how amenity considerations lengthen optimal rotation.
Therefore, it is very important to distinguish the different relations between timber production, conservation of forest landscape and recreational development.
To understand how the NIPFs can answer at the specific forest management, describe the double objectives of landowners with a timber income and a private value for the others uses of their forests. For Pattanayak et al. (2002), a typical landowner maximizes utility comprising income and amenities. Therefore, the timber supply is no more dependent of economic variables and market price but it depends on his self-use of forest. As explained by Pattanayak et al. (2002) "because amenities flow from the resulting forest condition, landowners are described as self-producing the amenities". Besides, we do not know if landowners' preferences coincide with public's preferences.

If it is not the case, landowners will be constrained to answer the social demand and will lead to a decreasing utility. In fact, an acceptation of free access of the public to private forests leads to accepting the perpetuation of the attendance and thus additional constraints, which directly affect forest management: lengthening of the optimal rotation to preserve a beautiful landscape. Here, timber production and amenity production depend on the same product process. But, for the recreational development, the nature of jointure is different; it concerns timber production and attendance. We think about the loss of forest surface to parking areas and bicycle lanes. Thus can exist a competition between the two activities. Nevertheless, there exist complementarity cases when the opening of trails can also help in the exploitation of timber (Bowes and Krutilla, 1985). To sum up, there are limits to the substitution and complementarity between timber production and recreational supply. When forests have a poor productivity, the attendance will less disrupt the timber production but a strong productivity could be disrupted by few people (Tomkins, 1990). In public forests, we can observe that forests for recreation are the least productive. Thanks to experiences in public forests, we know the economic consequences of the development of recreational activities and we can have an estimation of all the additional costs needed to develop recreational activities. We identify three types of costs: the cost to supply a recreational setting, the cost to manage the attendance and the cost resulting from a loss of utility. The last cost is even larger when a forest is over-crowded which leads to congestion costs (Mc Connell, 1985). In the local context of the Landes department, the loss of utility is mainly the inconvenience for the hunters. The table below sums up constraints and costs when private forests are opened to the public.

Economic consequences are various and numerous. In the addition to the risk of fire which affects the choice to accept a contract as we have seen in the first part with the example of the covenant of right of passage in the Landes department, others specifics actions must be undertaken in order to welcome the public in private forests in the best conditions. However, these actions lead to constraints and costs. Thus, public authorities must compensate landowners for all the constraints and costs in order for them to accept a contract.

In what follows, we evaluate the landowners' WTA for the different constraints identified above and with the assumption of an increasing risk of fire with an ambiguous probability.

Table 1: Summary of constraints and costs

Supply of recreational settings		Management of the attendance		Loss of utility	
Actions	Costs	Actions	Costs	Actions	Costs
Upkeep of landscape and trails	Costs of upkeep	Increase in safety measures	Additional cost for clearing and pruning	Inconvenience to hunters	Loss of utility
Abandon or delay of clear cutting	Loss of income	More security	Costs of signpost and of cleaning		
Organization of facilities of trails	Reduction of productive space				

III- Assessment of the WTA for different constraints generated by public recreational use and the impact of the perceived risk of fire.

Within the context of a contract, we use the willingness to accept in order to define the amounts which incite landowners to provide public goods and services. Its calculation is based on the compensation variation of the producer's benefit surplus when he has a loss because of additional costs (Bonnieux et al., 1998; Amigues et al., 2002). If the producer is the first beneficiary of the

public good or service that he produces at that time, we use the producer's variation of utility surplus (Dupraz et al., 2003). As we have said, we consider landowners as NIPFs so that they maximise their utility under their constraint of income stemming from timber selling and non-timber income (Pattanayak et al. 2002). Therefore, the WTA is composed of the compensation for the loss of profit, the loss of utility and the fixed costs stemming from the free access management. All these elements depend on the perceived risk of fire by private owners. This means that NIPFs argue about various values of mean probability of fire that they know in order to estimate their WTA.

The attendance remains unobservable and is seasonal, and the same applies to the probability of fires generated by the public. In this situation, we can define this probability as a random variable:

$$Q_s = q + \varpi_s$$

Let q be the mean, σ^2 the variance and s the days of year. In the context, ex ante, if a NIPF knows the distribution of the probability and if he is risk-averse, his utility to accept a contract with free access recreational activities, thus constraints, is:

$$U_1(c, R, q) = \alpha_1 + \beta \log(R) + \delta_1 Z + \lambda_1 \bar{c} S q + \nu_1 \bar{c}^2 S^2 \sigma^2 + \varepsilon_1$$

$S\bar{c}$ is the amount of the loss generated by the attendance, S the surface owned and concerned by the contract, and $\bar{c}$ the mean rate of damage. We assume it is fixed and identical for all the NIPFs. In the Landes department, we estimate $\bar{c}$ at 11.5%. $\bar{c}Sq$ is the mean amount of fire damage generated by the attendance, $\bar{c}^2 S^2 \sigma^2$ its variance. R represents the compensation amount supplied by the contract, Z the characteristics of NIPF and ε_1 the error term in the context of random utility.

Without contract, a NIPF's utility is U_0, with

$$U_0 = \alpha_0 + \delta_0 Z + \lambda_0 \bar{c} S q + \upsilon_0 \bar{c}^2 S^2 \sigma^2 + \varepsilon_0 .$$

We assume that the attendance, thus the risk, is the same with or without contract. Indeed, the contract has no influence on the mean attendance because the majority of the NIPFs are already confronted with an attendance of their forest and this attendance depends on the consumer's preference. However, it is the estimation of the risk generated by the attendance which influences the choice of a contract, especially when experts disagree on the estimation about the risk generated by the attendance. An ambiguity of the probability of fire is created, which means that there exists an uncertainty on the probability of occurrence of risk. Hence, when the landowner makes the decision to contract or not, each one argues about his subjective distribution of the seasonal mean of the fire risk.

Ex ante, his excepted utility in case of contract is:

$$EU_1(\bar{c}, R, q_j, S) = \alpha_1 + \beta \log(R) + \delta_1 Z + \int_{q_j} \lambda_1 \bar{c} S q_j . f(q_j) . dq_j + \int_{q_j} \upsilon_2 \bar{c}^2 S^2 \sigma_j{}^2 . f(q_j) . dq_j + \varepsilon_1$$

Hence,

$$EU_1(\bar{c}, R, q_j) = \alpha_1 + \beta \log(R) + \delta_1 Z + \gamma_1 S \mu_{q_j} + \gamma_2 S^2 \mu_{\sigma_j{}^2} + \varepsilon_1 , \text{ with } \gamma_1 = \lambda_1 \bar{c}, \nu_1 = \upsilon_1 \bar{c}^2, \bar{c} < 0 .$$

The function of utility allows for an interpretation of the NIPF's preferences with regard to ambiguity. The expected utility integrates the mean value of the mean probability of seasonal risk μ_{q_j} and the mean value of the variance of the mean probability $\mu_{\sigma_j{}^2}$. Here we have a formalisation in terms of second order probabilities in order to obtain an objective measure of ambiguity (Khan and Sarin, 1988; Riddel and Shaw, 2006).

Without contract, the expected utility is:

$$EU_0 = \alpha_0 + \delta_0 Z + \gamma_0 S \mu_{q_j} + \nu_0 S^2 \mu_{\sigma_j{}^2} + \varepsilon_0 , \text{ with } \gamma_0 = \lambda_0 \bar{c}, \nu_0 = \upsilon_0 \bar{c}^2, \bar{c} < 0 .$$

The minimum amount of WTA is the compensation that allows an equalisation of the two expected utilities for a risk-averse person and in a situation of uncertainty: $EU_1 = EU_0$.

Hence :

$$CAR = \exp\left\{ -\left[\alpha + \delta Z + \gamma S \mu_{q_j} + \nu S^2 \mu_{\sigma_j{}^2} + \varepsilon \right] \Big/ \beta \right\},$$

With $\alpha = \alpha_1 - \alpha_0$ and $\delta = \delta_1 - \delta_0$, $\gamma = \gamma_1 - \gamma_0$ and $\nu = \nu_1 - \nu_0$.

To conclude our empirical study, we need to know the WTA for each constraint and fire-risk subjective probability.

Concerning the WTA, we obtain an estimation with data stemming from a contingent valuation design conducted in 2006 in the Landes department. In our survey, the landowner chooses between the actual situation concerning his forest and a contract with imposed constraints (we have defined them before, table 1). He can receive compensation for each constraint. He has to do six successive choices. We use a referendum method and we follow Hanemann and Kanninen (1998) chosen four levels of bid. We define the amount of bid for each constraint by referring to market price. The contingent question consists of two steps. First, we ask the landowners if a financial compensation is necessary for each constraint in the contract situation. If they answer "yes" for one constraint, this means that their WTA is not equal to zero. The second step consists of the revelation of the WTA for landowners who said "yes" (i.e. 85%)

Lastly, to estimate the subjective distribution of fire-risk probability, we use answers to the importance of attendance and to the perception of diverse risks. Thanks to these answers, we can deduce the distribution of the subjective probabilities (table 2).

These distributions are 150 times higher than the statistical estimations by experts. This large distinction between statistical value and perceived value is classic in literature. The declarative method induces an overestimation bias but the important result is the difference of size between the two estimations, when there is an ambiguous situation.

In order to estimate the WTA, the recreation setting constraint is significantly different from the others. So we have two evaluations of WTA, one for the recreation setting and one for the others constraints. The WTA by hectare is a function of the surface and of the individual perception of the degree of ambiguity.

Table 2: Distribution of subjective fire-risk probabilities generated by the public

	Mean	Minimum	Maximum
$\hat{\mu}_{q_i}$	52%	22%	80%
$\hat{\mu}_{\sigma_q{}^2 i}$	21%	15%	25%

Table 3: Distribution of individual values of WTA and the characteristics of this distribution by hectare.

	Recreation setting				Other constraints			
	Aumount of bid (€/ha/year)	Area (ha)	CAR (€/year)	CAR (€/year/ha)	Amount of bid (€/ha/an)	Area (ha)	CAR (€/year)	CAR (€/ha/year)
Median	-	8	505	63	-	8	110	15
Mean		129	1382	183	-	129	338	47
Minimum	35	1	139	1.2	10	1	33	0.30
Maximum	400	4208	37692	617	90	4208	8820	144

We can first note that the WTA by hectare is not a monotonous function of the forest area and secondly that the WTA depends on the perception of the degree of ambiguity.
Econometric results conclude that, whatever the behaviour of NIPFs toward ambiguity, they will accept a contract with constraints when they consider the ambiguity on the loss sufficiently low, but the amount of compensation is increasing when the perception of the degree of ambiguity increases. We assume that the NIPFs are ambiguity averse because they have a high-risk perception whereas the probability is low. As Hogarth and Kunreuther (1989) have demonstrated by an experimental study, a person is ambiguity averse when the risk probability is low and his perception of risk is high.

Conclusion:

We demonstrate that the opening private forests to free access for public recreation leads to two sorts of constraints and costs. One is the increasing fire risk, other is constraints and costs which have consequences on the timber production and on landowners' utility.
Concerning the increasing fire risk, we estimate the landowners'willingness to accept for this increasing, in the frame of expected utility theory. We conclude that despite a generous compensation, landowners refuse it, as it happens in Landes department. It is the reason why we assume that it is necessary to compensate others constraints. We describe consequences of contracts for a free access and recreation of the public in private forests. Then, thanks to data stemming from a contingent valuation design led in 2006 in the department of Landes, we estimate the amount of willingness to accept for each defined constraint assuming that the perception of the increasing fire risk probability may influence it. Thus, we make our analysis in the frame of the subjective expected utility theory. We can conclude that the landowners' willingness to accept for a contract for recreational service depends on the perception of fire risk and their degree of ambiguity about the risk probability. However, we cannot affirm that landowners are ambiguity averse. In addition, for public policy, if the willingness to accept by hectare is the criteria to choice landowners, we cannot suggest to choose an important or not forest ownership.

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4. Economic sustainability of national parks in the Congo Basin: A case study of the Sangha Tri-national Park

Julius Chupezi Tieguhong and Janusz Zwolinski
Forestry, Faculty of Science & Agriculture, University of KwaZulu-Natal, P Bag X01, Scottsville 3209, South Africa. chupezi@yahoo.co.uk or 204523366@ukzn.ac.za
zwolinskij@ukzn.ac.za Tel. +27-33-2606007 Fax. +27-33-2606005

Abstract
The second largest complex of tropical rain forest is located in the Congo Basin. This forest is renowned for its biodiversity, harbouring thousands of rare species of plants and animals and providing environmental services at a global level. At the same time these forests are of critical importance to the people of the region. The local economies depend on timber harvesting, while the forest dwellers support their subsistence with forest products on daily basis. The dilema faced by policy makers, conservationists and the local communities is in merging the various ideals, objectives and needs at a local, national and global level in order to sustain the forests, their fauna and the people. Examples from Southern and Eastern Africa have shown that, with the right management in place, natural ecosystems managed jointly for ecotourism, conservation and recreation, can yield appreciable benfits at minimum environmental destruction. Therefore it is believed that well-organized tourism can become the best way to use the Congo Basin's forests for creating economic opportunities without destroying the resources. The challenge therefore, is in convincing decision-makers that conservation of forests can provide for sustainable economic development. However in the Congo Basin this potential has not been demonstrated thus far. Deliberate policy initiatives to cost recovery, profit making or generation of local business are woefully lacking. Not only are the protected forests maintained with marginal funds, but the management systems in place are also ineffective, especially regarding poor financial management resulting in losses of 2/3 of the expected revenue. The centralized collection and distribution of funding by government agencies prevents local initiatives from achieving financial sustainability. It also remains unclear how the fees paid by tourists visiting the parks are related to the operational costs and if these fee structures do in fact approximate tourists' willingness-to-pay (WTP). In this study the factors of (i) tourists' WTP higher entrance fees and (ii) duration of stay, were evaluated in two protected areas of the 28000 km^2 Sangha Tri-National Park shared by Cameroon, the Republic of Congo and the Central African Republic. It was found that if park facilities were improved the potential entry fee in the Lobeke National Park could be increased by an additional US$ 10 per visitor. At the Dzanga-Ndoki National Park, foreign, resident and national tourists could be paying an additional US$ 30, 20 and 7, respectively. To this end improvements in park facilities, efficiency in entrance fee setting and management structures are recommended.

Keywords: contingent valuation method, ecotourism, entrance fee, revenue management, visitation, willingness-to-pay

Introduction

African countries face huge challenges of poverty, wars, hunger corruption and unlawfulness and yet the objective of protecting forests is their high priority. Despite a criticism of weak political will and ineffective funding mechanisms for this cause (Tieguhong and Ndoye, 2004) there are various progressive intergovernmental agreements and supportive policy documents including: (i) a Conference on Central African Moist Forest Ecosystem, known as the Brazzaville Process of 1996, with various stakeholders from 10 African countries attending; (ii)the Yaounde Process of 1999 and its 12-point agenda (incl. creation of trans-boundary protected areas, inclusion of business,

promotion of sustainable processing, and strategies for sustainable financing) supported by seven heads of state; (iii) the Central African Forestry Commission started in 2000 and which is now known as the Council of Ministers; (iv) the Congo Basin Forestry Partnership - a free association of 33 stakeholder organizations operating in six countries in the Congo Basin since 2002 (CBFP, 2006; COMIFAC, 2005).

The most extensive complex of African indigenous forests is located in the Congo Basin where 57% of the 398.3 million ha is covered by tropical rainforests. In combination with a relatively low population density (20 persons/km^2), this gives the region an average of 2.9 ha of forests per capita compared to the global average of 0.8 ha/person (FAO, 2005). It is not surprising, therefore, that these forests are among the most important economic assets based on which jobs and external revenues are generated. At the same time this second largest complex of tropical rainforest in the world contains unique flora and fauna and therefore attracts attention of many environmental lobbies. Thus 14.4% of the area is currently protected against ruthless exploitation in 49 national parks (Table 1) (Nasi *et al*., 2006; FAO, 2005).

The cost of preserving these forest in terms of their protection, management and lost revenue is enormous, especially for the poverty stricken forest dwellers and budgets of the affected countries. Among the various management options for income generation, ecotourism and recreation have been shown to generate appreciative revenues in southern and eastern African countries with relatively little destruction to the environment. Despite that huge potential, economic sustainability of these protected areas has not been achieved in the Congo Basin due to inadequate policies and their implementation, marginal cost recovery, no profit making and lost business opportunities. According to James (1999) and Wilkie *et al.* (2001) budget allocations for the management of protected areas in the region ranked among the lowest in the world and ranged between 8 and 30 US$/ha compared to over 2000 US$/ha in South Africa and Kenya. Therefore one way of improving tourism and in turn the profitability of the parks is by increasing funding, staff numbers and service quality (James, 1999). The centralized approach in collecting and distributing money by the state is also criticized as inefficient (Spergel, 2001). Internal generation and the control of funding from fees, concessions, accommodation, rentals, selling of merchandise and others should stimulate proper pricing, marketing and income policies (Tieguhong, 2003).

Table 1. The extent of protected forests in the Congo Basin.

Country	Number of national parks	Protected forests	
		Area (ha)	Proportion of forest area (%)
Cameroon	14	3 227 361	14
Central African Republic	5	5 017 000	22
Democratic Republic of Congo	9	16 141 650	12
Equatorial Guinea	3	552 000	32
Gabon	14	3 955 285	18
Republic of Congo	4	3 819 002	17
Total	49	32 712 298	14.4

Overall, the national parks in the Congo Basin are constantly faced with three major difficulties (Blom, 2004; 2001; Wilkie *et al.,* 2001; Blom, 2000; Wilkie and Carpenter, 1999a&b):

- inadequate funding to cover the recurrent costs and investments needed to modernize the infrastructure, to advertise and to attract more tourists. With only 30% of operating costs being covered by state subsidies and erratic funding from international sources, the numbers of visitors and tourism-derived revenues have remained stagnant in recent decades;
- lack of effective and accountable financial management systems resulting in poor collection of fees, inefficient accounting and corrupt practices at a loss of 2/3 of the potential revenues from entrance fees and services;

- no business plan relating the operational and social costs, values and services to the current and prospective income from fees paid by tourists and their willingness-to-pay (WTP) higher fees as well as from other business opportunities.

Despite the opaque picture and stagnation, hopes may not be lost because prospects of improving ecotourism in the region remain very high (Yunis, 2003). In order to circumvent the above-mentioned difficulties, innovative strategies need to be developed to generate more sustainable funding and transparent accounting systems. Concomitantly, efficient fee setting, collection and financial management for all the protected areas are needed in the region.
In this study higher entry fees paid by the tourists and their prolonged visits were evaluated in two protected areas of the Sangha Tri-National Park shared by Cameroon, the Republic of Congo and the Central African Republic (CAR).

Study area and methods

After the Yaounde Declaration had been signed by the Heads of six Central African countries (COMIFAC, 2005), the forestry ministers of Cameroon, the CAR and the Republic of Congo established the Sangha Tri-National Park, known by its French acronym as 'Trinational de la Sangha' (TNS) in 2000. The TNS comprises of the Lobeke National Park (LNP) in Cameroon, the Dzanga-Ndoki National Park (DNNP) and the Dzanga-Sangha Special Reserve in the CAR, and the Nouabale-Ndoki National Park in the Republic of Congo. The objective behind this initiative was to protect natural resources on this 28000 km^2 of land by harmonizing forestry laws and putting into place a common management system, anti-poaching measures, ecological monitoring, scientific research, communication and logging controls (Usongo, 2002). In general, the principles of a sustainable forest management system are founded on balanced considerations of economic, social and ecological dimensions. With regards to the TNS, the ecological and ethnographic findings have been well documented in various reports (CBFP, 2006; van Germerden, 2004; Usongo, 2002; 1998) but very little, or nothing is known about its socio-economic dimensions. The TNS was established as a model park from which some generalisations should be drawn for other protected areas in the Congo Basin and beyond.
The data for this study was collected in the LNP and the DNNP by applying a questionnaire to tourists visiting the Parks. A stratified random sampling technique (Clairin and Brion, 1997) was applied for collecting data from two categories of tourists (national and foreign) in the LNP and three categories (national, resident and foreign) in the DNNP. The proportion of tourists in each category was calculated from the historical records kept by Park management. Questions in this survey were divided into four categories: (i) environmental issues, (ii) recreational activities, (iii) entry fees, and (iv) personal information.
The current entrance fee was used as a reference, and then increased by 100% and by 200%. The tourists were asked a question on the higher entry fees to obtain responses in the double bounded dichotomous format. Each time, motivational information was repeated for each tourist. A pilot study was conducted to ensure that questions are clearly understood and acceptable to the respondents. This questionnaire was administered in person to make sure that all questions are answered. As recommended by Loomis and Gonzales-Caban (1997) this survey targeted not less than 200 tourists over a period of 12 months in the LNP and 8 months in the DNNP.
The collected data was entered into Microsoft Excel for Windows 2003 and analysed by using STATA version 8 and SPSS version 12 (SPSS User Guide, 1999) to obtain primary statistics and to conduct binary logistic regression analysis. The bi-probit model was used to test a dependence of 100% or 200% increase in entrance fees in relation to the demographic characteristics of the tourists. A contingent valuation method (CVM) was selected to define the willingness to pay (WTP) entry fees. This method varies from various valuation techniques (Amigues *et al.,* 2002; Eagles *et al.,* 2002; Pieter *et al.,* 2002; Brown, 2001) because it is simple, commonly applied and used to estimate the values of both market and non-market goods and services including "artificial

markets"(hypothetical markets). Contrary to the "travel cost value method" the CVM can be used on "direct use values", such as forest recreation (Mohd Azim *et al*., 2002; Hu Mingxing, 1998). This method has increased in popularity worldwide because of its reliable outcomes (Lindberg 2001, Eagles *et al.,* 2000; Hackett, 2000; Hu Mingxing, 1998; Israngkura, 1998; Lindberg and Johnson, 1994). Six major steps are followed when applying the CVM (Whitehead, 2003; Adamowicz *et al*., 1998; 1997;): (i) setting a realistic hypothetical scenario; (ii) setting WTP questions, (iii) setting questions on the socio-economic and demographic characteristics of visitors, (iv) designing the survey, (v) implementing the survey and (vi) compiling the data, analyzing and reporting the results. Once the data had been generated, an average WTP value (a hypothetical market price for future visits to the Parks) was estimated according to the utility theory of value (Hu Mingxing, 1998) from the mean and median WTP and the current and projected numbers of tourists, based on their responses to theoretically improved infrastructure:

$$WTP=\sum_{i=1}^{k} AWP_i*(n_i/N)*M$$

where:

WTP - total willingness to pay for forest recreation by tourists
AWP_i - willingness to pay at entry fee level i
n_i - total number of tourists surveyed whose WTP is $AWP_{i;}$
N - total number of tourists surveyed
M - total number of foreign tourists.

Finally a tax maximisation principle was applied to calculate the maximum revenue associated with the optimum entrance fees as visitation increases. The tax maximisation technique was introduced by Arthur Laffer (Lecaillon and Pondaven, 1998) who stated that by increasing a tax rate, the revenue increases but only until a certain optimum tax rate is reached. After that optimum value, the revenue decreases because of tax evasions or a relocation of businesses (Figure 1). Cartesian curves were plotted with the entrance fee revenue (EFR) calculated from entrance fees and numbers of visitors in each category, from which the optimum entrance fee was determined for each category of tourists (Schultz *et al*. (1998). This is in accordance with Laffer who stated that there is no equation that permits the estimation of the optimum tax and that it can be done only by using graphical observations (Lecaillon and Pondaven, 1998).

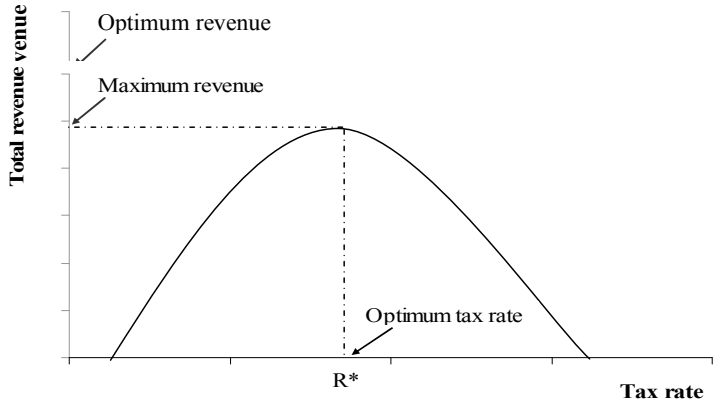

Figure 1. "Laffer's Curve" showing a change of tax revenue with increased tax rates (Lecaillon and Pondaven, 1998).

Results and discussion

In 2006, 300 tourists visited the LNP and 1042 tourists entered the DNNP. In both Parks the majority of tourists came from other countries while only 21% of the visitors in the LNP and 16.9% in the DNNP were locals. In the LNP the foreign visitors came mainly from Germany (17.1%), USA (15.2), France (12.7%), Spain (9.5%), Great Britain (8.8%) and 21 other countries. The DNNP

was visited by 11 nationalities including visitors from Spain (31.5%), Sweden (24.1%), France (14.8%), USA (5.6%), Norway and Belgium (3.6% each). Most tourists (79%) were of medium age (30 to 50 years) and 41.5% (LNP) and 33.3% (DNNP) of all the tourists were females. Most tourists, especially the foreign tourists, were well educated. Despite that the foreign tourists stayed longer in Cameroon (9.1 days) than in the CAR (7.9 days), their visits to the LNP were usually shorter than to the DNNP. It is likely that there are more attractions in Cameroon than in the CAR or that the DNNP may provide more comfort for prolonged visits (Blom, 2004). The unstable political situation in northern CAR possibly was also preventing tourists from staying longer in this country. Most tourists were interested firstly in wildlife and then in Pygmy culture and the rainforest, and their activities focused on observations of wildlife, nature photography and hiking. There were only a few visitors returning to the Parks while the majority of the tourists visited the area for the first time. Approximately 44% of the tourists indicated their interests in returning to the Parks while 20% and 25% did not intend to return to the LNP and the DNNP, respectively. Poor management and organization were usually given as the reason for dissatisfaction in the LNP while poor roads, infrastructure and harassments by the police were repelling visitors from returning to both Parks (Table 2). All tourist categories expressed interest in longer visits to the Parks if their facilities were to be improved. On average visits could be prolonged by 1.9 days in the LNP and 1.5 days in the DNNP. Most of the tourists supported higher entrance fees except for the resident tourists visiting the DNNP (Table 3).

Table 2. Percentage of tourists dissatisfied with various aspects of their stay in the Lobeke (LNP) and Dzanga Ndoki (DNNP) National Parks.

Improvement needs	LNP	DNNP
Roads and bridges	15.1	23.5
Information	13.3	0
Transparent accounting	8.8	8.8
Organization and management	8.1	2.9
Qualifications of staff and guides	8.1	0
Functioning of police	6.7	0
Poaching control	6.0	2.9
Accommodation	6.0	0
Road traffic	4.9	52.9
Communication network	4.2	0
Toilets	3.9	0
Restaurants	3.9	0
Camps	3.5	5.9
Watchtowers	3.5	0
Water supplies	2.1	0
Sanitation	1.4	2.9
Other facilities	0.7	0

Table 3. Proportion of tourists willing to pay more (WTP) for recreation in the Lobeke and Dzanga-Ndoki National Parks by various tourist category.

WTP	Lobeke National Park			Dzanga Ndoki National Park			
	National	Foreign	All	Foreign	National	Resident	All
Yes	85.7	84.2	84.5	81.5	78.6	53.3	75.9
No	14.3	15.8	15.5	18.5	21.4	46.7	24.1

This qualitative information on the WTP higher fees appeared promising for the improvement to the Parks' finances but insufficient to justify policy changes regarding the fees in the Parks. It was therefore considered important to make quantitative estimates on the actual amount of money that tourists would be willing to pay if park facilities, infrastructure and organization was to be improved. This was done with the use of the dichotomous choice contingent valuation method. The

results showed a prospective improvement in the income from the entrance fees of between 46% and 149% depending on a tourist category (Table 4).

Table 4. **C**onsumer surplus (US$) for various categories of tourists visiting the Lobeke and the Dzanga-Ndoki National Parks based on the current entrance fees and the willingness to pay (WTP) entrance fees calculated with the contingent valuation method.

Category	Lobeke National Park		Dzanga-Ndoki National Park		
	Foreign	**National**	**Foreign**	**National**	**Resident**
Current fee	10	4	30	3	20
WTP fee	18.65	9.95	53.6	4.9	29.3
Surplus	**8.65**	**5.95**	**23.6**	**1.9**	**9.3**

Foreign tourists offered the highest fees to enter the Parks. This could be justified by the fact that foreign tourists come from afar with well-calculated budgets to spend on recreation. This could also be linked to their higher income levels as compared to national and resident tourists.

Before the biprobit analysis was performed, all the qualitative independent socio-economic variables were dichotomized as follows: age (i) young and (ii) old (>40 years); gender: (i) males and (ii) females; marital status: (i) single and (ii) married, divorced and widowed; membership of conservation organizations: (i) member and (ii) non-member; education level: (i) standard and medium, and (ii) high; connectivity: (i) frequent visitor and (ii) first-time visitor; destination choice: (i) planned and (ii) incidental; trip organization: (i) self-organized and (ii) agent-organized; other destinations: (i) multiple destinations and (ii) singular destinations; awareness of TNS organization: (i) aware and (ii) not aware. A correlation matrix for foreign and national tourists showed that some of the independent variables were strongly auto-correlated and therefore they had to be dropped from the model. An individual decision was made on retaining or dropping variables which were only slightly auto-correlated.

The following variables were selected for foreign tourists visiting the LNP: annual income, marital status, age, gender, frequent visitor status, membership of conservation organisations, party composition, level of education, other destinations, trip organisation and destination choice. The biprobit model for national tourists to the LNP was based on four variables: annual income, party composition, frequent visitor status, and destination choice. In the DNNP the following variables were included in the biprobit models: (i) for foreign tourists - income, age education level, marital status, trip organisation, destination choice, and frequent visitor status; (ii) for national tourists - education level, annual income, trip organisation and destination choice and (iii) for resident tourists - annual income, marital status, trip organisation, and membership of conservation organisations. Coefficients of the significant ($p \leq 0.05$) independent variables for each park, tourists category and additional fee combinations are provided in Table 5.

Annual income was the only variable positively associated with the WTP higher entrance fees across most of the tourist categories. This is possibly also the reason while older tourists were prepared to pay more as older tourists were usually characterized by higher income. Married visitors were also inclined to pay more as most likely they used combined incomes to cover the costs of their trips. National tourists traveling alone or visiting specific parks can also pay additional fees. Tours organized by tour operators are costly and tourists expect that all their costs are covered. This was not the case in the DNNP where self-organized tourists were associated with a lower probability of willingness to pay higher entry fees. Tourists re-visiting the DNNP have been appreciative of improvements in the Parks and therefore they were supportive of higher entry fees. On the other hand the frequent visitors to the LNP and members of conservation organizations were dissatisfied with the state of the Park not believing that elevated fees would be used to upgrade the Park. Therefore the probability of increasing the fees would be reduced by them.

Table 5. Coefficients of independent variables significant ($p \leq 0.05$) in the biprobit models explaining willingness to pay by tourists higher entry fees in two national parks of the Congo Basin by various tourist category.

Variables	Lobeke National Park				Dzanga-Ndoki National Park					
	Foreign		National		Foreign		National		Resident	
	US$10	US$20	US$4	US$8	US$30	US$60	US$3	US$6	US20	US$40
Annual income	0.0012	0.0006	0.0001	-	0.00003	0.00001	-	-	0.0001	-
Marital status	-	-0.575	-	-	-	-0.768	-	-	1.478	0.798
Frequent visitor	-	-0.940	-2.407	-.8.190	1.157	1.075	-	-	-	-
Member of conservation	-	-1.005	-	-	-	-	-	-	-1.098	-
Party composition	-	-	5.896	-	-	-	-	-	-	-
Destination choice	-	-	1.184	0.920	-	-	-	-	-	-
Age	-	-	-	-	-0.971	-0.718	-	-	-	-
Trip organization	-	-	-	-	-1.045	-	0.857	-	-0.807	-1.214

The optimum entrance fees defined from the EFR (Laffer's) curves were US$ 20 and US$ 14 for the LNP foreign and national tourists, respectively, and US$ 60, US$ 10 and US$ 40 for the DNNP foreign, national and resident visitors, respectively. Therefore, the adjusted consumer surplus based on these entrance fee values was slightly higher than the CVM based consumer surplus values: in the LNP the method yielded an additional US$ 10 for any tourist category and an extra of US$ 30, US$ 7 and US$ 20 for the foreign, national and resident tourists in the DNNP.

Conclusions

A combination of widely understood sustainable forest management must be founded on the environmental, social and economic principles. Tourism is a unique way of natural resource utilization which integrates all three principles if correctly applied. The major challenge to the conservation of tropical rainforests in the Congo Basin is to convince the policy makers that regional development can be achieved without destruction to indigenous resources.
The Sangha Tri-National Park is an international milestone in forest conservation. Yet, its success will depend on how well all the objectives of sustainability are achieved. This analysis should help in making strategies on the management and organization of the Park as well as in pricing policies focused on specific customer groups. In the most general terms, the entrance fees are predominantly based on the tourists' ability to pay but also on the value for money which is associated with park facilities and service quality. Immediate improvements to the Park's financial situation can be made by adjusting the entrance fees as documented in this study. With an efficient fee collection, management and pricing, the LNP can realise an additional annual revenue of US$ 6566 while additional US$ 84 985 could be earned in the DNNP. To achieve that however, substantial changes in management, financial accounting and organization need to take place. In the immediate future investments should be made to improve the infrastructure, accessibility, hygiene and safety of visitors to the Parks.

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5. Estimating welfare measures due to informal recreation in the Romanian (natural or national) parks

Simona Dragoi, PhD
Forest Research and Management Planning Institute, 128 Sos. Stefanesti, Bucharest, **Romania**

Abstract

The paper aims at estimating the welfare measures due to informal recreation in some of the Romanian natural or national parks. The paper comprises four sections as follows:

1) examining visit patterns and visitors' socio-demographic profile;
2) quantifying the recreation demand function and analyzing the determinant factors;
3) estimating the welfare measures through contingent valuation and behavioral travel cost models;
4) conclusions and discussions are deemed to highlight the results interpretation in view of *inter alia* applying two different payment vehicles.

Keywords: welfare measures, natural and national parks

Contact: Simona Dragoi, PhD, email:si_dragoi@yahoo.co.uk

Session 4:
Protection of the environment and forest certification

1. Scenic and Recreational contribution to the asset of an old chestnut wood. A case of study

S. Pierrettori*, L. Venzi*
*University of Tuscia, Department of Ecology and Sustainable Economic Development – DECOS
Largo dell'Università, blocco E, 01100 Viterbo, Italy

Abstract
Forests, from the economic point of view, can be considered as a Mixed Good, both Private and Public Good, because of various services provided to the community and goods to the farms, as well.
This work aims at outlining the potential increase in economic value of chestnut orchards due to scenic and recreational amenities of the landscape. An innovation in managing the orchard, by the introduction of a recreational facility, aims at safeguarding the entire farm, preventing chestnuts thefts and generating additional income and employment.
The case study focuses on a large chestnut orchard located on the Cimini mountains in central Italy.

Keywords: chestnut orchards, multifunction, scenic/recreational amenities, asset evaluation.

1. Introduction

For a long time high stand woods in central Italy had been devoted to timber production and other forest products, both from beech and chestnut trees; these woods were in secluded, detached marginal areas, difficult to be reached by tourists and strangers. In the last decades this situation is totally changed, particularly in the areas of low mountains and high hills. Close to big cities, we notice in the woods a very large presence by city dwellers, who admire this landscape and enjoy recreation in this environment.
Forest, therefore, from the economic point of you, can be considered as a Mixed Good, both Private and Public, because of various services and utilities provided to the community and to private farms, as well. In addition to traditional marketable commodities, they provide Environmental Recreational Goods and Services (ERGSs). Examples of the latter include watershed management, pleasant landscapes, maintenance of rural lanes and footpaths, ground for sports and other recreational activities, and habitats for flora-fauna, maintaining biodiversity. These ERGSs are generally perceived by our society as public goods, since they are fully non-excludible and non-rival and, therefore, available to people for free. On the other side, pure private goods, like timber and fruits, are fully excludible and rival, and therefore available only to those bearing costs and/or paying a price as determined by the market (Merlo, Milocco, et al., 2000).
This paper will refer to the high stand chestnut orchards, not very distant from Rome, in several areas, such us the mountains of Tolfa, Cimini, Prenestini, Lepini, Simbruini and the Cittaducale and Antrodoco District, all situated around the capital city in a range of 100 Km.
These high stand forests, therefore, constitute very suitable and appreciated recreational grounds, where should be possible to have picnic, access by car, children's safe grounds and aged people enjoy the fresh and shadowy landscape. There is in fact a large appreciation of chestnut orchards and is quite frequent to find large crowds, trespassing fences and creating a controversial situation with landowners, who are worried about damages and, last but not least, illegal harvesting of products by visitors.
However, because of this multifunctional situation, we have certainly to consider chestnut orchards not only for the revenue from the fruits, but also for the other opportunities provided all year around by this various interests. So recreation is one element implying visitors' parking spaces, children's

playgrounds, barbecues and picnic facilities and so on, but also the amenity of the site is a prerequisite, which contributes to enhance the real estate asset, both in private terms and as public good.

The landscape determined by high stand chestnut orchards can now be included in the typologies of cultural heritage assets, according to the International Union for Conservation of Nature (IUCN) that extended its consideration also to woods, so providing a background for these areas to be protected as part of the regional rural landscape.

This environment was modified long time ago by human activities and now it represents the results of a centuries old culture: from this point of view the cultural heritage derived from the chestnut areas is part of our overall heritage that must be brought back and protected (Bounous, 2004).

This paper refers to a large chestnut orchard, around 30 hectares, in the Cimini Mountains, southwards sloping grounds, with trees 2 or 3 centuries old.

The increased value of the estate will be outlined as the result of generating recreational amenities, by the use of the methodology relating to the assessment of the impact of investments necessary to innovate on present management of the the wood.

2. Area description: Chestnuts in Italy and in the Lazio Region

Chestnut woods are an ancient tradition in Italy, that is one of the largest chestnut producers in Europe. In former times chestnuts were called “bread of the poor” and the Italian production was 10 times more than nowadays (Bellini, 2003; Pettenella et al.,2005).

The production structure at present is mostly based on few regions and single chestnuts orchards are limited in extension (80% of farms are within a range of 0-5 hectares), mainly located in low mountain and hilly districts.

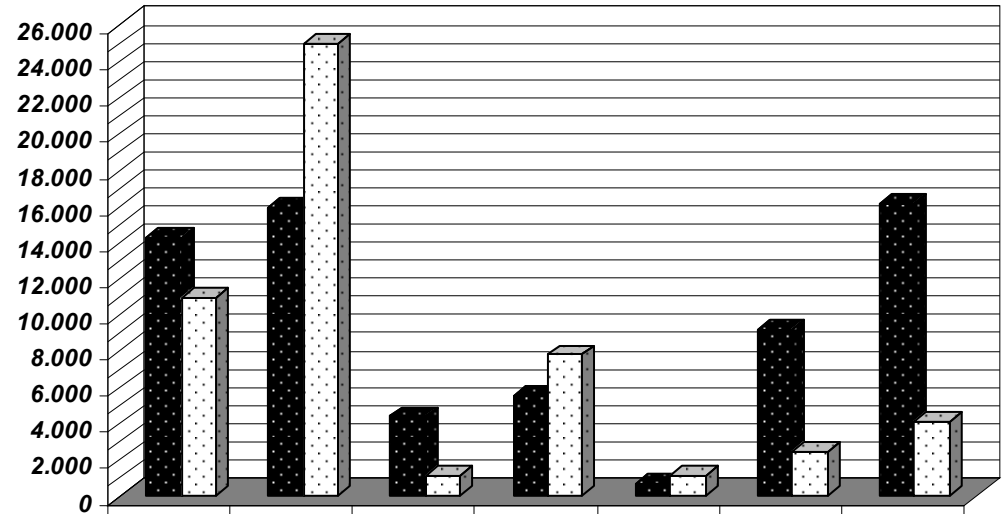
The largest surfaces under chestnut trees are in Tuscany, Campania, Calabria, Piemonte, Lazio and Emilia-Romagna, while in terms of yield, the picture changes quite heavily. Whilst Campania still keeps at the top of the list, Tuscany contributes to national harvest only by 7%, while Lazio produces 14% with much lower surfaces than Tuscany and Piemonte, given its particular and favourable pedo-climatic endowment.

Lazio is, therefore, among the most important producing regions in Italy. This area, located in the centre of Italy, consist of 5 Provinces, but just 4 of these are involved in chestnut production. In particular, the largest number of farms is situated in Viterbo and Roma Provinces, but with some differences, as dimension of farms, generally bigger in Viterbo and below one hectare in the other areas.

The reason of the leadership of the Province of Viterbo, both in the Region and, partially, at national level, is due to the Cimini mountains: their orographical and pedo-climatic characteristics generate a natural vocation as leader in Lazio (Pierrettori, Venzi, 2007).

Besides all that, a strong support to this situation comes from Public authorities, first of all the Cimini Mountains Community, which since a long time has intervened with actions aiming at the enhancement of the forest asset and, in so doing, managed to rehabilitate more than 50.000 old chestnut trees, turning 20.000 ha of chestnut coppice into high stands.

Moreover, joint efforts, both from public and private authorities, have managed to encourage mechanized harvesting, joint first processing of produce, organizing local meetings and food festivals, marketing campaigns for chestnuts and their sales (La Filiera del Castagno Laziale, DECOS – ARSIAL Project 2004).



	Calabria	Campania	Emilia-Romagna	Lazio	Lombardia	Piemonte	Toscana
Surface (ha)	14.278	15.916	4.400	5.568	703	9.180	16.138
Production (tons)	10.983	24.956	1.144	7.833	1.155	2.429	4.132

Figure 1. Italian Chestnuts Orchards Surface (ISTAT, Agriculture Census 2000) and Production (ISTAT, 2002)

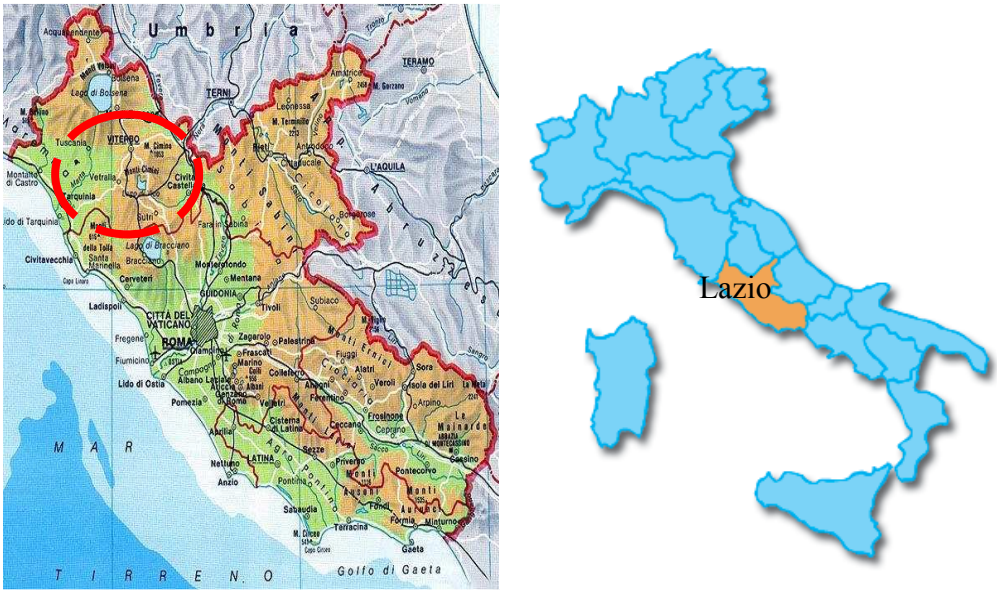


Figure 2. Lazio Region and the Cimini Mountains

3. The case study context

In order to study the increase in value of the chestnut orchards due to scenic amenities and recreational facilities we analyzed a case study focused on a large (by Italian standard) chestnut orchard in the Lazio region.

The orchard is around 30 Hectares, located on the Cimini Mountains and is southwards sloping. This farm has most favourable physical conditions, such as being a single large block of land, almost flat grounds that allows full mechanized harvesting, easy access from major roads, in the vicinity of pleasant and historical villages.

The trees are centuries old, of well known high yielding varieties and provide a continuous and superb canopy.
The owners manage themselves the farm; sales are secured by contract; the produce gets biological certification, commanding the highest prices.
No fences protect the woods, so people often feel to be in a position of free access on it, especially in the period of picking fruits, and, therefore, engaging arguments with the owners for the theft of chestnuts .

3.1. Materials and Methods

From the landscape aesthetic point of view, the most appropriate evaluation method of the asset is the Hedonic Pricing Approach, while from the recreational side a cost/benefit analysis is implemented, analysing a managerial strategy able to safeguard the property from damages and thefts, beside generating income and employment.
As it is well known, the Hedonic Pricing Approach is based on the idea that the observed price of a house, or parcel of land, is the sum of the unobserved prices of a bundle of attributes associated with that good (Rosen 1974).
The specification of hedonic price functions could theoretically refer to the buyer's marginal willingness to pay for various characteristics of a land parcel, or house, (Snider et al. 2007).
Little theoretical ground is provided, however, for the specification of hedonic price models; nevertheless, basically we could expect (Aronson et al. 2000):

$$P = f(F_i, R_i, S_i, L_i)$$

Were:
P = price of the parcel
Fi = forest parcel characteristics
Ri = recreational and aesthetics features
Si = sales characteristics
Li = parcel location

The aesthetic characteristics of forest parcels in recent studies are quite detectable and refer to important landscape features such as water (i.e. river or lake frontage), or other scenic factors.
Because of shortage of suitable transaction data, we could not follow here this methodological approach, but we deem that in the given range between 12.000€ and 24.000€ of the Cimini Mountains chestnut orchard land prices (INEA land price survey,2007), aesthetic features (old and tall trees, continuous canopy) certainly push values towards the upper limit, setting aside pressures on building development and productivity of the orchard.
This is confirmed by our survey, presented early at BOKU Conference (2008), on the aesthetic appreciation of chestnut woods, confronting coppice versus high stands, or well streamlined orchards versus poorly and "untidy" management of the under storey.
To analyze the contribution by chestnut orchards in terms of amenities, a questionnaire presented to a sample of 56 interviews, has been implemented.
We proposed people to choose from different pictures of chestnut woods and motivate and quantify their preferences on a range of marks denoting appreciation, or not.
Woods were divided: 1) by management form (coppice and high stand); 2) by size of trees; 3) by conditions of the under wood. At the end, we asked to choose the best, both from the landscape and from the recreational points of view among all pictures.
The information collected could be used to calibrate the aesthetic component in the range between min and max market prices by means of traditional real estate forest appraisal techniques. These evaluations are at the moment unfortunately still in progress.

However, on the other issue, i.e., to consider the amenities coming from recreation, we examined an innovation in the way to manage the orchard. In order to safeguard the estate from damages and thefts of produce, as a trade off with these, it is envisaged to enclose a portion (10% = 3 ha) of the total chestnut orchard and create on it a recreational ground with (ERGS):

- Car parking
- Playground for children
- Barbecues rings
- Pick nick tables
- Toilettes
- Water supply

All these facilities are given at a (modest) price, estimated at €5,00 per car.
This is done in order to avoid or, at least, to control free roaming into the orchard and binding the users of the recreational ground to certain rules and good practices. It is particularly aimed at reducing the risk of damaging the trees and setting free fires, by installing barbecue rings.
Furthermore, to discourage the theft of fruits is here considered the opportunity of under pricing (same price as charged to wholesalers) for the chestnuts collected in the entire orchard by the visitors of the recreational ground.
The recreational effects are here considered as selling ERGs fuctions to visitors, instead of banning (unsuccessfully) access to the property, and increasing the harvest by the amount collected and paid by visitors.
A Cost-Benefit analysis (CBA) is now considered in order to compare the new hypothesis of management of the wood with the present and traditional one.
The works and equipment to be installed for the recreational area, as well as additional management charges generate the following Costs:

- park area construction, 3ha fencing, pick nick tables, service rooms, etc.:	65.238,00€
-staff attendance: (3 persons: 70 working days + 50 holidays, each one)	21.441,00€
-maintenance costs of the orchards(over 30ha):	25.893,00€
As for the Benefits:	
-parking tickets (5€) over 100 car spaces, occupied at different % over 120	26.900,00€
-former stolen chestnut (5% of harvested now picked by visitor and bought at 2,30€/kg:	9.009,00€
-damages not occurred to the trees because of vandalism, or fires	n. a.

The lifespan considered for the project is 15 years.

The cash flow of data collected for the recreational project proposal are compared in the following table with those coming from the present balance sheet of the farm subject to our study.

(over 30ha)	Time			
Ex Ante	**1° year**	**2°year**	**.....>**	**15°year**
Total Revenue	180.180,00	180.180,00	.....>	180.180,00
Variable Costs	25.893,90	25.893,90	.....>	25.893,90
Gros Margin	154.286,40	154.286,40	.....>	154.286,40
Fixed Cost	45.120,00	45.120,00	.....>	45.120,00
Net Margin	109.166,10	109.166,10	.....>	109.166,10
Ex Post	**1° year**	**2°year**	**.....>**	**15°year**
Total Revenue	216.089,00	216.089,00	.....>	216.089,00
Variable Costs	25.893,90	25.893,90	.....>	25.893,90
Gros Margin	190.195,10	190.195,10	.....>	190.195,10
Fixed Cost	136.193,00	66.561,29	.....>	66.561,29
Net Margin	54.002,10	123.633,81	.....>	123.633,81

Benefits-Costs	**1° year**	**2°year**	**.....>**	**15°year**
	-55.164,00	14.467,71	..... >	14.453,71

Table 1. Cost Benefit Analysis scheme: values not discounted (€)

4. Results

The information reported above in Table 1 were used to implement the usual Cost Benefit Analysis from the basic financial point of view, i. e. using direct market information on revenues and costs. Various criteria were implemented, such as Net Present Value and Benefit/Cost Ratio (both with a range of different discount rates). The Internal Rate of Return has been also determined according to Figure 3.
The financial results obtained by the analysis are quite satisfactory and the trade off proposed in recreational terms looks encouraging.

r	NPV	(B/C) R
3%	117.550,55	1,34
4%	105.693,58	1,32
5%	95.005,85	1,18
.....	.....	.....
24%	2.725,53	1,02
25%	670,66	1,00

Table 2. Results from Cost Benefit Analysis,
values in €; r = discount rate; NPV= net present values; R = ratio of Benefits over Costs;

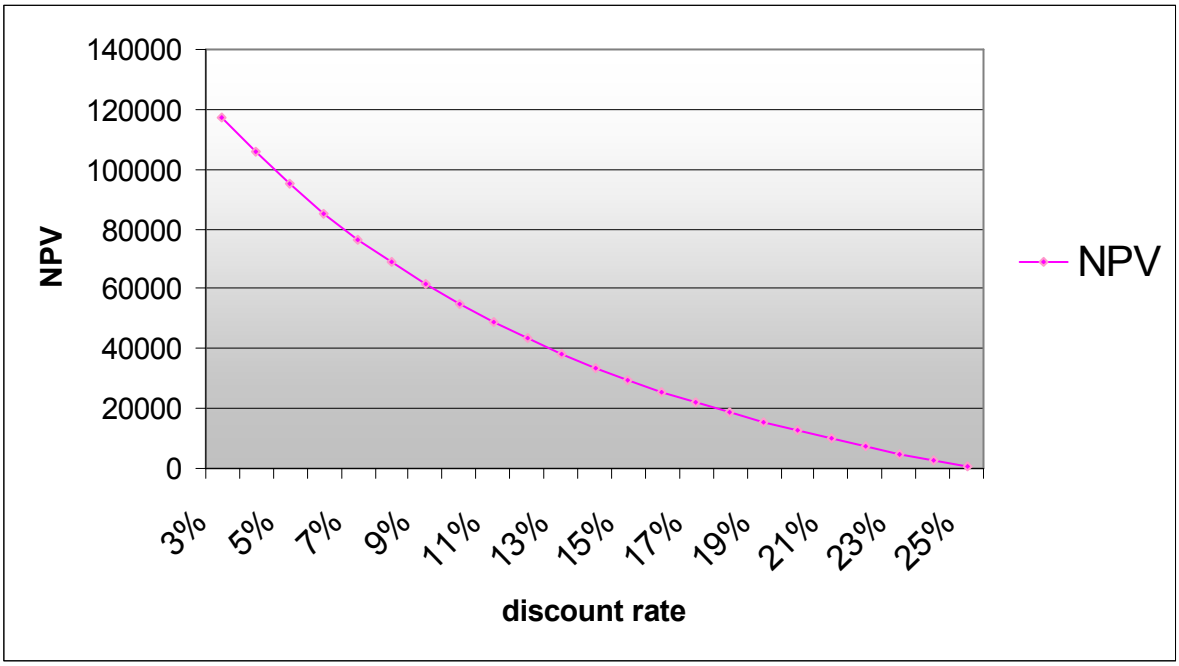


Figure 3. Internal Rate of Return of the project (IRR)

From these results we can imply that not only a suitable return to the invested capital is provided, but also a quite consistent employment is generated in areas which are marginal on that respect.
In terms of overall gains for the whole chestnut orchard we can see that there is an increase (after the implementation of the recreational ground) of 14.000,00€ (almost 10%) for net margin. This value can be capitalised (at 2.5% ,for 15 years of the project) and further added to the real estate value of the whole farm, which given the positive features already shown, could be easily ranked at the top value of the INEA survey range(i.e.24.000,00€/ha), enhanced by this extra bonus of 3-4.000,00€/ha.

5. Conclusions

Aesthetic features play an important role in determining forest prices. This is an area of relevant research topics, so far, little explored in Europe.
Suitable methodologies are available and in progress, but lack of relevant data impinges so far quantifying the aesthetic components.
Recreation ,instead, in chestnut orchards could turn a danger prone activity (fire, theft, damages, etc.) to an employment provider and a profitable business, if properly managed and endowed with suitable facilities.
The recreational facilities and the connected activities generate an extra flow of income which could be estimated and included in the valuation of the orchards as leading to an increase of their value by capitalizing the additional flow of income.
Question is, now, about how much of the above discussed opportunity can be transferred and implemented from a well kept chestnut orchard to other woods in central Italy. How many public owned estates (common lands, municipal, Mountain Communities,etc.), or private ones can and want activate this innovative management ? The new financial provisions along with the new E U regional Rural Development Plans (2007-13) can provide
adequate funds, but it is not only a matter of investment capacity.
However, other new opportunities have recently appeared in the countryside, such as agritourisms, bed and breakfasts, food festivals, E-commerce.
Why this should not occur also to ERGs ? A lot of work still remains to be done.

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2. *Economical Evaluation of the Opportunities for Regional Development of Highly Biodiversity Valued Forested Natura 2000 Dobrava-Jovsi Area*

Gregor Danev, Amela Smajić Hodžić, dr.Darij Krajčič
Institute of the Republic of Slovenia for Nature Conservation, Ljubljana, Slovenia
tel: 00386 (0)1 230 95 32, Fax: 00386 (0)1 230 95 40

Abstract
In Slovenia are almost 50% of all forests in Natura 2000 network (70% of the Natura 2000 areas). Although this means a responsibility for maintaining high biodiversity level in forested areas is also meant as an opportunity for possible development of the local eco and recreational tourism. Government of the RS has adopted the Operative Program for Strengthening the Regional Development Potentials in 2007-2013 periods, which recognize the Natura 2000 sites as an opportunity for accordant regional development in Slovenian rural areas in assuring new job positions, human well being and better health conditions. With LIFE III - Nature project "Natura 2000 in Slovenia", which beneficiary was IRSCN we tried to incorporate the consciousness of the highly biodiversity valued forested areas to the local people minds. In Dobrava-Jovsi project area Institute together with Kapele local community, Slovenian Forestry Service and Agricultural Chamber of the RS made investments in corncrake informational footpath with over then 100 ecocells of old oak trees in private forests, bird watching-tower, informational educational center in Kapele, etc. The Dobrava forest is important because of oak-hornbeam forests and extensive river flood plains. Oak-hornbeam forest represents an important habitat for the middle woodpecker and other threatened forest bird species. On waterlogged meadows of Jovsi we can find corncrake which is one of the most threatened bird species in Slovenia and worldwide. With promotion strategy and investments we tried to make a good practice example of the possible development in the low-developed rural area in connection with biodiversity conservation measures. Kapele and Municipality Brežice are developing the tourist promotion strategy, trying to connect with large regional tourism companies as Spa Olimje etc. They are also trying to develop the joint trademark of products which are originating from the Dobrava – Jovsi area. Evaluation of all costs in establishing the tourist infrastructure and measures for preserving the biodiversity are being accounted with increased income of the local community, better recognition of the area and possibilities for new job creations. On the other hand some costs as ecological services are very difficult or even impossible to evaluate at least in all extents.

Keywords: Natura 2000, evaluation, accounting, forest, tourism, development;

Contact: Gregor Danev, Email: gregor.danev@zrsvn.si

3. *Forest Certification Schemes in Europe*

Matthias Bösch
Technische Universität München, Institute of Forest Economics,
Am Hochanger 13, D-85354 Freising, Germany
Phone: +49 8161 71 4636, Fax: +49 8161 71 4631
E-mail address: boesch@tum.de

Abstract
In recent years, environmental problems and the concept of sustainability have become key issues in the forest sector. One consequence was the emergence of forest certification as one example of a non-state, market-driven governance structure for addressing environmental problems. While certification originally was introduced to stop deforestation in the tropics, by far the most of today's certified forests can be found in the industrialised countries of the Northern Hemisphere. In this paper, some factors that explain the existing interregional divergence when it comes to forest certification are examined. Moreover, I analyse the historical development and the present situation of forest certification in Europe, where the Programme for the Endorsement of Forest Certification Schemes (PEFC) and the Forest Stewardship Council (FSC) are by far the most important competitors. Both frameworks are non-governmental organisations and both aim to operate at a global level striving to achieve the same ultimate objective: sustainable forest management. As one of Europe's most important marketplaces for timber products, the case of Germany is especially considered.

Keywords: Forest certification; PEFC; FSC; Sustainable forest management; Europe; Germany

1. Introduction

During the last few decades, public concern for the environment has grown remarkably, especially in developed countries. As a consequence, environmental issues have become increasingly more important for policy makers around the world.

Traditionally, there are two basic instruments that are applicable for governments to protect the environment and to foster sustainable development: command-and-control regulations which have historically enjoyed widespread acceptance, and market-based incentives which promote flexibility in achieving environmental goals (Van Kooten et al., 2005). In the last few years, unconvincing success of these classic approaches has increasingly led to the emergence of non-state, market-driven governance structures for tackling environmental problems. Of such governance structures, forest certification is possibly one of the more popular examples. This innovative idea was born after the failure to sign a global convention on forestry at the United Nations Conference on Environment and Development (also known as the "Earth Summit") held in Rio de Janeiro in 1992.

Forest certification is aimed at issuing a credible guarantee that wood and timber products come from responsibly managed forests, taking economic, social and environmental aspects equally into consideration (CEPI, 2006). Basically, forest certification is a process which involves assessing the quality of forestry practices against a set of predetermined principles and criteria and that eventually results in a written certificate being issued by an independent third party (Perera and Vlosky, 2006). Through the mechanism of forest certification, the problem of market failure stemming from asymmetric information of consumers and producers, as far as the environmental impact of wood production is concerned, can be solved.

In the literature, different economic aspects of forest certification have been examined by various authors. For instance, empirical research has identified factors that determine why forest companies

voluntarily agree to let their products be certified without the threat of state involvement.[2] However, we want to examine some conditions that encourage the rise of certification activities in the forest sector of a country.

This paper is organised in the following way: Section 2 presents figures about forest certification and asks the question why the share of certified forestland in some areas and countries is higher than in others. Section 3 takes a closer look at the history and structure of the two most important competitors in the European forest certification field of today and compares them to each other. Section 4 briefly describes the situation in Germany as one of Europe's most important marketplaces for timber products and provides reasons why one forest certification system prevails over the other. Some conclusions follow in Section 5.

2. Explaining regional differences in the number of certified forests

On a global scale, roughly 295 million hectares or about 7% of the total forest area in the world is certified (Forestry Certification Info, 2007). While certification initially was introduced to stop deforestation in the tropics, by far the majority of today's certified forests can be found in the industrialised countries of the Northern Hemisphere, namely 166 million ha in North America and 87 million ha in Europe. In this chapter, I want to examine some reasons for the existing interregional divergence when it comes to forest certification.

Maslow's Hierarchy of Needs

One possible explanation for this divergence could be gained from looking at forests from a needs-satisfaction point of view, following Abraham Maslow's famous hierarchy of needs.

Human beings have fundamental needs that eventually result in physical or psychological suffering if they are left unsatisfied. Needs may be delineated as requirements for a person's survival, health or basic liberties (Juslin and Hansen, 2002). In his seminal analysis, Maslow (1970) describes five needs in a hierarchy of "prepotency" (Figure 1).

The hierarchy exists since "higher" needs emerge after "lower" needs are met and this progressive fulfilment becomes the motivating force behind a person's behaviour. One important aspect of this hierarchy is that once a need is fulfilled, it does not act as a motivating force any more. In fact, it ceases to exist and re-emerges only if its provision is stopped.

Countries and societies around the world vary in their intensity and method of forest utilisation. In developing countries, forest products are predominantly used for fuelwood or shelter and the forest industry is relatively unimportant. On the other hand, in industrialised countries, forest industry may be highly developed. Yet, people of these nations have become less reliant on tangible products from forests and now often consider them to be resources for recreation and conservation. Hence, forest usage changes as a society develops. Maslow's hierarchy can be a useful tool to describe these changes.

[2] In addition to economic factors that affect profits directly or indirectly (through consumers), Van Kooten et al. (2005) mention here perceived pressure from shareholders, the environmental lobby and neighbourhood/community groups, firm size, financial health, past environmental performance and regulatory threats as most important parameters.

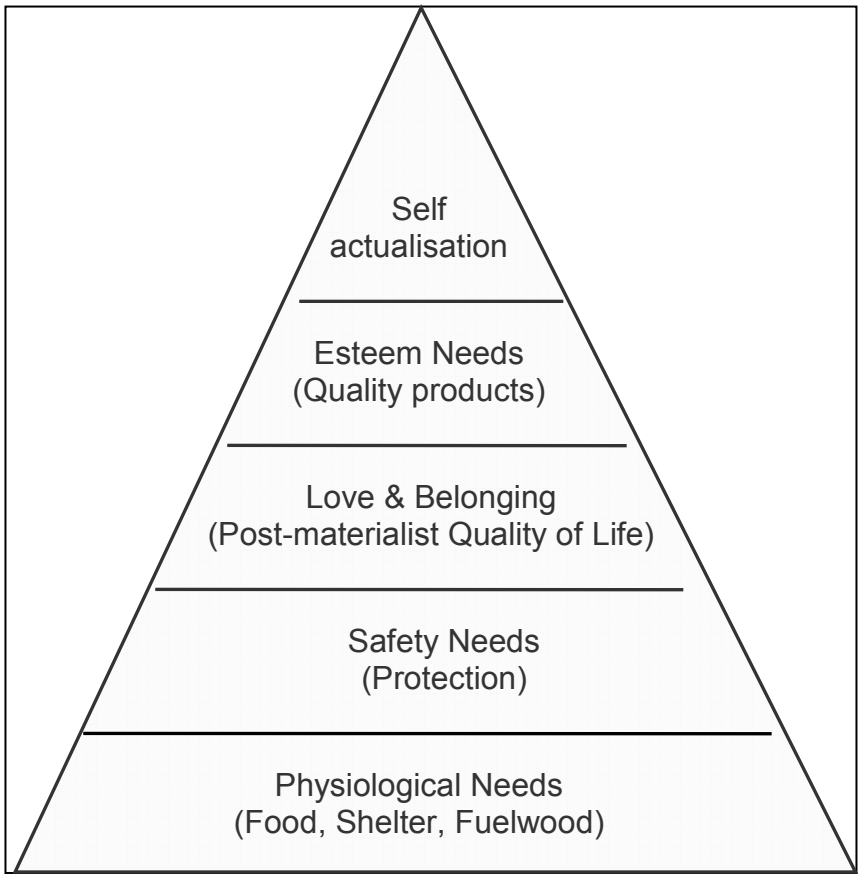

Figure 1. Maslow's hierarchy of needs and the offerings of forests
Source: Juslin and Hansen, 2002

Juslin and Hansen (2002) present an example of the relationship between Maslow's hierarchy of needs and the services of forests, which is illustrated in Figure 2. Physiological needs, the lowest level in the hierarchy, are mainly satisfied through non-wood forest products that provide food or shelter. Fuelwood also belongs to this category, 90% of which is used in developing countries (Juslin and Hansen, 2002). The next level consists of safety needs that are met by forests' protective functions. The conservation of biodiversity belongs here, which is also important for the recreational use of forests and thus overlaps with the level of love and belonging needs. Esteem needs can be satisfied through high quality products, while the need for self-actualisation is met by forests providing peace, tranquillity and contemplation.

A shortcoming of this approach is that for different societies, or even for different individuals, a service may stand for different levels of need satisfaction. For instance, one person may buy a certified wood product to protect the environment (safety need), whereas another may buy it just to show others how conscientious he is (esteem need). However, it should be obvious that in a country where not even basic physiological needs are fully met, forest certification cannot be an important matter and therefore, the area of certified forests is rather small.

Van Kooten's Model of Explaining Forest Certification

Van Kooten et al. (2005) use a more analytical manner to find some conditions that foster the growth of a forest certification sector in a country. In what follows, I want to summarise the most important results of their study.

The authors use a regression which takes on a logistics functional form that can be estimated using OLS as follows:

$$\ln\left(\frac{y_i}{1-y_i}\right)=\alpha_0+\alpha_1 x_{1i}+\ldots+\alpha_n x_{ni}+\varepsilon_i$$

The dependent variable y_i is expressed as a log-odds and is measuring the share of total forestland which is covered by a certification scheme in country i, α_k $(k=1,\ldots,n)$ are parameters to be estimated and $\varepsilon_i \sim N(0,\sigma)$ are normally distributed error terms.. Data was available for 106 countries that have an area of more than 100,000 ha covered with forests and/or forest exports that accounted for 1% or more of total exports. The regression results are provided in Table 1.

The environment in industrialised countries usually has greater opportunity costs than in developing countries, since demand for environmental products and services increases as income rises. Under such circumstances people are willing to pay more to protect the environment, for instance to protect watersheds or to conserve wildlife habitat. Therefore, the probability of a country's forests getting certified can be expected to increase as income rises (if the forest industry reacts to changes in domestic preferences). However, purchasing power weighted per capita GDP does not have a significant impact on the quantity of certified forestland.

A country where forest companies and landowners export a high proportion of their wood products is more likely to have a considerable area of certified forests. One could argue that internationally operating forest companies may be particularly worried about incidents on foreign markets, for example lawsuits or threats of product boycotts, and therefore voluntarily decide to sell certified products.

The authors also include the proportion of the total population that lives in rural areas as an explanatory variable in their model. The positive and statistically significant coefficient might seem surprising at first, since in many less developed countries with a high percentage of rural population, forests are often converted to agricultural areas that yield higher profits. If this is the case, forest landowners are less willing to adopt forest certification principles because woodlands are harvested once and then transformed. On the other hand, there are few property rights for many rural people in the world. Forest certification can provide a guarantee that the benefits these farmers get from their forests will continue to exist in the future. Thus, they will put pressure on their governments to introduce forest certification. Here, the latter factor seems to be the crucial one.

Finally, it is conjecturable that forest companies are more willing to seek certification in a country where political, economic and social institutions are more advanced. To model these impacts, Van Kooten et al. use two indexes, namely the "size of government" and the "structure of the economy and use of markets", both ranging from 0 to 10, and the overall literacy rate to measure the extent to which a country's citizens are empowered. While the "size of government" variable does not provide a statistically significant explanation, the "structure of the economy" index and the literacy rate show the expected positive sign and are statistically significant.

	Forest Certification
Intercept	-19.14** (-5.07)
GDP per capita	0.0001 (0.85)
Proportion of forest products exported	16.728** (3.03)
Proportion of population living in rural areas	6.832** (2.05)
Size of government	-0.455 (-1.32)
Structure of economy and use of markets	0.867** (3.17)
Overall literacy	0.077** (2.47)
Number of observations	106
R^2	0.5198
F-statistic	31.66**

Table 1. Certified proportion of total forest area: OLS regression results[a]
Source: Van Kooten et al. (2005)

[a] = White's (1978) corrected standard error t-statistics provided in parentheses
* = statistical significant at the 0.10 or better level
** = statistical significant at the 0.05 or better level for a two-tail t-test

3. European Forest Certification Systems

During the last decade, two global forest certification frameworks, which are also predominant in Europe, have evolved: the Forest Stewardship Council (FSC) and the Programme for Endorsement of Forest Certification (PEFC). The latter especially has gained rapid momentum in the last few years. In December 2006, FSC and PEFC together accounted for almost 278 million hectares or about 94% of total certified forestland in the world. Only a tiny area of the world's existing certified forests (about 17 million hectares) is not attributable to either of the two leading systems (Forestry Certification Info, 2007).

Forest Stewardship Council (FSC)

The Forest Stewardship Council (FSC) is an international non-profit organisation which established and operated the first system for sustainable forest management. The official mission of FSC is "to promote environmentally appropriate, socially beneficial and economically viable management of the world's forests" (FSC, 2007).

The history of FSC started in 1990, when a group of timber users, traders and representatives of environmental and human-rights organisations gathered in California to talk about the installation of a reliable system to identify well-managed forests as acceptable sources of forest products. The requirement of an independent global organisation that would facilitate the process of certification was emphasised. In March of 1992, the interim board of directors was established and in October of 1993, 130 participants from 26 countries worldwide met in Toronto, where the founding assembly took place. The secretariat office, originally opened in Oaxaca, Mexico, was re-located to Bonn, Germany in January of 2003 (FSC, 2007).

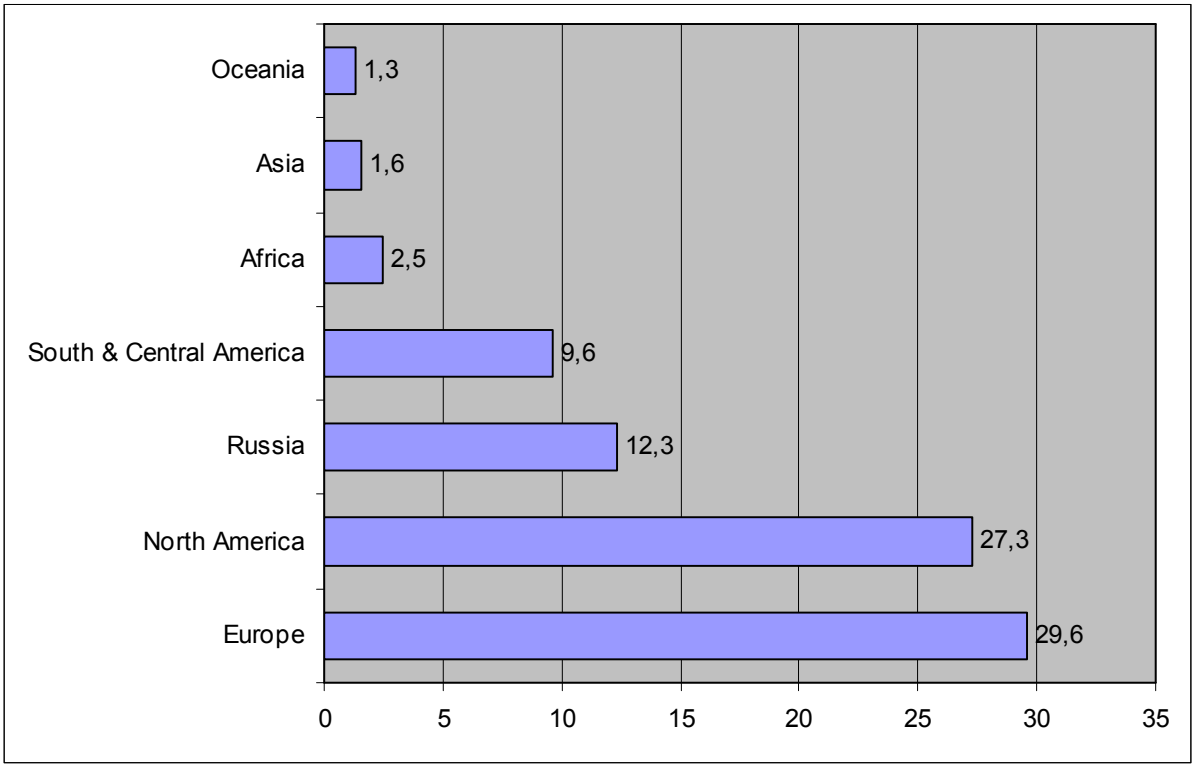

Figure 2. Area of FSC-certified forests by region in December 2006 (million hectares). Source: Forestry Certification Info, 2007

A timber company or another organisation which wants to get certified to FSC standards and to bear their logo must get in touch with an accredited third party certification body. FSC itself does not certify forest operations or manufacturers but certifies the auditors that do. Timber stemming from well-managed forests is entitled to carry the FSC logo. Products are also tracked through the supply chain from the forest to the consumer. This guarantees that commodities with the FSC emblem are coming from certified forests (Frambach, 2002).

In the middle of 1998, the threshold of 10 million hectares of FSC-certified forests around the world was reached. Presently, about 84 million hectares in more than 70 countries worldwide are certified to FSC standards (Forestry Certification Info, 2007; FSC, 2007). As Figure 2 shows, the majority of certification activities take place in Europe and North America.

Programme for Endorsement of Forest Certification Schemes (PEFC)

The Programme for Endorsement of Forest Certification Schemes (PEFC) acts as an international umbrella organisation. Its aim is to facilitate the assessment and mutual recognition among the different national certification systems, which are essentially based on the criteria and indicators developed by the Ministerial Conference on the Protection of Forests in Europe. It was mainly landowners who developed the PEFC, because these groups felt that their needs and opinions were not adequately incorporated into the environmental-organisation-led FSC (Van Kooten et al., 2005). The PEFC was launched by representatives of eleven European countries[3] in 1999 as the Pan-European Forest Certification scheme. Just one year later, the Finnish Forest Certification Scheme, the Living Standards and Norwegian Forest Certification Scheme, the Swedish PEFC certification scheme as well as the forest schemes of Germany and Austria were endorsed. After Canada and the

[3] Founder members were: Austria, Belgium, Czech Republic, France, Finland, Ireland, Norway, Portugal, Spain, Sweden and Switzerland.

United States joined the organisation in July 2001 as the first two non-European countries, the name was officially changed. In April 2007, PEFC opened its China Office in Beijing (PEFC, 2007).

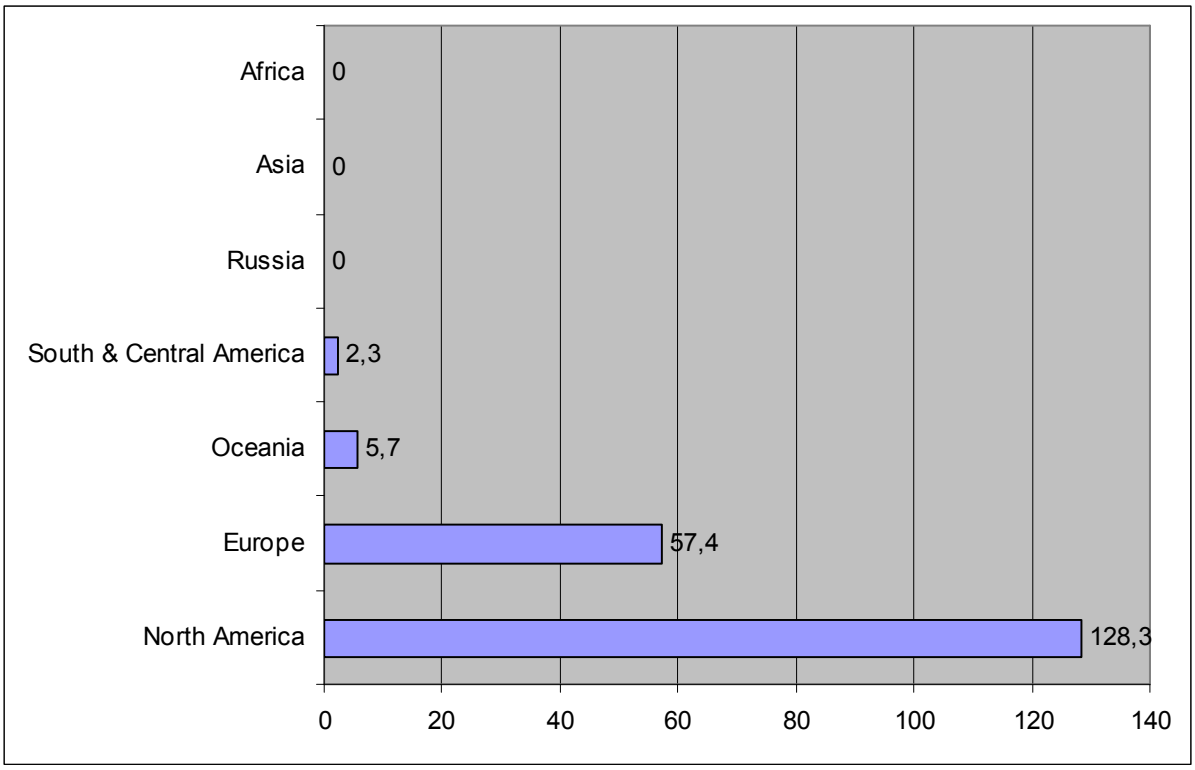

Figure 3. Area of PEFC-certified forests by region in December 2006 (million hectares). Source: Forestry Certification Info, 2007

Today, PEFC has the largest area of certified forests in the world, with about 194 million hectares in 20 countries certified (Forestry Certification Info, 2007; PEFC, 2007). As is the case with the FSC, certification to PEFC standards mainly occurs to the Northern hemisphere (Figure 3).

Comparison of FSC and PEFC

Both the FSC and the PEFC are independent, non-profit and non-governmental organisations, which operate at a global level and aim for the same objectives: sustainable forest management. The concept of sustainable forest management that the two systems promote is largely the same. Both emphasise that forestry should conserve the economic, environmental and social forest functions, and that a participatory, consensus-building approach should be used to reach an adequate balance between these functions. To reach their objectives, both schemes use the same mechanism: independent third party assessment of forestry practices against a predetermined set of standards (CEPI, 2007).

A key difference lies in the structure and operation of the two certification schemes. While the PEFC endorses fully autonomous certification schemes operating at national level, the FSC follows a more centralised approach and acts as a global framework to accredit certification bodies.

The main differences between the forestry principles of the FSC and PEFC can be found in the level of detail provided on different aspects of forest management. For instance, the PEFC is more specific than the FSC in its standards for forest protection against pests and fire, whereas the FSC has higher requirements concerning public consultation during forestry operations (CEPI, 2007).

4. The Case of Germany

The roots of forest certification in Germany go back to the late 1980s, when slogans like "save our last rainforests" by German environmental groups led to public awareness and to boycotts of tropical wood. In 1991, the German association of tropical timber importers demanded a certificate of origin. It should ensure that all tropical timber imported to Germany would be produced in a sustainable manner (Teegelbekkers, 2003).

In the mid 1990s, when pressure for certification had broadened on temperate and boreal forests, certification started to directly impact the domestic forest industry. German environmental groups created or supported programs like Naturland and eco-timber that, in turn, were refused by private landowners and the German Forestry Council (consisting of state forestry agencies, forest products associations, private landowner associations and academics; Klins, 2000). In their opinion, the labels were inappropriate for the German case, where today about 2 million forest owners are managing 11.08 million hectares of forest and almost half of the forests (43%) are privately owned (Mrosek et al., 2005).

In 1997, when the German FSC working group was established, the forest sector responded by working together with forest landowners all over Europe to create its own label, the PEFC. Germany even acted as a coordinator of the PEFC initiative that was originally led by Finland and France. The actual starting point for the PEFC in Germany was a demonstration of forest owners in Hamburg in 1997, where several companies of the pulp and paper industry were accused of forcing forest owners into the FSC certification scheme (Teegelbekkers, 2003). Subsequently, the PEFC gained broad support from nearly all private and state landowners, while the FSC was essentially endorsed by all major environmental NGOs and forestry labour unions (Cashore et al., 2003). Today, the PEFC is by far the most important competitor in Germany's forest certification field, with 7.19 million hectares or about 65% of the total forestland certified to its standards, whereas the FSC plays only a marginal role (PEFC, 2007).

A main reason for landowners' refusal of the FSC lies in the fragmentation of the forest in Germany, where a private forest enterprise has an average size of only 2.5 hectares (Mrosek et. al, 2005). On this level, individual certification comes with two disadvantages: firstly, indicators of sustainability can hardly be measured on such a small unit, and secondly, the certification fees are disproportionately high. Therefore, forest landowners integrated the possibility of regional and group certification into the PEFC.

Another main reason for demanding an alternative certification system was the three-chamber system of the FSC, in which the majority of the forest landowners felt that their opinions and interests were not adequately represented.[4] In addition, some of the original certification criteria of the FSC were simply not acceptable for the forest landowners, for instance a complete ban on harvesters, or leaving 10% of the forest area totally unmanaged. As a result, in the German Forest Certification Council (the decision making body of PEFC) private, communal and state forest owners cannot be outvoted (Teegelbekkers, 2003).

Germany has a long tradition of sustainable forestry, with its roots dating back to 1713, when tax accountant and mining administrator Hans Carl von Carlowitz published his book *Sylvicultura oeconomica* – the first comprehensive treatise about forestry, wherein he came up with the concept of sustainability (Grober, 1999). Moreover, the German forestry legislation is widely considered to be one of the most comprehensive in the world. Hence, the support for the PEFC was less because forest landowners deemed a certification scheme to be absolutely necessary, but more because they feared losing their market access and came to believe that in the absence of a competitor program, the market might force them to adopt the unacceptable FSC. Thus, the PEFC is almost seen as the lesser of two evils (Cashore et al., 2003).

Compared to most other countries in the world, German forest certification has really made headway in recent years, with today less than one third of total forestland uncertified. Based on the

[4] The three FSC chambers are the Social, the Environmental and the Economic Chamber.

experiences of the forestry sector, attempts have recently been made to widen the concept of sustainability certification into agriculture.

5. Conclusions

In recent years, environmental problems and the concept of sustainability have emerged as key issues in the forest sector. Forest certification offers a means to meet public expectations. Today, the FSC and the PEFC are by far the most important competitors in the forest certification field aiming at the same ultimate objective: sustainable forest management. The two schemes together account for about 94% of total certified forestland, mainly located in the Northern Hemisphere.

During the last decade, several other schemes have evolved in addition to the two major players. The proliferation of certification systems has some potential disadvantages. Most importantly, with an increasing number of labels in the market, it will likely lead to confusion in consumers' minds. Mutual recognition between different certification schemes could be a way to avoid this confusion. However, the example of Germany, where recent efforts aiming at mutual recognition between the FSC and PEFC were aborted, shows that it is far from being easily done. Moreover, in the context of transborder environmental management, harmonisation of forest criteria between different countries is an important issue, since many forest owners in wood-exporting countries with stricter certification standards feel disadvantaged in relation to others (personal interviews).

Thus, despite its promising role as a non-state, market-driven governance structure, some issues still need to be addressed if forest certification is to gain real momentum in the future. It is still difficult to forecast which role it will finally play. On a global scale, the volumes of certified timber traded will surely increase, as more and more countries pass their national certification standards and the worldwide demand for timber is rising. However, the deciding factor will be consumers' perception and willingness to pay – which is currently far from clear.

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4. Evaluating the impact of forest management certification

Dr. Marion Karmann
(IUFRO Deputy Coordinator 6.08.02– Education, gender and forestry)
Manager Monitoring and Evaluation Program,FSC International Center GmbH
Charles de Gaulle Strasse 5,53113 Bonn Deutschland/ Germany
Phone: +49 (0)228 367 66-77, Fax: +49 (0)228 367 66-65
E-Mail: m.karmann@fsc.org

Abstract:
International trade in forest products is affected by environmental and social concerns. Growing environmental awareness and consumer demand for more socially responsible businesses helped third-party forest management certification emerge in the 1990s as a credible tool for assessing the environmental and social performance of forest operations. The Forest Stewardship Council (FSC) is an international non-profit membership-based organization which develops standards to ensure that timber and other forest products are coming from sustainably managed forests. FSC's international and nationally adapted standards are widely accepted among a broad cross-section of stakeholders as being consistent with the principles of good forest stewardship and sustainability. The FSC logo is a powerful incentive for forest managers and decision makers to improve their forest management continuously: As of April 2008, FSC has certified more than 100 million ha of forest in more than 79 countries.
In conducting forest audits, FSC-accredited certification companies do not certify that a forest management unit has 'achieved sustainability', nor do they require or imply the implementation of uniform sets of forest management prescriptions: they certify that FSC-approved standards of forest management have been met.
Spilsbury (2005) for CIFOR analyzed public certification assessment reports coupled with a review of findings published in recent literature, and found that certification in developing countries has - helped secure or improve environmental services in certified forests; - improved worker conditions within certified forests; - acted to reduce social conflict in and around certified forests; - helped in securing land tenure and usufruct rights (in certified community forests); - improved the image of the forest management enterprise locally and in associated markets; - provided greater access to premium timber markets (where they exist); and - helped promote sustainable forest management more generally through dialogue between the private sector, government bodies, non-governmental organizations and civil society (M.J Spilsbury 2005).
The paper will show, building on CIFOR's findings, where an update of the evaluation of impact is needed, and where research institutions can provide assistance to improve the strength of compliance with FSC's Principles and Criteria, so that the certification of sustainable forest management in a changing world meets the growing demands for transparency and accountability of the many forestry stakeholders.

Keywords: Forest management certification; impact; research needs.

Introduction

It is widely accepted that forest resources and associated lands should be managed to meet the social, economic, ecological, cultural and spiritual needs of present and future generations. Growing public awareness of forest destruction and degradation has led consumers to demand that their purchases of wood and other forest products will not contribute to this destruction but rather help to secure forest resources for the future. In response to these demands, certification and self-certification programs of wood products have proliferated in the marketplace.

The Forest Stewardship Council

The Forest Stewardship Council (FSC) is an international body which accredits certification organizations in order to guarantee the authenticity of their claims. In all cases the process of certification will be initiated voluntarily by forest owners and managers who request the services of a certification organization. The goal of FSC is to promote environmentally responsible, socially beneficial and economically viable management of the world's forests, by establishing a worldwide standard of recognized and respected Principles of Forest Stewardship. In 1993 the FSC introduced the set of FSC's Principles and Criteria (P&C) together with an international certification and labeling scheme for products from forest management. With this certification and labeling scheme FSC commits itself to a challenging mission, as reconfirmed in the FSC Global Strategy 2007:

FSC Mission

"The FSC shall promote environmentally appropriate, socially beneficial, and economically viable management of the world's forests.

Environmentally appropriate forest management ensures that the harvest of timber and non-timber products maintains the forest's biodiversity, productivity and ecological processes.

Socially beneficial forest management helps both local people and society at large to enjoy long term benefits and also provides strong incentives to local people to sustain the forest resources and adhere to long-term management plans.

Economically viable forest management means that forest operations are structured and managed so as to be sufficiently profitable, without generating financial profit at the expense of the forest resources, the ecosystem or affected communities. The tension between the need to generate adequate financial returns and the principles of responsible forest operations can be reduced through efforts to market forest products for their best value."

FSC Principles and Criteria

The FSC's P&C apply to all tropical, temperate and boreal forests. Many of these P&C apply also to plantations and partially replanted forests. More detailed standards for these and other vegetation types may be prepared at national and local levels, based on a consensus of a broad scope of stakeholder in the given country. Currently 46 countries are elaborating national or trans-national sets of indicators for responsible forest management in their own region.

The P&C are to be incorporated into the evaluation systems and standards of all certification organizations seeking accreditation by FSC. While the P&C are mainly designed for forests managed for the production of wood products, they are also relevant, to varying degrees, to forests managed for non-timber products and other services. The scale and intensity of forest management operations, the uniqueness of the affected resources, and the relative ecological fragility of the forest will be considered in all certification assessments. Differences and difficulties of interpretation of the P&C will be addressed in national and local forest stewardship standards. These standards are sets of indicators and verifiers, they are to be developed in each country or region involved, and will be evaluated for purposes of certification, by certifiers and other involved and affected parties on a case by case basis. The FSC P&C should be used in conjunction with national and international laws and regulations. FSC intends to complement, not supplant, other initiatives that support responsible forest management worldwide.

Certification process

Forest management certification is the process of inspecting forests to assess their management according to this agreed set of P&C and involves an inspection of the forest management unit by an independent FSC-accredited certification body to check that the forest complies with the internationally-agreed FSC Principles of Responsible Forest Management. If the forest complies with FSC standards, the certification body issues a certificate for the operation for a 5 year period, with annual monitoring audits. The findings of each assessment (pre-assessment or "scoping" with stakeholder consultation, main assessment with office audits and side audits in the forest management unit, and annual re-assessments) are described in a detailed certification report. The non-financial / non-confidential parts of these reports are publicly available.

Certified forest operations can claim that the forest products they produce come from a responsibly managed forest. However before a producer or supplier can sell their products as FSC certified, they must also obtain chain of custody certification (FM/COC) which tracks the origin of the timber or non-timber forest product along the supply chain.

FSC certification standards cover (a) forest management (FM), (b) the Chain of Custody (CoC) of products coming from FSC certified forest management, and (c) FSC Controlled Wood (CW) for forest management companies that comply with the five FSC Controlled Wood criteria, to be able to supply FSC Controlled Wood to FSC Chain of Custody operations which may then be mixed with wood from certified forests.

There are currently more than 10.000 FSC certificates in total (FM, FM/COC, COC, CW), about 10% of them are for responsible forest management (FM). From here on I will focus on FM certificates.

FSC certified forest management area

FSC is growing fast. The founding conference was held in 1993; in March 2008 more than 100 Million ha of forest were FSC certified, distributed over 79 countries (FSC Data base). The latest UNECE/FAO Forest Products Annual Market Review of the United Nations, Economic Commission for Europe (2007) confirms FSC to be the fastest growing forest certification scheme in the world. Globally, the area of FSC certified forests represents in early 2008 the equivalent of 7% of all production forests.

By forest type, more than 50% of FSC certified forests are natural, only around 8% are pure plantation forests. About half of all FSC certified forests are in boreal, around 13% are in tropical / subtropical eco-zones.

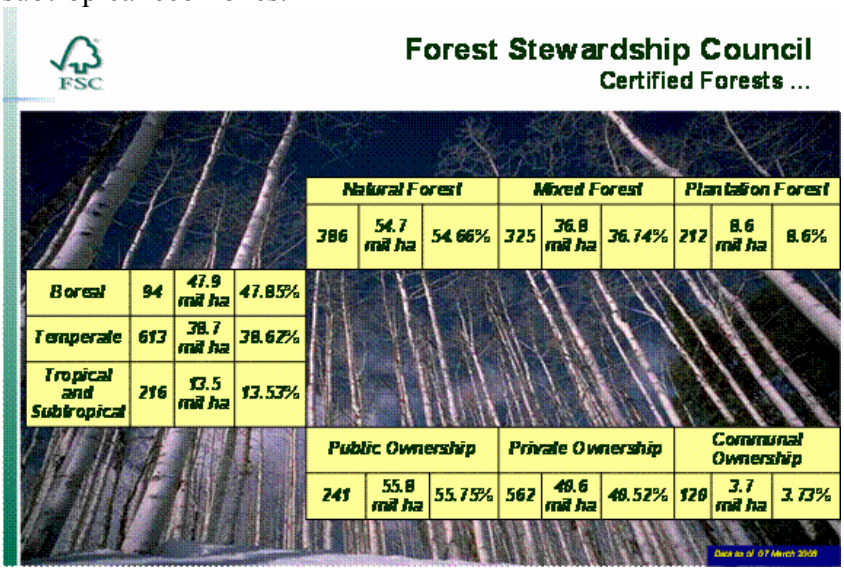

Table 1: FSC certified forest area (March 2008). Number of certificates / ha / %.

Currently 18 conformity assessment bodies / certification bodies are accredited by FSC according to international guidelines to verify the conformity of each certified forest management unit against the FSC standards, the certification bodies' generic standards and the national set of indicators (where applicable).
With the accelerated growth and associated expansion of FSC in new geographical areas over the past years, FSC is focusing particular attention on adapting and reinforcing its systems to new challenges in order to maintain and strengthen its credibility. The high demand for FSC certified forest management and forest products is demonstrating the strong market interest in FSC. The support of major environmental NGOs and of several development aid agencies and for example labor unions is showing that the FSC standards for responsible forest management are widely regarded as the most rigorous social and environmental standards in the industry.

Showing impact on the ground

The FSC forest management certificate as a proof for responsible management

To summarize the information above: The larger the forest area certified to FSC standards, the larger the forest area that is managed socially and environmentally responsibly. The underlying assumption of the FSC concept is that each additional hectare certified to FSC standards brings us closer to achieving FSC's mission: to improve forest management world wide.
This assumption is based on the fact that the certification bodies are visiting each certified forest management unit at least every year to check that the requirements of the standards are fully respected. FSC and FSC-accredited certification organizations will not insist on perfection in satisfying the P&C. Failures are described in the certification reports as Corrective Action Requests (CAR). These CARs have to be rectified within a certain timeframe. These decisions will be taken by individual certifiers, and guided by the extent to which each Criterion is satisfied, and by the importance and consequences of failures. Some flexibility will be allowed to cope with local circumstances. There are minor and major CARs, major CARs have to be dealt with before a certificate can be issued. However, major failures in any single Principle will normally disqualify a candidate from certification, or will lead to decertification. A FSC FM certificate issued by independent third party auditors can therefore be regarded as proof of responsible forest management according to the standards.

Monitoring and Evaluating FSC's impact

But in conducting forest audits, FSC-accredited certification companies do not certify that a forest management unit has 'achieved sustainability', nor do they require or imply the implementation of uniform sets of forest management prescriptions: they certify that FSC-approved standards of forest management have been met.
Different organizations – certified companies, research institutes, development aid agencies, environmental NGOs, are working to describe the impact on the ground which FSC certified FM operations are having compared relative to the situation prior to certification or compared to non-certified operations. Some of these organizations are using FSC certification as a tool to implement their own forest management related goals, they have a certain interest to analyze the impact of FSC and to confirm that FSC's assumptions are correct (e.g a German development investment bank (DEG) regards FSC certification at the end of the project time as one indicator for a successful investment in the forest management project.) These organizations are conducting evaluations themselves or through other professional evaluators.
In many cases these evaluations are based on an indirect assessment against the certification reports. The CARs listed in the reports are used as indicators to show where a change or adaption of management practices was required as necessary to comply with the FSC standard. The CARs are therefore monitored (over certain time frames, eg focused on selected Principles or Criteria). This approach is an indirect method to evaluate the effects of FSC certification processes, based on the

evaluation done by the certification bodies. One example for these papers is “Does Forest Certification Matter? An Analysis of Operation-Level Changes Required During the SmartWood Certification Process in the United States”, by D. Newsom & V. Bahn & B. Cashore, 2005. The researchers systematically assessed the changes that 80 SmartWood-certified forestry operations were required to make. Systems elements such as Management Plans, Monitoring and Inventory most frequently required change (by 94%, 79% and 71% of certified operations, respectively), followed by ecological elements such as High Conservation Value Forests, woody debris and legacy trees (by 71% and 63% of operations, respectively). Even the early adopters of certification were required to make important changes as a result of the certification process. The finding that these FSC-certified operations in the US were required to address an average of 14 different thematic areas as a condition of achieving and maintaining certification is a strong indicator that certification helps prompt forestry operations to make important changes in their forest practices and provides practical evidence that forest certification does have quantifiable on-the-ground impacts, assuming all conditions are implemented.

With the aim to assess the impact of the Center for International Forestry Research (CIFOR) Criteria and Indicator research, which was itself partly aimed to enhance the legitimacy and credibility of the certification standards set by the FSC, Spilsbury for CIFOR analyzed in 2005 FSC public certification assessment reports coupled with a review of findings published in recent literature. Spilsbury found that FSC certification in developing countries is reflected in several outcomes, e.g. in changes of the certified forest management, in better communication between forest management and stakeholders affected by the forest management. The study attributes influence on forest management practices to the use of CIFOR research on Criteria and Indicators for Sustainable Forest Management. In doing so, the study assesses a broad range of impact pathways, including forest certification requirements and various national regulations. He summarizes that the impact of FSC certification in developing countries has

a) helped to secure or improve environmental services in certified forests;
b) improved worker conditions within certified forests;
c) acted to reduce social conflict in and around certified forests;
d) helped in securing land tenure and usufruct rights (in certified community forests);
e) improved the image of the forest management enterprise locally and in associated markets;
f) provided greater access to premium timber markets (where they exist); and
g) helped promote sustainable forest management more generally through dialogue between the private sector, government bodies, non-governmental organizations and civil society (M.J Spilsbury 2005).

The University of Wageningen (WU) initiated in 2007 a program on “Benefits of FSC certification in community forestry”, commissioned by Prof. Freerk Wiersum and Mr. Chris van der Goot. An explorative comparative analysis of existing case-studies was developed by a group of MSc students from WU, and a first publication presented the comparative analytical tool in March 2008. Several MSc thesis studies were taken up within this framework by students from WU and University of Amsterdam. The research approaches are coordinated with representatives of the FSC and with donor organizations, which are also supporting communities in the global south and good forest management to jointly discuss ongoing activities, preliminary study results and issues for further attention. It is expected that the scope of the research network will be extended from mainly socio-economic impact to also ecological impact assessments.

The World Wildlife Fund (WWF) also conducted several studies based on analysis of CARs from FSC reports, with a focus on environmental issues. An example for the research conducted by WWF is "The effects of FSC certification in Estonia, Germany, Latvia, Russia, Sweden and UK", by the WWF European Forest Programme. This analysis across 6 countries shows that FSC certification is delivering a number of benefits for a wide range of stakeholders in the forest industry, and provides hard evidence of tangible improvements that the voluntary mechanism of credible certification delivers for society, the environment and the economy. Certification has improved the social conditions for forest workers through the implementation of health and safety

legislation and favoring employment of local people. In all 6 countries surveyed, FSC certification improved the conservation status and enhanced biodiversity levels in forests.
There are papers with a more specific approach about direct assessment of FSC's certification outcomes and impacts on forest management, and for example on communities and indigenous groups managing forests. More than one in six forest management certificates issued by FSC are to communities and small forest owners, and several development aid agencies support these stakeholder groups, therefore directly or indirectly supporting FSC processes. Other papers have a focus on price premiums for certified forest products or on aspects of biodiversity in forest management units before and after certification, or on governance processes within the FSC network and the outcomes of stakeholder consultation processes during scoping visits. One example of the impact on biodiversity is "Short-term effects of reduced-impact logging on eastern Amazon fauna", by the Instituto de Pesquisa Ambiental da Amazônia (IPAM), 2006, which evaluated the short-term effect of reduced-impact logging (RIL) on species richness, abundance and composition of native Amazonian fauna 6 months after logging. All sites in the study area are certified by the FSC and have implemented reduced-impact logging since 2000.
Another focus of papers is on FSC's influence on the global market, as for example "Branded! - How the 'certification revolution' is transforming global corporations" by M. Conroy, 2007, making the case that a certification revolution in the last 15 years has led to a profound transformation of the social and environmental practices of global corporations. Yet another type of papers has a focus on the governance systems within FSC, as for example "Private governance and the South: lessons from global forest politics" by P.H. Pattberg, 2006, analyzing the risks and the potential of private governance for the South, with the example of private forest politics and FSC as its most prominent embodiment.

Call for coordinated research

So far not much has been undertaken in systematic approaches following the examples of CIFOR and the University of Wageningen. While FSC has cooperated in such studies, FSC has not directly commissioned the work for reasons of scientific objectivity, leaving the researchers to arrive independently at their conclusions. More work is required to demonstrate impact and FSC very much welcomes any interest in conducting impact assessments about FSC certification related processes.
More evidence through direct assessments, and cooperation in approaching these topics would be appreciated for example:

→ on socioeconomic and ethical factors in certified operations:
- development of employment rate and family income in communities adjacent to FSC certified companies,
- evidence for dynamics re occupational health and safety conditions;

→ on the ecological impacts of FSC certification on biodiversity:
- evidence for population dynamics,
- impact on soil and water systems through improved management practice,
- impact of silvicultural management on marketable lesser know species;

→ on market access and market price development for certified forest products:
- impact of access to certification on forest product depending communities,
- synergies of joint FairTrade and/or organic certification and FSC certification,
- options for synergies between FSC schemes and REED, carbon credit markets and other markets for environmental services,
- implications for policy, law and trade re public procurement and certification,

→ on the effectiveness of the certification process itself:
- effectiveness of stakeholder consultations during certification processes,
- impact on the organizational level of forest management operations;

→ on the options for integrating FSC with other conservation tools:

- FSC's influence on setting standards for conservation easements,
- Potential of conservation easements to cover the costs of certification,
- Synergies of government tax incentives and promotion of good forest management practices, stewardship programs.
- Potential for certifying ecosystems services, including biodiversity conservation, carbon sequestration, watershed protection, soil retention and recreational forest use.

All these topics are just examples for the broad field of potential research themes. The reader is very welcome to approach FSC with further requests for information or for discussion on additional research topics. FSC considers itself as a learning organization, and the FSC standards are reviewed regularly, so any insight on FSC processes strengths and weaknesses can be used to further improve the quality of the FSC and FSC's potential impact in a broad range of different aspects of forest management, so that the certification of sustainable forest management in a changing world can meet the growing demands for transparency and accountability of the many forestry stakeholders. FSC itself can offer access to a broad network of partners and internal expertise. This is a call to researchers to get in touch with FSC to identify meaningful topics for applied research. Additionally for the development of a data bank on FSC's impacts an exchange of research papers is highly welcome. Please contact the Monitoring and Evaluation Program of the FSC.

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FSC Database: www.fsc-info.org

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www.fsc.org/figures and www.fsc.org/charts

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Session 5:
Accounting, Statistical and economic analysis

1. Forestry measures in rural development policies – new needs in statistics and accountancy data

Luca Cesaro, Raoul Romano ([5])
INEA – National Institute for Agricultural Economics
Rome, Via Barberini, 36
Mail: cesaro@inea.it, romano@inea.it

Abstract
Forestry policies and forestry measures have been strongly reformed and modified in the last 10 years. In many European countries new forms of intervention have been introduced as application of the part of rural development policies devoted to forestry measures.
The paper briefly presents the state of the implementation of forestry measures in the rural development policies at European level, comparing different countries.
A special focus is then devoted to the new needs in term of statistical data and economic analysis both for the definition of the level of premium (how to avoid overcompensation of beneficiaries) and for the midterm and ex post evaluation.
General statistics and economic data in forest sector are not homogeneous at European level. It is evident that, despite a good level of information which is generally available in Scandinavian and north European countries, in the south European and Mediterranean area most of information are, at the present, not available.
With specific reference to Italy, is then presented how the problem of lack of data is (or will be) tackled in the next future.

Keywords: Rural development, Forest policy, Statistical forestry database, Forestry measures

1. Introduction

The EU Forestry Strategy (1998) emphasizes the role of forest resources on the maintenance and improvement of condition of live in Community rural areas. The strategy also recognizes that "a chapter specially dedicated to forestry inside the Agenda 2000 could provide a basis to implement the guidelines of resolution for an European Forestry Strategy". In a sense this statement has been the first step towards an wider consideration of forest resources in the European policies for rural end regional development.
The first instrument for Rural Development Policy has been, as it is well known, represented by Council Regulation N. 1257/1999, which stated objectives and operational rules for the implementation of Rural Development policy over Europe and constitutes the legal framework of RD since 1999.
As a matter of fact, since the reform, the policy programming instruments for rural development measures have been subject to a unification process that combine structural measures, environmental measures and forest measures into a single policy (Storti and Monteleone, 2004) and, from a strictly operational point of view, into a single programming document. This approach, clearly due to the need of simplification, has caused a few problems in terms of implementation.
Referring specifically to forestry measures these have been grouped in the programming period 200-2006 into two categories: afforestation (both of agricultural and non agricultural land) and a large group of measures named "other forestry measures". Both have been financed by rural development founds. Planned EU spending on forestry for the period 2000 to 2007 is, for all EU

[5] This paper is partially based on data, information and elaborations conducted in the framework of the EU research project AGRIGRID SSPE-CT-2006-044403.

Member States, about 4,8 billion euro, half on afforestation and half on other forest measures.

Four years after the implementation of the rural development policy as stated by the Agenda 2000, the process of review started at the community level and, consequently, within the Member States. This process has leaded to the approval of the new RDP Regulation (1698/05) and to the consequent application of RD Policies in the 25 Member States in the Union.

Differences with the previous programming period are actually relevant. First of all the approach to forestry measures seems to be wider than in the previous programming period, with measures which are not concentrated in one of the three axis, but distributed between competitiveness (axis 1) and environment (axis 2). New forestry measures have been added, the most important are forest-environmental measures and Natura 2000 for forest area.

The growing importance of forestry measures/policies in the framework of RD measures makes more evident the need of a stable and continuously updated statistical information and figures. In fact, while the monitoring system, which is obligatory in the framework of rural development, provides data and information on the beneficiaries of individual measures, general economic, environmental and social data on the forest sector as a whole are, in most European countries, difficult to find or not available at all. This fact represents a serious problem both in the evaluation and in the formulation of the programmes. In fact statistical information are, as it can be easily understood, necessary and fundamental in the process of policy evaluation, but they are extremely useful also in the formulation of RDP. In the following paragraphs, after a brief description of how the forestry measures have been implemented at European level, some evidence about the current situation and needs of information in this field are presented.

2. Forestry measures in the context of Rural Development – Europe and Italy.

The overall principles of the EU forestry strategy (e.g. multifunctionality and sustainability) are reflected (or at least they are supposed to be) in the rural development policy, which brings together economic, social and environmental objectives, and transforms them into a coherent package of voluntary measures.

As stated by the "Communication from the European Commission to the Council and the European Parliament on implementation of EU forestry strategy" (SEC(2005) 333), the integration of forestry aspects in the rural development policy follows three pathways, in particular for privately owned and municipal forests:

1 investments to improve the multifunctional role of forests (article 30)
2 afforestation of agricultural land (article 31)
3 improvement of forest protection values (article 32)

The large set of measures related to article 30 and 32 are generally grouped in the category of other forest measures.

Despite the improvement with respect to old programming period the implementation of rural development policy is still rather complex.

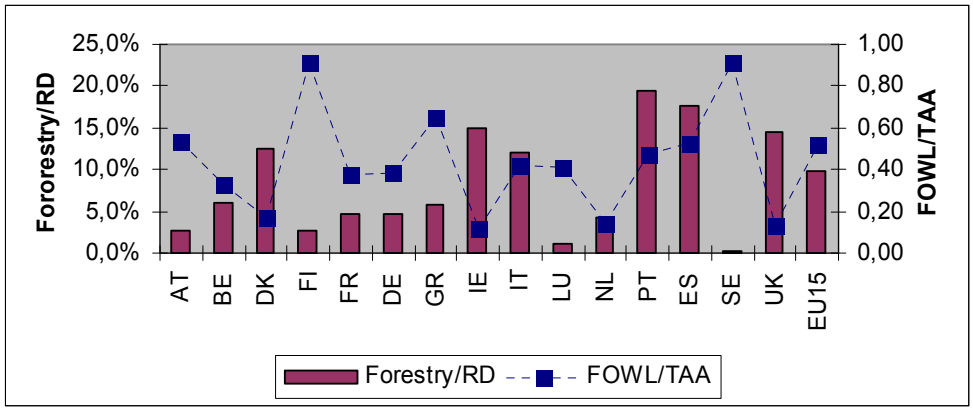
Referring to Italy, the process of devolution to regional authorities lead (Monteleone and Storti, 2004) to a high fragmentation of rural policies together with a regional diversification of policy strategies. This is true particularly in the case of forestry measures, often fragmented (not only in Italy, but also in the European context), in a large set of different measures, not always completely coherent with territorial analysis and diagnosis.

On the other hand, having included forestry measures into RD plans leads to a better consideration of forest policies at European level. In fact, since the Agenda 2000, forest policy has been a prerogative of Member States (in some cases Regions) without common objectives at the European level.

Despite common objectives introduced by the Agenda 2000 and adopted by regional and state administration in the formulation of RDPs, the implementation of forest measures within Rural

Development schemes, has been rather diversified across Europe.
Firstly, even if in general the quantity of financial resources reserved is rather high [(6)], on average around 10% of the total budget of rural development, the situation results extremely diverse across Europe. In fact, when comparing (Table 1 and figure 1) financial commitments of individual European countries, can be noted that about half countries destined more than 10% of rural development total budget to forestry measure. There is apparently no rule for that, in fact within that group are, at the same time, included Mediterranean countries (IT, ES, PT) and Nordic ones (UK, IE, DK). On the other hand, there are a few countries that are relevant for forest production, which destined to forestry measures only a small proportion of RD budget (first of all SE 0,3%, but also FI 2,6% and AT 2,6%).
Figure 1 also compares the ratio between *budget for forestry measures* and *total budget for RD* (left hand side axis) and the ratio between Forest and Other Wooded Land (FOWL) and Total Agricultural Land (TAA) on the right hand side axis.
Firstly one can note that countries where the stock of forest resources is low, and consequently the need of investments in forest sector is expected to be high (typically DK, Ireland, UK), destined a relevant part of RD budget to forestry measures. On the other hand countries where FOWL is a relevant part of TAA (typically AT, FI, SE) and forest sector is well developed the amount of financial resources devoted to forestry measures is extremely low.

Figure 1 – relevance of forestry measures on total RDP budget



Source: Eurostat New Cronos (FOWL and TAA), EU Commission (RD budget)

For sure it is interesting to note that the relevance of other forestry measures compared to the total budget allocated for forestry measures is rather variable. On average at European level, 50% of the financial resources for forestry measures is destined to other forest measures, but this seems to be higher in those Countries where forest sector is more important and well established and Total Forest and Other Wooded Land (FOWL) is relatively high. A generalization could be done by saying that Countries which are less rich in term of forest resources addressed a higher quantity of financial resources to afforestation and vice-versa. However, this statement could be unrealistic in some cases, in fact, as it was highlighted by several reports (mid term evaluations, UE Court of Auditors 2004) much of the money available for forestry measures in period 2000-2006 has in practice already been allocated in the form of CAP accompanying measures because of the long contract period for afforestation of agricultural land. Afforestation established before 2000 and running for a maximum of 20 years (compensation for loss of income can be paid for a so long period) have taken up considerable found for the afforestation measures. As a matter of fact both UE Commission and Member States are expecting a low level of application of the afforestation measure in the period 2000-2006.

[6] With reference to the previous programming period (1992-1999) more than twice financial resources are forecasted to be dedicated to forestry measure in 2000-2006. In fact some 1 500 million euro were spent in the period 1992-2000 on afforestation of agricultural land (UE Reg. 2080/92), while reg. 867/97 has been of scarce importance in financial terms.

Tab. 1 – Financial forecast (.000 euro) of the rural development programmes 2000-2006 and forestry measures within the programmes: EU contribution under EAGGF

Country	EAGGF Budget for rural development	EAGGF Budget for forestry measures			forestry / total RD budget	Other forestry measures / total forestry
		Afforestation	other forestry measures	total forestry		
Austria	3.249.445	8.080	78.620	86.700	2,7%	90,7%
Belgium	401.767	6.153	18.068	24.221	6,0%	74,6%
Denmark	336.420	35.330	6.600	41.930	12,5%	15,7%
Finland	2.393.294	23.330	40.731	64.061	2,7%	63,6%
France	5.762.532	37.606	238.268	275.874	4,8%	86,4%
Germany	8.661.787	110.012	299.379	409.391	4,7%	73,1%
Greece	3.253.700	57.800	129.967	187.767	5,8%	69,2%
Ireland	2.558.291	350.800	31.500	382.300	14,9%	8,2%
Italy	7.493.685	560.123	341.189	901.312	12,0%	37,9%
Luxembourg	91.000	14	1.101	1.115	1,2%	98,7%
Netherlands	427.000	12.210	5.450	17.660	4,1%	30,9%
Portugal	3.552.483	345.865	341.116	686.980	19,3%	49,7%
Spain	8.515.947	663.539	832.793	1.496.332	17,6%	55,7%
Sweden	1.232.269	0	3.621	3.621	0,3%	100,0%
UnitedKingdom	1.555.509	175.910	51.452	227.362	14,6%	22,6%
Total	**49.485.129**	**2.386.772**	**2.419.854**	**4.806.626**	**9,7%**	**50,3%**

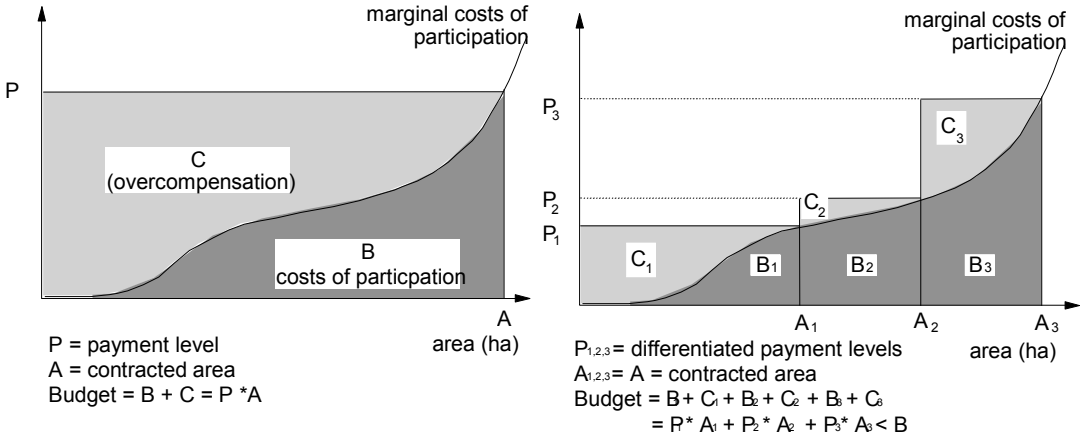
Source: Commission staff working document annex to "Communication on the implementation of the EU Forestry Strategy.

3. Data needs for RD programs formulation

The process of designing rural development programs at regional or national level is a typical decision making process and, as it is obvious, needs that decisions are taken on the basis of a detailed analysis of the situation, trying to avoid the possibility that the system of incentives creates over-compensations or, on the opposite site, under-compensation. The first situation determines a well known producer rent and creates inequity, while the second determines a relevant quota of potential beneficiaries to remain out of the scheme.

To avoid these distortions the EU Commission, in the programming period 2007-2013, stressed the managing authorities to formulate measures in a way which avoid distortions and overcompensation. On the other side the technical services of the Commission enforced the managing authorities that the definition of the level premiums per each individual measure and for each different situation must be based on a clear evidence of additional costs and loss of revenue for the beneficiaries taking part to the individual measure compared to those adopting "usual" production standards.

Fig. 2.– schematic representation of the effects of flat rate vs. differentiated RD payments



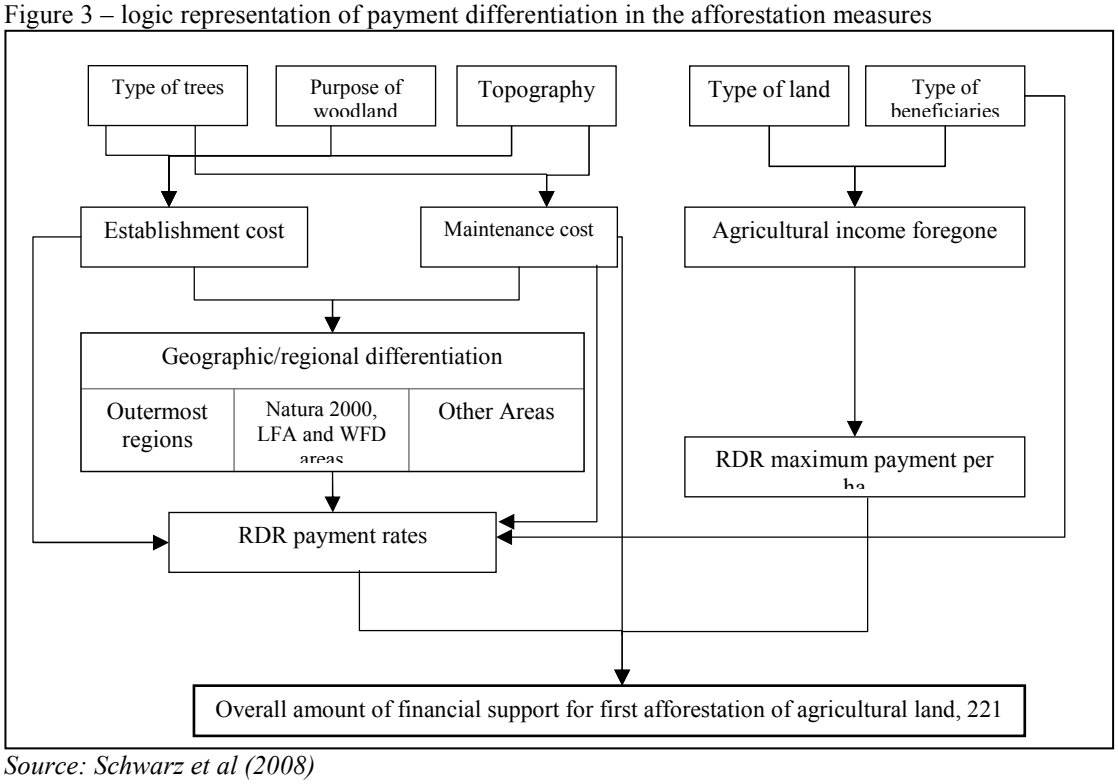
Source: Nieberg, Hofferman and Hecht, (2008)

In the reality this is something which was already in the regulations and technical documents of the Commission in the programming period 2000-2007, but most of managing authorities did not give much importance to the process of premium "justification" and fixed the level of premiums more on the basis of bias information or "tradition" than on the basis of sound and demonstrable data and information.

It is clear that, the more detailed is the differentiation the more complicated is to determine standard (or average) costs and revenues for each differentiation category.

Just to give an example of the way in which the differentiation of RD premiums for forestry measures is organized, figure 3 summarizes the logic representation of payments differentiation in measure 221 (afforestation of agricultural land) and 223 (afforestation of non agricultural land). The scheme represents a synthesis of the differentiation element relevant in the countries involved in the AGRIGRID project.

Figure 3 – logic representation of payment differentiation in the afforestation measures



Source: Schwarz et al (2008)

It is clear that the more complex the differentiation elements are, the more detailed the geographical breakdown of figures must be. This is often a problem for forestry data, which are generally not available with *geographical* (and often *type of forestry*) detail. In fact the AGRIGRID project made evidence that additional costs and loss of revenues estimations are often based on "standardized" gross margin figures based on expert opinion or estimates, while real data (from statistical surveys) are never available. So lack of data and missing opportunity to test the reliability of results remains one of the most important issues. One fundamental step to have in the near future an harmonized approach for payment calculation is to increase the data availability, particularly in the area of costs and revenue of silvicultural activities (planting, felling, harvesting …).

3. Data needs for evaluation

Evaluation (ex ante, intermediary and ex post) is a mandatory process for all the European policies. In the framework of the valuation two different situations and needs for data can be found, these make reference first to the definition of the baseline for the evaluation (typically needed in the ex ante evaluation) and second to the ad intermediary and ex post evaluation where, in general terms, a comparison between beneficiaries and non beneficiaries is done, or a comparison over time is done.
Regarding the first point (statistical and economic information for the baseline assessment) the European Commission (2006) underlines the limited data availability, in fact the Commission says that "there is a need for a detailed geographical breakdown … and time series data". This is true for Rural Development measures as a whole, but seems to be dramatic for forestry measures. Here the standardization of statistical definitions, data collection techniques and methods, geographical detail, is still far to come.
The list of baseline indicators provided by the EC contains all together 36 very general indicators which are used to define the baseline (i.e. the starting point for the evaluation of impacts of RD policies). Only 4 of these are strictly related to forestry:
14. (axis 1) Labour productivity in forestry
15. (axis 1) Gross fixed capital formation in forestry
19. (axis 2) Biodiversity: tree species composition
24. (axis 2) Climate change: production of renewable energy from agriculture and forestry.
Nevertheless many other indicators have strict connections with the forest sectors, these are for example those representing the biodiversity status, such as population of birds, or soil (areas at risk of soil erosion) and many others.
In addition to the above listed of baseline indicators, other indicators are necessary for the annual monitoring of RDP, these (indicators for rural development report) are mainly structural ones and, in the case of forestry, they include mainly information on the structure of forest area, such as "area available for wood supply", "ownership" and "size of firms". It is quite interesting to note that, while the indicators on forest structure and productivity are available at EU27 level (with the exception of average size of private holdings that is missing in Bulgaria and Romania), most of baseline indicators are missing.
Taking as example labour productivity in forestry, this is available only for 10 Countries over 27, a similar situation exists in the case of Gross Fixed Capital Formation (GFCF) in forestry, where only 11 Countries over 25 present a figure. In addition to that economic figures are often rather old, being referred to statistics published in 2000 or 2002.

Tab. 2 – Structural and baseline indicators for forestry measures in RD

Indicator	Forestry structure		Forestry productivity	Gross fixed capital formation	Labour productivity
subindicator	% of FOWL available for wood supply	average size of private holdings of FOWL	average net annual volume increment on FAWL	GFCF as % GVA in forestry	GVA/employed
Source	Eurostat (TBFRA 2000)	MCPFE 2003	Eurostat (TBFRA 2000)	Eurostat Economic accounts for forestry (2004)	Eurostat Economic accounts for forestry / LFS
Belgium	95,1	2,5	8,0	27,3	n.a.
Czech Republic	97,3	3,0	8,0	60,6	11,4
Denmark	81,8	14,9	7,3	n.a.	n.a.
Germany	94,4	14,2	8,8	n.a.	n.a.
Estonia	89,4	10,8	3,7	n.a.	n.a.
Greece	47,5	n.a.	1,1	n.a.	11,4
Spain	40,3	30,8	2,7	n.a.	22,0
France	85,2	3,7	6,4	20,4	80,1
Ireland	98,1	12,5	5,9	n.a.	n.a.
Italy	55,5	8,8	3,1	39,1	7,0
Cyprus	15,4	n.a.	1,0	n.a.	n.a.
Latvia	80,6	11,2	4,6	n.a.	n.a.
Lithuania	82,2	3,7	5,0	13,9	n.a.
Luxembourg	96,6	3,4	7,8	n.a.	n.a.
Hungary	94,0	14,1	5,8	n.a.	n.a.
Malta	0,0	-	-	n.a.	n.a.
Netherlands	92,6	5,7	7,0	25,6	25,2
Austria	85,4	n.a.	8,2	18,1	99,5
Poland	92,8	1,8	4,8	n.a.	n.a.
Portugal	54,7	7,5	6,8	17,0	45,5
Slovenia	88,8	2,8	5,9	n.a.	n.a.
Slovakia	84,8	24,0	7,2	n.a.	n.a.
Finland	90,8	36,7	3,5	14,1	119,3
Sweden	70,2	93,6	4,0	6,0	n.a.
United Kingdom	84,7	16,4	6,9	69,0	11,5
Bulgaria	80,0	-	3,3	n.a.	n.a.
Romania	84,1	n.a.	n.a.	n.a.	n.a.
EU25	72,9	11,7	4,9	19,2	38,5
EU15	70,1	13,6	4,8	17,2	43,9
NMS10	88,8	3,9	5,4	n.a.	n.a.
EU27	73,5	n.a.	n.a.	n.a.	n.a.

Source: European Commission (2006), Rural Development in the EU – statistical and economic information

Moving from the ex-ante evaluation to those done during the programming period (intermediary or final evaluation) other information are needed. While the baseline and structural indicators are typically based on macro data (National Statistics, National Economic Accounts, Forest Inventories), the process of evaluation is normally based on farm level data and figures.

During the previous programming period most of data and information have been collected by means of "ad hoc" investigations. In fact a comprehensive analysis and a continuous monitoring system on the socio-economic situation of forestry firms is, in most European Countries still missing. Only a few countries (e.g. Austria, Germany, Norway and the Netherlands) have in the recent years established a monitoring system for farm forestry enterprises. What is common between these Countries (Niskanen A., Kallio T., 2001) is the idea of systematically collect data on the socio-economic situation and using the information to evaluate the effects of proposed and prevailing policies in the forest sector.

There has been a long discussion in the forestry sector, particularly within the academy and research institutions, about the need of having an harmonized (and mandatory - maybe also co-financed by the EU) system of Forestry farm accountancy data network (similar to that existing since 1965 in European agriculture), but until now nothing occurred at European level. One of the points against the proposal of an European Forestry FADN has been the nonexistence of a proper forest policy at European level, however the - no longer recent - European Forest Strategy (1998) and the inclusion of forestry measures in the rural development policies make more urgent a decision on the

monitoring system. One minimal proposal should be the inclusion of forestry activities in the agricultural FADN, this is actually a very simple solution, but not without problems. In particular the accounting scheme for agricultural firms is, for some aspects such as the distribution of cost and revenues over time, completely different from forestry. On the other side the establishment of a completely new system of accounting, network and sample implies some theoretical and practical problems (Niskanen and Sekot, 2001):

- the difficulties to obtain both a current and comprehensive list of forest owners to design the sample,
- the high probability of having a poor initial and continuing participation in bookkeeping by forest owners,
- the validity of the data, i.e. whether the farm forest owners are willing to give correct information,
- the rate bias, i.e. the selectiveness of the respondents.

4. Conclusions

For the first time in the community policies, a broad and overall operational implementation is given to the forest policy that, after decades of discussion (Glück 1998), has been formally adopted in 1998 with the Communication of the Forestry Strategy of the EU, further adopted by a Resolution of the Council (Kremer 1998). Until recently, such a policy, defined as "virtual policy" (Flasche 1998) or "shadow-policy" (Pettenella 1994), only produced some specific typologies of support (afforestation of agricultural land, interventions against forest fires, forest improvements, monitoring of health and few others).
However the absence of a common legislative framework on forestry at European level makes the problem of definition of common standards, statistics, and inventories rather complicated. A very simple example in this sense is the fact that still now a common definition of what is (and what is not) forest accepted at European level does not exists.
Nevertheless it is clear that, as a matter of fact, the new consideration of forest policy, or at least forestry measures in the framework of a European strategy, makes the need of an harmonised system of statistical and economic information extremely important.

List of acronyms and abbreviations

RD:	Rural Development
RDP(s)	Rural Development Plan(s)
EAGGF	European Agricultural Guidance and Guarantee Found
GFCF	Gross Fixed Capital Formation
GVA	Gross Value Added
LFS	Labour Force Survey
TB	Timber Committee
FRA	Forest Resources Assessment
MCPFE	Ministerial Conference on the Protection of Forests in Europe
FOWL:	Forest and Other Wooded Land
TAA	Total Agricultural Area
UAA	Used Agricultural Area

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2. Sustainability Report – A Tool for Forest Enterprises?

Hans A Jöbstl
BOKU - University of Natural Resources and Applied Life Sciences, Vienna,
Feistmantelstrasse 4, A-1180 Wien, **Austria**
Tel: +43 1 47654 4421, Fax: +43 1 47654 4429

Abstract
"Sustainability reports" are being introduced to an increasing extent into the accounting of listed enterprises, including the forest and paper industries in particular. The term is also being more frequently used in individual forest enterprises that are not listed. It refers to the inclusion or holistic consideration of interdependencies between the environment, the economy and social aspects. Since the business year 2004, the Austrian Federal Forests Company has labelled their annual report as sustainability report. In addition to the traditional business report section with balance sheet, financial results etc., social and environmental dimensions are also discussed there. Sustainability balanced scorecard and GRI guidelines embody target orientation and responsibility for the future. Many facts are represented by criteria and indicators. Continuous development is a must. However, a main weakness from the point of view of forest economics is the missing representation of changes in forest assets, for example. The IAS 41 (Agriculture) wherein appraisal at fair value is regulated cannot be applied.
The main objective of a sustainability report, apart from its usefulness as a management tool, is external presentation, i.e. public relations: How does the enterprise deal with the environment? What does it accomplish for the owners, the employees and the stakeholders? In this context, the following questions arise: What are the benefits of sustainability reporting for the enterprise and for the industry? What is the procedure for the future? Which information is of interest to the individual target groups? What do forest visitors, politicians or investors expect? Conceptions are still relatively vague, and most forest visitors are still unfamiliar with the term sustainability.
This paper presents results of a recent study about the information wishes of forest visitors in the Vienna area and some considerations concerning the further development of annual accounting.

Keywords: forestry accounting, annual reporting, sustainability report, forest assets

Contact: Hans A Jöbstl, email: hans.joebstl@boku.ac.at

3. *The influence of circular sample plot sizes on volume estimates of a selection stand*

Vedriš Mislav[1], Jazbec Anamarija[1], Frntić Marko[2], Božić Mario[1], Goršić Ernest[1], Seletković Ante[1]
mvedris@sumfak.hr; jazbec@sumfak.hr; marko.frntic@hrsume.hr ; bozic@sumfak.hr ; egorsic@sumfak.hr, aseletkovic@sumfak.hr
[1] Faculty of Forestry, University of Zagreb, Svetošimunska 25, Zagreb, Croatia
[2] „Hrvatske šume" Ltd., Lj.F. Vukotinovića 2, Zagreb, Croatia

Abstract:
Stand volume estimate is based on data from sample plots. The aim of this research was to compare stand volume estimates based on a systematic sample of circular plots with different radii. By this, influence of plot size on volume estimate and efficiency of stand measurement was also indirectly assessed. Measurements were conducted in a beech-fir selection stand situated in the Educational and Experimental Forest Site "Zalesina" in the region of Gorski Kotar in Croatia. Tree diameters at breast height (DBH) were measured in a systematic sample of 16 concentric circular sample plots. Tree location from the plot centre was recorded with the azimuth and distance. All the trees with DBH of 10 cm or more were measured in the plot with a 13 meter radius, and the trees with DBH 30 cm and more were measured in the plot with a 19 m radius and the trees with DBH of 50 cm and more were measured in the plot with a 26 m radius. The computer programme CirCon was developed to calculate the stand volume based on measured and simulated plots (the radii were different from the measured ones). The plots based on real measurements were simulated according to the ones used in the forest management practice (singular and concentric circle plots). We simulated 7 methods: K1-12 (12.62 m radius plot); K2-5.12 (concentric circle plot with radii of 5 and 12 m); K2-7,14; K2-10,15; K2-12,16; K2-13,19; and K3-13,19,26 (three concentric circles with radii of 13, 19 and 26 m). The calculated volume estimates on the same standing points differed from method to method depending on spatial tree distribution and plot size. There was no statistical difference in the total volume among the analysed methods (repeated measurements ANOVA: F=1.31, df=6, p=0.259). We compared the similarity of the analysed methods using Cluster analysis. Three clusters were sorted out: C1=(K1-12; K2-5,12), C2=(K2-7,14; K2-10,15; K2-12,16), and C3=(K2-13,19; K3-13,19,26). In order to distinguish the methods within the clusters, we compared relative precisions ($SE/mean \cdot t_{0,05}$) for a 95% confidence interval. In C1, precision was about 18%, in C2 it ranged from 17.19% to 19.93%, while precision was best in C3. For K2-13,19 precision was 12.57% and for K3-13,19,26 it was 10.47%. The choice of a measurement method should be governed by the cost of measurements and the expected precision.

Key words: forest inventory, circular sample plots, volume estimation, precision, computer model

Introduction

Forest mensuration or inventory is the basic prerequisite for the planning of sustainable forest management. Data on the condition of a stand may be obtained in a number of ways. Since it is generally not possible to measure all the trees, the elements of a stand structure are regularly obtained using sample plots. For this reason it is very important to select a good (representative) sample, which, apart from the spatial distribution, also includes the shape and size of sample plots. Data based on samples are an estimate of real parameters. The quality of a sample is estimated on the basis of sample error, or precision. It is almost impossible to determine the closeness of the estimated to the real parameter (accuracy), because it involves many error sources. Apart from sample errors, estimate quality is also affected by measurement errors, errors in the calculation of

stand size, methodical errors in volume calculations (the applied volume tables) and other factors. Volume (growing stock) is one of the basic features of a stand structure. According to the Croatian Forest Management Regulation, the precision of volume estimate (sample error) is 7% for 95% confidence at the management class level (management unit). The precision of volume estimate is directly affected by the variability of the feature (volume) in a stand and the size of the sample (number of plots). The estimate of mean values and variability is dependent on plot size and shape (Schreuder et. al., 1993, Koprivica 2006), and on their spatial distribution. Since a stand is the basic management unit, it is important to know the precision of stand volume assessment obtained by field measurements. This paper is part of research into the precision of the assessment of structural elements and sample sizes in selection forests. The objective is to compare the assessed values of stand volume (per hectare) obtained in differently sized plots, as well as the achieved precision. Different field measurement methods in even-aged forests have already been investigated and compared in Croatia on several occasions (Lukić, 1984; Galić, 2002; Indir, 2004). Due to higher spatial and structural variability, as well as possible specific features, this research was conducted in the area of uneven-aged selection forests. It is an introduction to a more extensive project involving the determination of the optimal sample for inventories in this field. Research is running simultaneously with the improvement of the state forest measurement system in Croatia (Permanent Plot Project), and the already initiated National Forest Inventory Project (Čavlović and Božić, 2005). Since sample planning is a feature which may increase or decrease the cost of field measurement processes, we maintain that the necessary sample size should be calculated so that the desired quality of results could be achieved.

Materials and methods

The area of research was in the Dinaric region of selection forests in Gorski Kotar in the north-west of Croatia. An uneven-aged mixed beech-fir stand of high silvicultural form was selected for field measurements. The stand covers 20.63 ha and is situated in the Management Unit Belevine of the Educational and Experimental Forest Site Zalesina. The stand occurs at an altitude of 790 to 850 m, southern to eastern exposition, with terrain slope of 5 – 10 °. It belongs to the management class of uneven-aged seed forests of fir in the second site class.

For reasons of simplicity, practicality and extensive use in forest inventory, a systematic pattern of sample plots was selected. A square grid with sides of 100 m was placed over the area map. A total of 16 circular plots were placed on the grid intersections as a practical and frequently used plot shape in forest inventory (Schreuder et al., 2004). By comparisons with the used size plots in forest inventories in Croatia (National Forest Inventory, management measurements), three concentric circles of 13, 19 and 26 m were selected. The position of plot centres in the field was determined with a compass and a distance metre. Tree diameters at breast height were measured with millimetre precision in each plot, and so were their distances from the centre, the slope and azimuth. The 10 cm taxation limit of breast diameter measurements was applied (according to the Croatian forestry practice, Article 19 of Forest Management Regulation). Tree breast diameters were measured in concentric circles grouped according to the used diameter classes for selection forests (Forest Management Regulation): all the trees above the taxation limit were measured in the circle with a 13 m radius, trees of 30 cm and more were measured in the circle with a 19 m radius, and trees with diameters of 50 cm and more were measured in the circle with a 26 m radius (K3-13, 9, 26). The selected circle sizes were bigger than those assumed necessary, the purpose being to simulate different radii and shifts in circle positions during processing.

The following measuring instruments were used: Haglof tree calliper with a millimetre scale, Suunto compass with a monopod staff, ultrasonic hypsometer Vertex III, and a measuring tape (to measure trees with breast diameters over 80 cm). Field work was performed by two to three workers, of which one determined the azimuth and tree distances, the second one measured breast diameters, and (the third) recorded the data.

Since the goal was to compare volume estimates for different plot sizes, this work did not take into account the existing error sources, i.e. errors in measurements, errors in determining stand area, and errors in tariff selection and volume calculation. The volume was calculated using single entry volume tables for fir and beech (Šurić, 1938; Pranjić, 1966), used in the valid management plan for the Management unit Belevine (Čavlović and Božić, 1999). Linear volume interpolation was made for diameters measured with millimetre precision.

The CirCon programme was created to process the data (Figure1). The programme calculates the entered data per plots and simulates the desired plot positions and sizes in relation to the real measured condition. The basic calculation unit is a tree in a given plot. Data on all measured trees in the plot (breast diameter, azimuth and horizontal distance from the centre) were transferred to the CirCon. Volume from the volume table was determined for the entered trees in dependence on the species and site class. Volume in the plot per hectare was calculated depending on tree diameter, i.e. plot size in which the tree was measured. Volume per hectare was calculated by dividing total plot volume by plot size. After the measured plots were entered and calculated, CirCon made it possible to calculate volumes for plots with different (smaller) radii than those really measured on the basis of the distance of an individual tree from the plot center and the desired plot radius. Since the programme calculates automatically whether a tree is within the plot or not, it is possible to simulate any plot size (smaller than the measured one). It is also possible to set a larger number of concentric circles with different radii and marginal values of tree diameters that are being calculated in the plot.

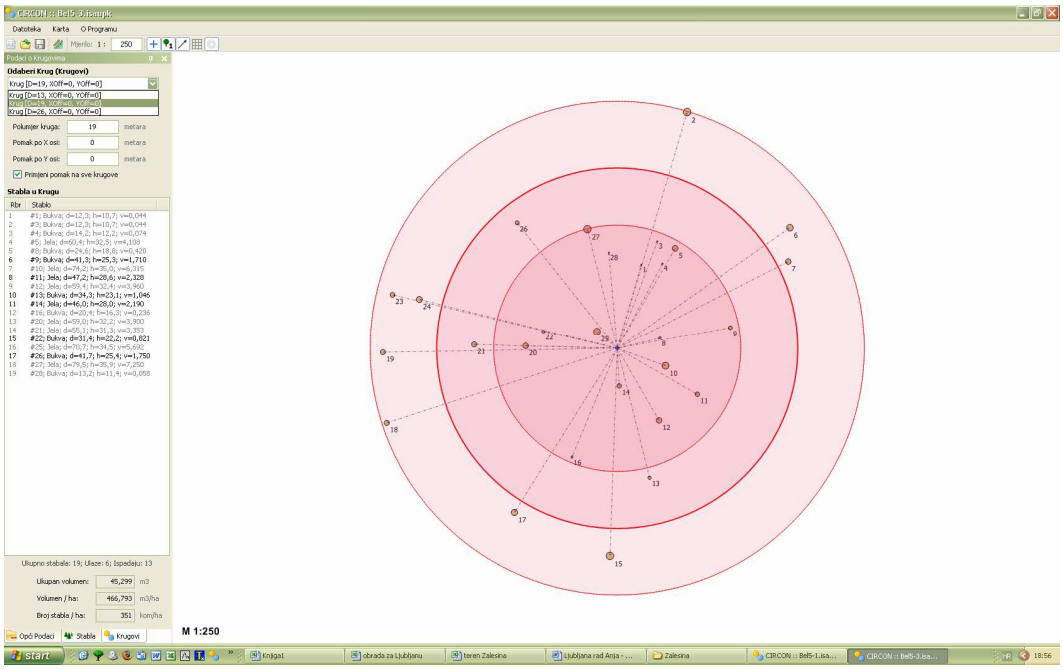


Figure 1. Interface of CirCon programme

Several different sizes of circular plots were simulated, of which a few were chosen for comparison with originally measured ones. These were primarily circular plots used until recently with a radius of 12.62 m (K1-12) (area 500 m^2), and a double circle with a 5 m radius (area 78.54 m^2) for the trees from 10 to 29.9 cm and a 12 m radius (area 452.39 m^2) for the trees of 30.0 cm and more (K2-5,12). These are currently in official use in state forests. Double concentric circles with equal boundaries of diameter measurements were also chosen for comparison (a smaller circle for diameters of 10 – 29.9 cm and a bigger circle for diameters of 30.0 and more). The radii were 7 and 14 m (K2-7,14), 10 and 15 m (K2-10,15), 12 and 16 m (K2-12,16), and 13 and 19 m (K2-13,19). For each of the methods (plot sizes) statistical volume parameters were calculated: volume of all the trees per hectare for each plot and overall for the entire stand, standard deviation, and a 95%

confidence interval. By multiplying the standard error with the associated value of *t* – distribution, the sample error in the absolute amount was obtained. By dividing the sample error with the arithmetic mean, the relative sample error was obtained (precision) (P).

$$95\%CI ..... \bar{V} \pm t \cdot \frac{s}{\sqrt{n}}$$

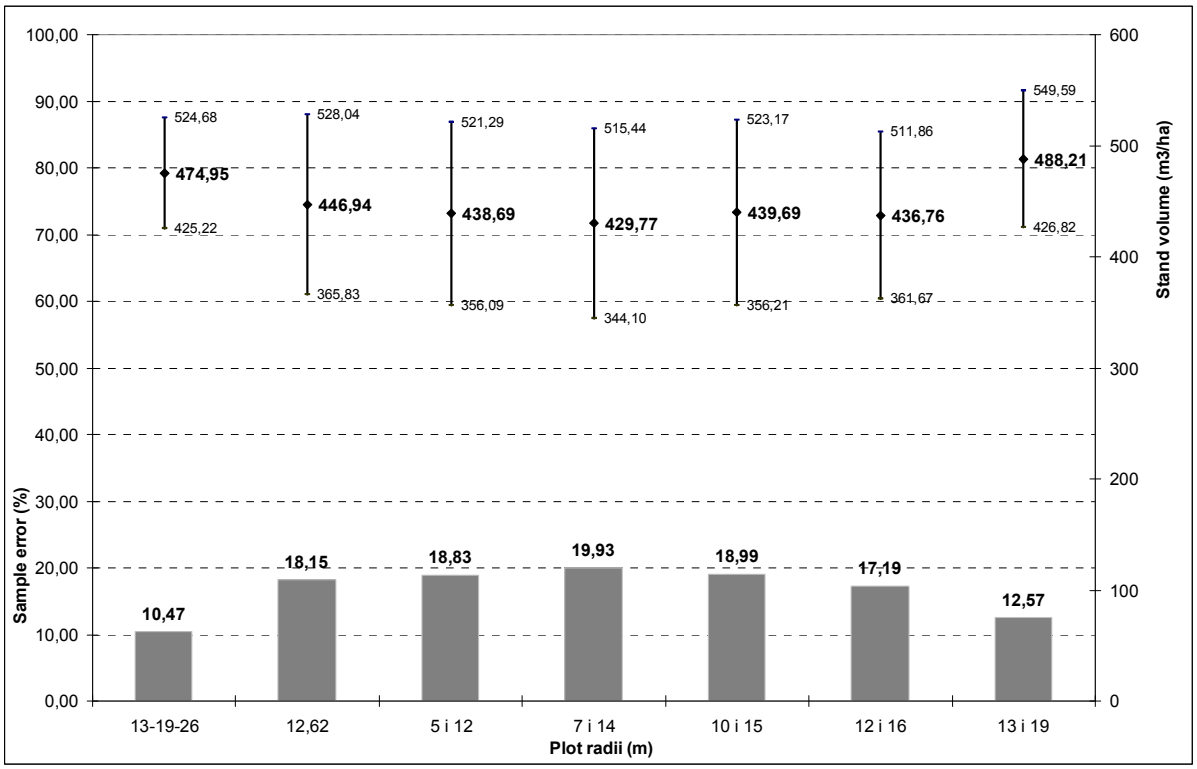
$$P ..... \frac{t \cdot \frac{s}{\sqrt{n}}}{\bar{V}}$$

95%CI ……. 95% confidence interval
P …….. precision, relative sample error
s standard deviation based on sample
$\bar{V}$ …… mean volume
t ..... critical value for upper 2,5% of area under *t* distribution with n-1 degrees of freedom
n …… sample size

To calculate statistical parameters from the sample (arithmetic mean, standard deviation, standard error, sample error), assumptions and equations for random sample were used, which are also considered acceptable for systematic samples (Pranjić and Lukić, 1997).
Since simulation results are connected (as they refer to the same centres and partially to the same trees), they cannot be considered independent samples. Therefore, to test the differences in the values of total stand volumes per hectare, we used variance analysis of repeated measurements for different methods (circle sizes) with significance boundary of 0.05. The similarity of the monitored methods was compared using cluster analysis. Euclidian distance was used as a dis(similarity) measure. The minimum (single linkage) method was used for hierarchical clustering algorithm (Sokal and Rohlf, 1995).
All statistical analyses and graphic presentations were made using Statistica 7.1 and EXCEL 2003 statistical programme packages (StatSoft, Inc., 2007).

Results

The results of stand volume estimates (m^3/ha) based on the measured plots and the mentioned combinations of concentric and single circular plots are given in Figure 2. In addition to the average, the interval was also given for 95% confidence and the relative sample error for the compared methods.



Explanatory note: Bars denote relative sample error, dots are average volume estimates and vertical lines stand for 95% confidence intervals of average volume.

Figure 2. Average stand volume estimate and sample error by different plot sizes.

Different plot sizes provided different volume amounts for individual plots and overall for the stand. The average volumes range from 429.72 to 488.21 m^3.

Table 1. Results of repeated measurements ANOVA

Effect	Degr. of Freedom	MS	F	p
Between subjects				
Error	15	104038		
Within subjects				
Method	6	7751	1,3139	0,259118
Error	90	5899		

Although volume estimates with different methods are not statistically significantly different (Table 1), there are differences in the estimates of confidence intervals and precisions.

Increasing the plot size does not lead to an increase or decrease in volume estimates in this stand. Standard volume deviations do not differ significantly for the circles with radii from 10 to 15 m. They range from 152.20 m^3 in the plot with a 12.62 radius to 160.78 m^3 in the double circle with radii of 7 and 14 m. It is only the larger circles with radii of 12 and 16 m, and of 13 and 19 m that contributed to reduced standard volume deviation. Volume obtained on the basis of the measured treble concentric circle with radii of 13, 19 and 26 m provides the smallest standard deviation. Naturally, this is the consequence of an increased number of measured trees per plot resulting from increased radii. This accounts for a decrease in volume difference between individual plots in the stand. Since the number of plots is equal for all the methods, differences in sample error depend exclusively on the size of standard deviation for each method. Thus, the sample error ratio is proportionate to the variability (standard deviation) of the volume obtained in different plot sizes. Dividing the sample error with the associated mean volume value provided relative amounts, for which equal relations are valid. The highest relative sample error occurred in plots with 7 and 14 m

radii (19.93%), closely followed by plots with radii of 5 and 12 m, and 10 and 15 m radii (18.83% and 18.99%). Measurements in single circles with a 12.62 radius provided the relative error of 18.15%. A significant decrease in the sample error was obtained for the methods K2-13,19 (12.57%) and K3-13,19,26 (10.47%).

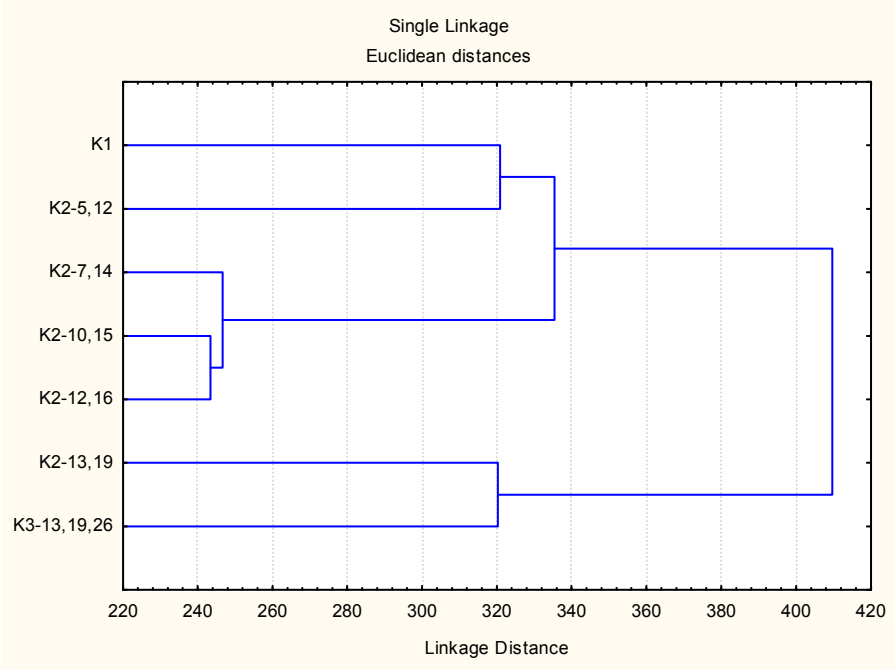


Figure 3. Tree diagram for 7 analysed methods illustrating hierarchical clustering.

According to the tree diagram (Figure 3), the analyzed methods can be classified into 3 clusters (subgroups):

- C1=(K1; K2 -5,12)
- C2=(K2-7,14; K2-10,15; K2-12,16)
- C3=(K2-13,19; K3-13,19,26)

The clusters were evidently formed according to plot sizes, since the plots of similar sizes incorporate a similar number of the same trees.
In order to distinguish the methods between the clusters, we compared relative precision for a 95% confidence interval. In C1 precision was about 18%, in C2 it ranged from 17.19% to 19.93%, while C3 showed the best precision (less than 12.5%).

Discussion and conclusions

Calculating the growing stock per plot was made easier and automated using the CirCon programme. Plot volume simulation and calculation that differ from the originally measured ones is also very simple and visually clear. A good feature of CirCon is its visual interface, which provides plot ground plan with the position of trees at a desired scale. This makes it suitable for the purposes of teaching and presenting plot samples to a wider public.
The results of measurement were compared with each other without knowing the referent value, that is, the real volume amount. This would be possible if all the trees were measured. However, even such measurements could not be taken as the absolute measure, as they involve possible measurement errors (Lukić, 1984; Pranjić, 1987). The same thing happens in practice, since the total census is rarely done, and it is always the matter of better or poorer estimates.

The entire processing was very practical, so no theory of optimizing sample sizes on the basis of desired/known variability was involved. Instead, we tried to test in practice some already familiar and used measurement methods.
In line with similar research conducted in even-aged stands (Lukić, 1984; Galić, 2002), the results of variance analysis showed that the obtained volume differences per methods were not statistically significant at the 0.05 level.
The results in the measured stand show that there was no distinct trend in the reduction of sample errors by increasing the plots. Only in plots with radii of 13 and 19 m was the sample error significantly reduced. In the case of equal precision, smaller plots are more economical. Taking into account that in smaller stands with a smaller number of plots the sample error will be even bigger that the ones we obtained, other possibilities of improving precision should be investigated (denser network, specific radii, remote sensing methods).
Three concentric circles measured for the needs of simulation and comparison are definitely unacceptable in practice as they require too much time and consequently provide more possibilities for measurement errors (Indir, 2004). Their purpose was primarily to provide the possibility of simulating smaller plots and their shifts in space.
Precision obtained on the basis of plots shows significant differences in dependence on plot size. Interestingly, the plot with a 12.62 m radius showed almost equal precision as the concentric circles with 5 and 12 m radii. If these two plots sizes are compared, costs of measurement time needed to achieve equal precision should be investigated in detail. In case of concentric circles a smaller tree is measured, but the possibility of error is bigger due to more edge trees, which must be checked, thus prolonging measurement time.
Plots with radii 7 and 14 m and 10 and 15 m provide even poorer precision than the plot with 5 and 12 radii in researched stand. This may seem unexpected, since an increase in the number of trees should lead to reduced variability, that is, to averaging the values. Here, the higher number is clearly not high enough for variability to decrease. On the contrary, it increased due to the trees in the wider diameter range. It should be investigated how many trees are needed in a plot to achieve the desired precision and with which plot size can this be accomplished.
Volume is the targeted parameter whose estimate precision is legally prescribed for a management class. For this reason, we tried to check the differences in volume estimates based on different plot sizes. However, the results of volume estimates contain a series of other errors apart from the sample error, which are hard to assess. Their amount should also be included as an additional estimate "imprecision". According to Pranjić (1987), basal area is a better indicator of inventory precision as it does not contain the volume calculation error. Therefore, it would be advisable to compare the estimate of tree number with basal area as an indicator of estimate precision.
The obtained volume results are valid for this stand and the stands of similar structure. They are a contribution to broader research in the optimal sample needed to assess different structural parameters (number of trees, basal area, ratio per species, etc.) for uneven-aged stands.
The choice of a measurement method should depend on the cost of measurements and the expected precision.

Acknowledgements

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4. Regional Forest/Timber Accounting for Measuring Net Reduction of Carbon Emission

Koichiro Koike
SHIMANE University
Faculty of life and environmental sciences
1060 Nishikawatsu, Matsue 690 0823 JAPAN
Phone: +81 852 32 6510 Fax: +81 852 32 6499
e-mail: koikek@life.shimane-u.ac.jp

Abstract

After COP3 in Kyoto, forest/timber accounting has been charged with new, important role, to describe forest related carbon circulation. The mass Balance concept of resource / environment accounting is easily extended to carbon accounting.

Additional extraction of forest resources and corresponding increase in material/ energy consumption brings wide influence to regional economy. Tables in matrix form show sharp distinction between petroleum dependent society and Bio dependent one.

Keywords: environment accounting, resource accounting, regional economics, bioenergy

Introduction

In 1997, challenging protocol to reduce carbon emission had been concluded. To attain significant reduction, there are three ways to reduce, by saving, by substitution and by sequestration. Saving will be saturated and sequestration is not yet reliable. So substitute fossils by renewable is the most secure way to get near the target.

Forest biomass, holding the largest part of photosynthesis outcome, is very important and also hopeful resource for forest rich regions.

1. Environment Resource accounting - Basic Concept

To describe interactions between human activities and environment, there are several methods. We choose material/Energy balance scheme for our research.

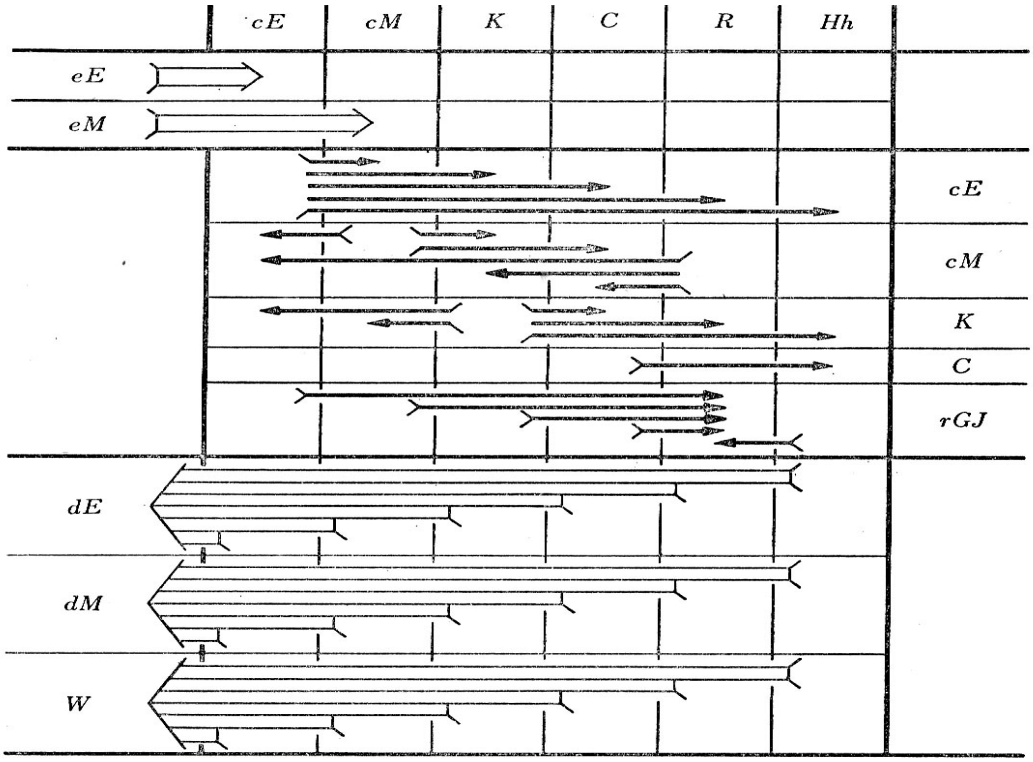
Historically we have some preceding ideas. I/O Model by Leontief is widely used but analysis in physical terms are not yet developed.

Theoretically, Georgescu-Roegen had established a basic framework of physical accounting from a view point of thermodynamical economics. He emphasized on distinction between a state function and conserved amount. Energy and Material are always conserved but degrade simultaneously from available state to unavailable state. Availability is necessity condition of having value, for all the commodities.

Between physical account and economic account there is conceptual difference of dimensions. There must be some conversion schemes. Along with a development of SNA, System of National Account, UNSO had proposed a concept of satellite account. Satellite accounts are a liaison or interface which connect economic account with specific account on area of concern(s). Satellite Accounts are often compiled in physical term.

From 1980s, as a kind of satellite account, resource and environment accounting had been developed by OECD and several other institutions. The most successful outcome has been established in the field of accounting on forest and timber by Norwegian and Finish researchers.

Fig. 1 Energy/Material Balance by N. Georgescu-Roegen



cE controlled Energy	eE Energy in environment
cM controlled Material	eM Material from environment
K capital Goods	dE dissipated Energy
C Consumer goods	dM dissipated Material
R recycling	W Waste
Hh Household	rGJ Garbojunk

2.Analysis on prominent "Success Story" (Växjö in Sweden)

By the law of conservation, all inflow go into the system must be the same as total outflow from the system. Amount of carbon go into specified partial system(region) must come out from the region. These tables show which type of energy are used by corresponding sectors. We have compiled the balance sheet on Kronobergs län in southern Sweden. Växjö is the capital of this Län and one of the most remarkable municipalities acting for climate issues.

Table-1 Sector/Fuel Sheet of Kronobergs Län in Energy term (Twh)

	Domestic	Import	DH	Industry	Service	Public act.	Transport	Household	Loss
Electricity	60	2159		774	386	200	31	703	125
Coal		52		52					
Woodfuel	1152		492	447				213	
Heat	660			52	108	100		280	120
Fuel oil		1206	128	396	272	100		310	
Gas. & D		1610		70			1540		

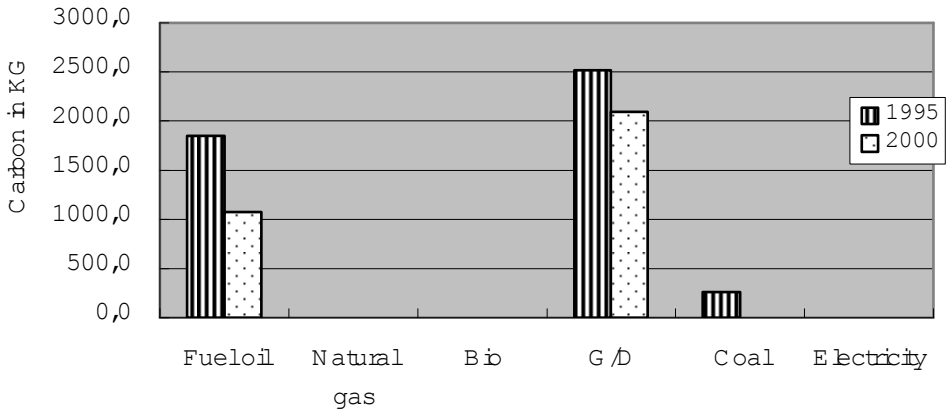
Table-1 shows which sector consume how much amount of fuels by fuel category. First two columns are energy supply to the region. Third column DH, District Heating, is an intermediate sector, which consume biomass or other type of fuels and produce heat and/or electricity. Coal, petroleum and almost all electricity come from suppliers outside. Domestic supply is mainly wood fuel, and followed by limited amount of electricity.

Table-2 Sector/Fuel Sheet of Kronobergs Län in Carbon term (Ton-carbon)

	Domestic	Import	DH	Industry	Service	Public act.	Transport	Household	Loss
Electricity	0	0	0	0	0	0	0	0	0
Coal	0	16900	0	16900	0	0	0	0	0
Woodfuel	0	0	0	0	0	0	0	0	0
Heat	0	0	0	0	0	0	0	0	0
Fuel oil	0	323208	34304	106128	72896	26800	0	83080	0
Gas. & D	0	421820	0	18340	0	0	403480	0	0

Table –2 showss the carbon balance of the region. Carbon emission comes from two type of energy consumption. One is heat from coal and fuel oil combustion. The other source is gasoline and diesel oil for transportation sector.

Fig.-2 Per Capita Carbon Emission in Kronobergs and Kalmar Län



From Fig-2, Fuel oil can be replaced by domestic biomass easily with well developed direct combustion technology. But in transportation sector, reliable liquid fuel for vehicles are not yet developed. These fact suggest that substitution of fossils by biomass should be carried with stationary use (boiler for heat) at first.

3. Area description – Historical Background of Iwami

Around the 17th century, Japan accounted for about one-third of world silver production and the Iwami mine produced the bulk of silver in Japan.

Recently Iwami silver mine has been listed in World Heritage sites of UNESCO. One of principal reasons for adoption is sustainable forest resource use for centuries. 39 adjacent villages supplied wood fuel and 6 of them also brought two kind of charcoals.

This region also produced steal from iron sand until end of 19th century but forest resource had been sustained relatively in good condition.

Fig-3 Iwame silver mine in a Map drawn in 16th centuly (1570), By Abbaham Oelius "Theatrvm Orbis Terrarvm", Antwerpen

<Stated by the discription of UNESCO>
The elements of the property showing the original mining land-use system remain intact; the organic relationships among the individual elements exhibit the full expression of the mechanism of the original land-use system. They are a living part of the contemporary lives and livelihoods of the local society in unity with the abundant mountain forests and hence the integrity as a cultural landscape is maintained.

After the decline of iron production, this region had begun to supply charcoal for household use in urban area until 1950s. Liquid Petroleum gas had finally destroyed productive use of forest resource.

4. Energy Balance in rural JAPAN today

Table-3 is a energy balance of Kawamoto municipality neighboring Iwami silver mine.

Generally, transportation sector of these municipalities are heavily dependent on gasoline and diesel oil for vehicles. In order to reduce carbon emission earlier, it will be accomplished by replacing 26.8 Gwh fuel oil with domestic woody biomass.

As mentioned above, forest in this region has enough potential and now extremely in under use status. 26.8Gwh energy is about 6700ton timber. It means 13400cubic meter in volume. 85% of Kawamoto is covered with forest. Average annual yield here is around 8 cubic meter/year/ha. Assume that using 50% of forest area for extraction, this municipality will be able to utilize more than 36000 cubic meter timber per year. By experiences of well wood use countries, it is more economically efficient to use wood with a cascade process, material then energy.

5. Conclusion

Material/Energy balance shows that reduction of carbon emission is possible in region with forest resource, but transportation sector might continue to use fissile fuel. Balance sheet also shows which sector, which type of use is easier to replace fossil resource.

In case of ordinary municipalities in Japan, forest resource can supply more energy than used now every day for heat and hot water now.

Table-3 Sector/Fuel Balance of Kawamoto in Energy term (Gwh)

	Domestic	Import DH	Industry	Service	Public act.	Transport	Household	Loss
Electricity		23.0	3.8	2.7	5.5		10.8	
Coal								
Woodfuel	1.0						1.0	
Heat								
Fuel oil		26.8	2.3	3.2	6.3		15.0	
Gas. & D		58.4				58.4		

Acknowledgements

Municipality of Kawamoto, Shimane Japan
The New Energy and Industrial Technology Development Organization (NEDO)

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5. Modelling natural risks in forest production models by means of survival probabilities

Bernhard Möhring, Kai Staupendahl
Department of Forest Economics and Forest Management, Burckhardt-Institute, University of Göttingen, Büsgenweg 5, D-37077 Göttingen, **Germany**
tel.: +49 551 393421; fax: +49 551 393420

Abstract
Against the background of climate change the influence of natural risks (storm, insects, etc.) on the silvicultural production needs to be considered in forest management more than ever. As a contribution to this topic this presentation shows a simple spreet sheat which calculates different variables of forest production under the influence of natural risks, whereas risk is expressed by the proportion of the stand area which is lost until a definite age (here 100 years). This proportion can also be interpreted as the survival probability. In order to model the decrease of the stand area, a function is used which describes the remaining area over time. Data from literature are used to estimate the form and coefficients of such a survival function.
In a forest production model we combined this survival function with yield functions we developed on the basis of the growth model TreeGrOSS, an Open Source project of the Northwest German Forest Research Station. Using a multitude of growth simulations increment and yield functions were derived, which are easy to implement in such a spreadsheet calculation model and reflect the current growth conditions and silvicultural practice (thinning with release of crop trees, girth limit felling) better than the classical yield tables used in the German forest practice.
On the basis of such a risk including forest production model and using actual data it can be demonstrated how the shape of the survival function influences relevant economic key figures and decision criteria.

Keywords: modeling, forest production, natural risks, survival probability, Northwest German Forest Research Station

Contact: Bernhard Möhring, email: bmoehri@gwdg.de; Kai Staupendahl, email: kstaupe@gwdg.de

Session 6:
Forest management practices

1. A transdisciplinary learning model for integrating research and policy in sustainable forest management

Lyudmyla Zahvoyska, Lyudmyla Maksymiv
Institute of Ecological Economics, Ukrainian National Forestry University,
103 Gen. Chuprynky, Lviv, Ukraine 79057,
Tel.: + 38-032-2392778; fax: +38-032-2970388.
E-mail addresses: zahvoyska@yahoo.com; maksymivl@ukr.net

Abstract
It is widely acknowledged that transformation of a society towards a sustainable pattern demands an effective collaboration of all stakeholders and intensive knowledge exchange within a well-known triangle academia-business-society. Indeed, education and training are main driving forces of a society reshaping with regards to sustainability. But it has to be mentioned that it is not enough just to address environmental and social issues in a curriculum. Skills and competences for dealing with highly complex and ill-defined problems have to be developed in order to effectively cope with sustainability challenge. University education is expected to generate and implement new didactic forms to intensify a polylogue and mutual learning from each other across all stakeholders to tackle and handle sustainability puzzles. Atelier as a specific form of transdiciplinary case studies occupies a fitting place in this variety of educational eco-innovations aimed at sustainability learning. Atelier paradigm, ontology, methodology and management are examined in the paper.

Keywords: atelier, transdisciplinary, real-world problem, sustainability learning

Introduction

Sustainability challenges became a powerful driver on a way of crystallizing post normal science paradigm. Attempts to solve environmental puzzles forced scientists to recognize a synergetic nature of ecological-economic systems, which cannot be well understood in the framework of cause-effect paradigm. Hence, demand for new methods of investigation, tackling and handling environmental problems, new approaches and instruments for identifying and discovering impacts of human activity, which cascades in a complicated way through the global ecosystem, arises. Epistemological tensions in science, comprehensively described by Peter Söderbaum (2000), echoed in sustainability learning techniques. Co-operative learning through integrating knowledge of all stakeholders including academia) facilitates searching consensus, mitigating conflicts and developing realistic scenarios for a real-world problem being faced by a particular community or region.

All these peculiarities particularly feature forest decision-making process due to multifaceted nature of forest ecosystems, their vital role in sustaining economic system and diversity/discrepancy of stakeholders' interests. Forest ecosystems provide a lot of goods and services crucial for our life and well being. Most forest ecosystem goods are excludable and rival, so they are traded on a market; demand on them is coming from markets transactions. On contrary most ecosystem services (like climate regulation, habitation, scenery beauty etc.) are non-excludable and non-rival, so they are off markets and demand on them is underestimated, there is no market incentive to provide them (Costanza et al., 1997). Hence permanent shift from ecosystem services, ultimately non-substitutable and essential for human survival, towards desirable and substitutable goods, which production ruins ecosystems structure, in a systematic way arises until we are guided by the dominant neoclassical economic paradigm.

But discovering nature of permanent market incentive to harvest ecosystem structure over ecosystem structure conservation is not enough to achieve SFM. This knowledge should be

demanded by society and delivered to it. And only in this situation we can expect translation of academia findings into decision-making, everyday practice and behavior. SFM is highly dependent on stakeholders' knowledge and perceptions of forest ecosystem goods and services, their sustaining and containing role. A transdisciplinary case study (TCS) model should facilitate to fill existing gap between ecological economics, forest science, policy making and everyday practice in a straightforward and comprehensive way.

Transdisciplinary case study for sustainability learning

Quoting R.Scholz (Scholz et al, 2000, 2006), transdisciplinarity can be defined as an integration of values and knowledge from society into the production of scientific knowledge. In Europe the first TCS was undertaken at the Institute of Human-Environment Systems Natural and Social Sciences Interface at the Swiss Federal Institute of Technology in ETH Zurich in 1994 (Posh and Scholz, 2006). Nowadays a lot of transdisciplinary case studies are arranged by European universities. Gained experience of innovative teaching was discussed at a symposium on "Transdisciplinary Case Study Research for Sustainable Development" (Helsinki, June, 2005) and is highlighted in the International Journal of Sustainability in Higher Education (2006). Applying transdisciplinary case studies as a mean of organizing sustainability learning becomes an effective and popular form of mutual learning by doing and it allows academia to implement developed findings in real world conditions.

American experience of transdisciplinary learning can be presented using example of *an atelier*, a form of TCS, conducted by academicians in a local community for solving real-world problems within the framework of sustainable development through integration of education, research, and co-operative learning. This research and training methodology, originated by the Gund Institute for Ecological Economics (GIEE, University of Vermont, US), becomes especially beneficial both for academia and society being conducted in countries under market transformations or in developing countries. It helps a lot to integrate findings of different schools of ecological economics, to enrich scientific skills and problem-solving capabilities through guest lectures, site visits, interdisciplinary case studies, and applied work on an investigated ecological-economic problems. GIEE's experience of TCS is presented in the book by J. Farley, J. Ericson and H. Daly "Ecological Economics. A Workbook for Problem-Based Learning" (2005).

The term "atelier" usually is referred to an artisan's workshop. The GIEE adapted it to a description of an environmental problem-solving process (http://www.uvm.edu/giee/ateliers). For the first time it was conducted in 1995 in regards to Valuation and Management of Fynbos Ecosystems. Since then this methodology became an essential part of educational programs in ecological economics, hold by GIEE.

The main advantages of ateliers are:

- Building both students' and stakeholders' capacity of real-world problems solving using interdisciplinary background and methodology;
- Augmenting both academia and society by new knowledge and experience;
- Stimulating students towards self-regulating education and approaching their future professional activity;
- Developing new educational model integrating usual lectures with field-based teaching and internet-based education;
- Facilitating dialog and mutual understanding among academia and community, among stakeholders itself;
- Improving research-society communication, knowledge dissemination and collaboration.

As our experience suggests simply developing an atelier in a local community induces a flow of benefits both for academia (papers, monographs, further researches) as well as community (new level of stakeholders' collaboration, knowledge dissemination, perception of own connection and responsibility for changes toward sustainability) etc.

According to Scholz et al (2006) the core patterns of TCS theory are: ontology, epistemology, methodology and project management conceptualization. We present the atelier paradigm following this framework and using an example of a particular atelier.

Ontology of Atelier

Ontology conceptualization involves description of a system being investigated, its initial and target states and a relevant transition process, as well as system's dynamics and indicators of its quality to make comparable different states of an examined system.

As an illustration of a particular atelier we will use one of the latest ones, which dealt with ecological economics and SFM. Last autumn GIEE and the Institute of Ecological Economics (IEE), Ukrainian National Forestry University, applied the atelier approach to tackle problems on a way of transition forest management toward a sustainable pattern. The international atelier "Ecological Economics and SFM in the Ukrainian Carpathian" took place in Lviv and Transcarpathian regions (Western Ukraine). It has to be mentioned here that Ukraine now establishes own economic system, which is being transformed from a centralized to a market one. In the mainstream of these much-needed changes are questions of building a proper property system to enhance natural capital of the country; one of the main components of it consists of forests. Ukraine has a low percentage of forest cover and an overall deficiency of forest resources (UNECE, 2003). Value of forest resources and forest ecosystem functions is very high. At the same time forests are located over the territory in a very irregular way: in steep zone forest cover is 1.32 million ha (5.4 %) and in the Carpathian it is 2.08 million ha (36.7 %) accordingly. Forest of Carpathian region habitats a lot of endangered species, high biodiversity features Carpathian forests.

In the same time permanent bias toward harvesting forest over maintaining natural capital drives revenue-searching decision-makers to a destructive natural resource management despite high dependence of local community on such ecosystem services as a water supply and water regulation, absorption etc. The urgent and vital question is how to balance business and environmental interests in a market system being developed, how to make compatible meeting primary needs with achieving sustainable development standards.

The atelier brought together scientists and students from US, Sweden and Ukraine, forest experts and entrepreneurs, local community representatives and environmental NGOs for the sake to highlight challenges, obstacles and drivers toward implementing SFM in conditions of transition economy (http://enareco.narod.ru).

As usually the atelier deals with an ill-defined problem. Typology of problems to be solving in TCS is descried by Scholz et al (2006) and well illustrated in this paper. The guiding question in this case study was question of how Carpathion region could be transformed to a sustainable one to the most beneficial from society point of view development of natural, human, social and cultural capital. Indeed, only rough vision on transformations to be done and obstacles to be overcome during this process are available. Initial state of the system is not well described. Target state and consequently barriers are not known.

Epistemology of Atelier

Epistemological framework of TCS approach according to Scholz et al (2006) consists of normative and systemic spheres, which complement each other. Ateliers in this attitude do not differ significantly.

The guiding question of the atelier was formulated according to the normative concept of sustainable development and was revealed through stakeholders' perceptions, values and preferences. Systemic sphere involves such epistemics as understanding (the highest level of hierarchy), conceptualization and analysis (the lowest level of hierarchy). As Scholz et al show

(2006, pp. 234-235), all these "three systemic epistemics are strongly interrelated along the streams of decomposition (down-stream) and synthesis (up-stream)". The epistemological principle of Probabilistic Functionalism, coined by Brunswik (1950), developed by Hammond and Stewart (2001) and explained by Scholz et al (2006, p. 236-237), enables translation of basic epistemological reflections into relevant for particular case study methodology and provides in this way achieving appropriate solutions for problems, caused by human activity, subject to fuzzy inputs and targets.

Methodology

Conceptualizing methodology of the atelier approach we would like to note that all methods ateliers apply should be arranged into two groups: (1) general methods to be widely used in ateliers irrespective of a specific examined case study and guiding question and (2) specific methods determined by a specific context of the problem to be solved.

General methods, like problem decomposition, analysis, synthesis, brainstorming, communicating, web-based teaching, backward planning etc. are to be in common practice (Farley et al, 2005, Scholz et al, 2006). The most interesting and discussible is the second part. Usually this so-called 'hidden curriculum' consists of qualitative like deep interview, focus groups, questionnaire development, and quantitative techniques like statistic and valuation methods, forecasts, advanced computer-aimed techniques etc. Participants choose the most relevant methods for a specific case study and for facet in it.

The aforementioned atelier on ecological economics and SFM brought together scientists and students from US, Sweden and Ukraine, forest experts and entrepreneurs, local community representatives and environmental NGOs. Hence Gund Institute's expertise was complemented by IEE's and Faculty's of Forest Sciences, Swedish University of Agricultural Sciences skills and integrated with the local knowledge and ability. For instance services generated by local forests ecosystems are to be examined using relevant software, stakeholders' preferences regarding these services were identified by conceptual content cognitive mapping technique and examined by means of non-parametric statistic analysis (Zahvoyska, 2007), and changes in landscapes were traced from historical perspective using database and GIS.

Atelier Management

An atelier per se is an important and multifaceted scientific event and, naturally, it demands relevant managerial efforts. Usually web-based courses and an appropriate spadework help a lot to participants to use a precious field time in the most effective way. Main stages of the aforesaid atelier are illustrated by Figure 1.

Talking about aforementioned atelier in Ukrainian Carpathians it is worth to mention that all preparations were done by faculties and students of GIEE and IEE. This phase of the atelier development induces a lot of academic contacts both personal and institutional. Common search of relevant institutions and stuff, sources in periodical press and monographs, as well as in virtual space brought benefits for both sides and resulted in a huge volume of relevant publications. In the framework of this stage scientist panel "Ecological Economics and Conservation in Eastern Europe" in the framework of lecture cycle "Conservation in the 21st Century: A Challenge for Leadership was held by IEE scientists at GIEE (http://www.uvm.edu/conservationlectures/?Page=video_spring07.html).

Atelier realization demand some special skills from its manager to ensure suitable and acceptable field-trip logistics, efficient use of a precious field time, relevant data collecting, comprehensive interviewing and numerous and fruitful discussions with stakeholders.

Without any doubts we can say about an important role of the final stage. Accurate documentation, illustration and concluding home research will make an atelier constructive and creative. Dissemination of atelier participants' findings among all participants, stakeholders (especially out of academia) will bring a lot of benefits to community first of all. Variety of findings will be crystallized in papers, books, and conference proceedings. Usually closing conference to be held in few months brings to the final point of the study.

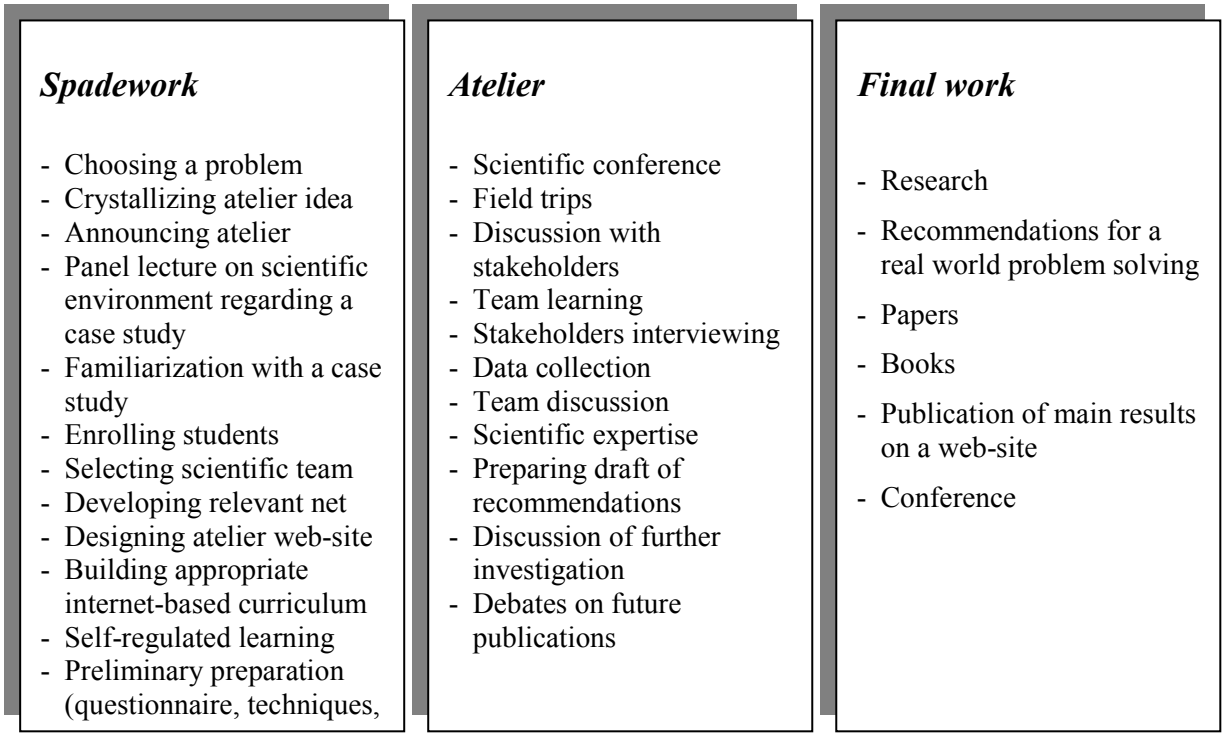

Figure 1. Atelier "Ecological Economics and SFM in the Ukrainian Carpathian" management scheme

Results

Ateliers as a form of TCS have a lot of outcomes. They can be organized in three groups: educational, scientific and social. Addressing the first group – educational benefits several items should be mentioned:

- Innovation form of sustainability teaching is pioneered /updated;
- Self-regulating sustainability learning is originated / improved;
- Cross-institutional knowledge exchange is facilitated;
- Sustainability capacity-building curriculum and didactics is enriched;
- A fruitful blend of academic lecturing, problem-based learning and internet-based education;
- Interdisciplinary and collaborative teaching model for mutual academia and society learning is designed and implemented.

Viewing ateliers' result from a scientific perspective we have to mention following:

- New approaches, tools and techniques usually accompany context-depended case study of specific phenomena caused by human activity in ecological-economic systems;
- Scientific knowledge are complemented by knowledge of a society, community and / or stakeholders;
- Strengthen relations between university education and science. It should be mentioned here that in former USSR a university education was decoupled from pure scientific research;

hence the question of establishing strong links among them takes special attention from the Ukrainian Ministry of Education and Science.

And indeed, the last but not the least – social benefits, the third pillar of the sustainable development:

- Communities involved in atelier development obtain a powerful surge of knowledge, ideas, scientifically-grounded recommendations toward implementing eco-innovations in business, professional and personal environment;
- Communities established links to academia;
- Creative and fruitful polylogue among stakeholders was originated;
- Students familiarized themselves with a real-world problem and community capacity-building methodology they will face throughout those future careers;
- Institutions and communities improved cross-cultural relations
- Feeling of own responsibility for sustainable development in a specific point on the Globe was born.

Discussion of ateliers' findings

This capacity-building methodology (both to students and to society/community) put new requirements for teachers and students. Teachers (tutors) become coaches, supervisors of the problem-solving process. They help students (first of all) to activate and to reveal own knowledge and capacity, to uncover approaches, techniques and methods to be self-studied by students and to communicate own results to other participants. Another interesting point to be mentioned here is a development by common efforts of students and tutors team-learning skills. That is why a well-prepared and familiarized with TCS methodology tutor could be considered as a key for a successful completing of the case study. Instead a tradition sender-receiver model of teaching a model of interactive problem-based mutual learning arises. Some features of this model are presented on the figure 2, which is a development of the idea by Stauffacher et al (2006).

Such experience is very useful for students. Besides knowledge they obtain skills of real-world problem solving under the framework of sustainable development. In the same time these invaluable feature of students' capacity is completed by skills of learning/working it teams. For tackling environmental challenges in cross-cultural multi-institutional and interdisciplinary environment such ability is crucial.

Such ateliers are useful to society as whole too. As we can see from our experience, bringing together all stakeholders and providing relevant consultations facilitates discussions and, consequently, mutual understanding results and catalyzes relevant changes.

Conclusion

Basic premises of evolving paradigm of post normal science are that investigated phenomena are evolutional, context- and values dependent and hence decisions are subjective and Illuminate, dialog and co-operative learning are essential. Under these conditions new style of behavior, decision-making and teaching is demanded. An atelier methodology as a advanced form of TCS approach to real-world problems solving is needed to help society as whole and to community in particular to tackle sustainability challenges. Indeed, such science-intensive decade, to be proposed by an atelier, which combined international conference, panel lectures and discussions, field trip and group work, brought a sharper insight of a real-world problem, improved existing model of problem-based interactive learning and enrich it through concrete examples of community capacity-building activity, induced a plenty of further research, papers and other inter- and transdisciplinary and cross-cultural exchanges. It helped local stakeholders to understand real character of existing

problems, possible scenarios and trends of their development, instruments and arrangements for dealing with such problems according to the sustainable development strategy.

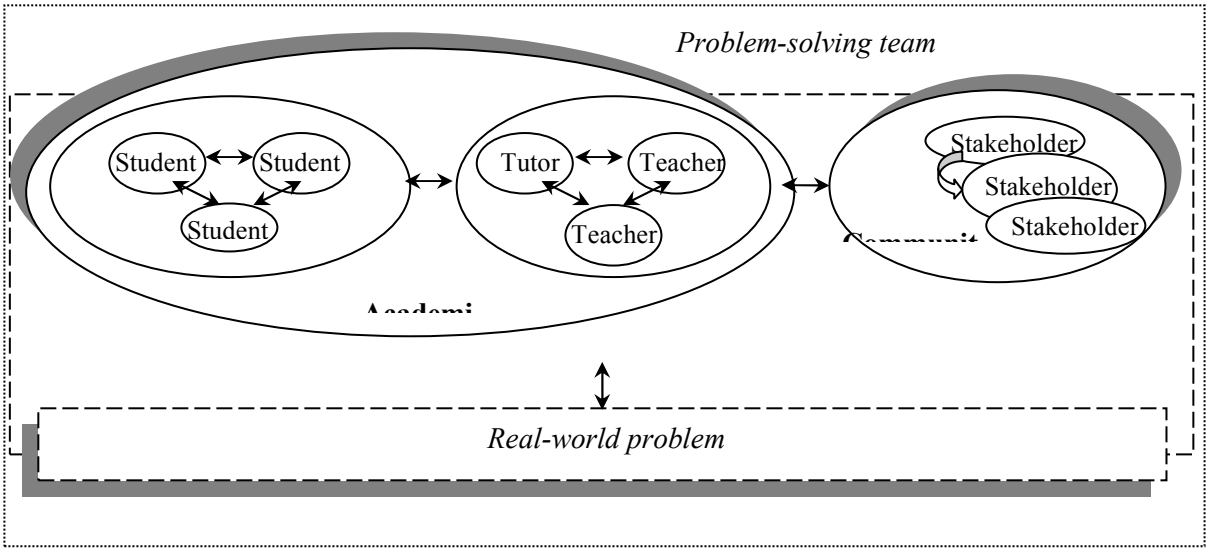

Figure 2. Model of interactive problem-based mutual learning

As we are convinced now ateliers as well as TCSs are essential part of education for sustainable development on the whole and in approaching SFM in particular. Weak links between practice and forest research could be mentioned as one of subjective limitations on the way of dissemination of new knowledge (Peyron, 1999). And considered practice of mutual learning, research and problem solving will catalyze transformations towards sustainable development in forest sector as well.

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2. *The trade-offs between different types of sustainability in Finnish forestry*

Vehkamäki, S. , Hanski, I. and Vierikko, K.[7]
University of Helsinki, Finland

Abstract

During the last decades the diversity of different types of sustainability in forestry has given rise to a lively scientific and political debate concerning the sustainability indicators in Finland. The purpose of this study is to demonstrate the possibilities and difficulties in compiling coherent economic, social and ecological sustainability indicators for forestry and the trade-offs between them. It is based on regional accounting and statistical data representing 39 LAU1-regions. The data includes 9.1 million hectares of forests with regional accounting and demographic data, data from the forest inventory for 1996-2003, population data for the flying squirrel for 2003–2004 and the timber harvesting data for 1995-2003.

The Cross-sectional Simultaneous Equations technique is the main approach used in tackling the problem. The Generalized Method of Moments is used for estimation. Pooled data models are used as auxiliary approaches to deepen the understanding of the behaviour of sustainability indicators and their trade-offs. The main results show that it is very difficult to draw unequivocal conclusions. However, it seems that economic and ecological values are contradictory and that the contribution of forestry to social sustainability in the form of employment is positively dependent on the economic ones. The employment effect is declining due to the increasing productivity of labour in forestry.

Keywords: economic sustainability, social sustainability, ecological sustainability, forestry, forest management, trade-off

Introduction

In addition to the traditional sustainability requirements of forest management, economic, ecological and social elements were introduced explicitly into the sustainability of forestry during the last decades. Basically, sustainability is made up of social norms and shared expectations of behaviour indicating what is desirable and appropriate in society. The Diversity of Sustainability concept in forestry has given rise to a lively scientific and political debate concerning its indicators and the trade-offs between them. The concept has two temporal dimensions: inter-generational and intra-generational. Intra-generational sustainability involves reconciliation of the present economic, social and ecological needs. To fulfil inter-generational sustainability implies that present forestry behaviour is commensurate with the anticipated needs of the coming generations.

[7] Contact information
Seppo Vehkamäki: seppo.vehkamaki@helsinki.fi, Department of Economics and Management, P.O. Box 27, FIN-00014 University of Helsinki
Ilpo Hanski: ilpo.hanski@helsinki.fi, Finnish Museum of Natural History, P.O. Box 17, FIN-00014 University of Helsinki
Kati Vierikko: kati.vierikko@helsinki.fi, Department of Biological and Environmental Sciences, P.O. Box 65, FIN-00014 University of Helsinki

Purpose of the study

The purpose of the study is to examine a set of economic, social and ecological sustainability indicators statistically and to consider possibilities and difficulties in drawing conclusions from trade-offs between different types of sustainability in Finnish forestry. The trade-off of sustainability is defined as a balance realised between two desirable but often incompatible features of forestry. The study is based on the ideas of a research report on the trade-offs between the socioeconomic and ecological variables (Vehkamäki, et al. 2006). The examination is done within the framework of conventional economic, social and ecological data. The data consist of both time-series and cross-section data. The formulation of the problem is illustrated diagrammatically in Fig. 1. Its axes form a three-dimensional value space in terms of the modern sustainability concept as a function of a forest utilisation indicator. The sustainability indicators, the axes of Fig 1, are operationalized as follows: *Forest utilisation indicator*: H = volume of timber harvesting per hectare; *Economic indicator*: V = gross value added of forestry per hectare; *Social indicator* L = employment of forestry per hectare; *Ecological indicator* B = relative density of flying squirrel population per hectare. The dependencies in the quadrants are represented at two levels of harvesting technology *i* and *ii*. The labels TO_I, TO_{II}, TO_{III} and TO_{IV} represent partial derivatives and trade-offs between the sustainability indicators.

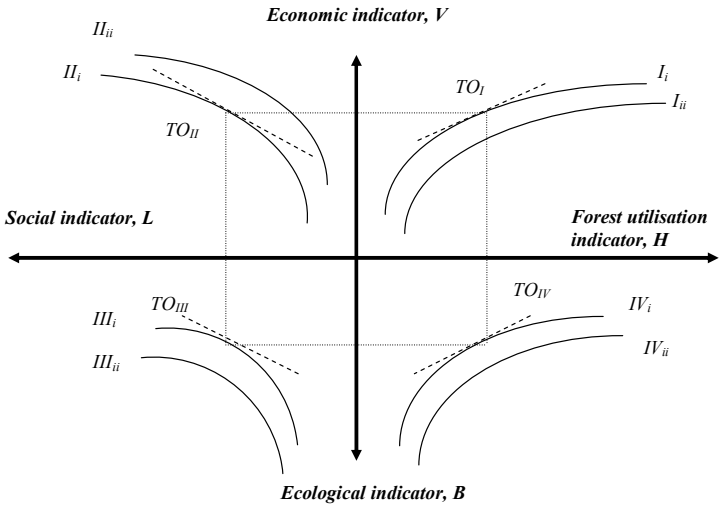


Fig.1. Illustration of the problem formulation

Data

The empirical data consist of regional accounting and demographic data, regional forest inventory and flying squirrel population data from the 39 regions LAU (Local Administrative Unit) 1-unit (European Commission 2008). The regions have 9,1 million
hectares of forest. The LAU 1-units make up a functional territorial division based on employment, commerce, traffic, public services, etc. The sample regions are presented in the appendix. The available data and variables for the study are presented in Table 1.

The data is imperfect in many respects. The territorial division is an important scale factor when sustainability requirements are considered; the smaller the observation unit is the less the probability that the sustainability requirements will be realised in a short-term study. Also, the compilation of regional accounting data is more difficult for small units than for large ones; e.g. identification and registration of commodity and service flows is more difficult for small units than for large ones. New market structures based on modern transport and communication technology make registration of flows diffuse, especially for small units. This means that e.g. it is not possible

to estimate inter-industry effects in terms of input-output analysis based on the LAU1-data. But on the other hand, in the case of larger units the relevance of ecological examinations would be lost. To identify the sustainability effects of economic, social and ecological phenomena is often difficult. Indicators have time-dependent variation due to price movements, technological and organisational development, internal population dynamics, etc. that is not possible to take into consideration in the study. Economic, social and ecological phenomena are often collinear and vary in the same way. In some cases, the availability of statistical data based on business transactions is restricted because of market competition reasons: the smaller the unit the more restricted the availability. As an ecological sustainability indicator the relative density of flying squirrel populations has its restrictions (Hurme, E, et al.).

Tab 1. Data and variables

Data and variables	**Time series/ Cross section**	**Source**	**Sample period**
Timber harvesting – Timber harvesting (*H*)	Time series, annual	Finnish Forest Industries Federation	1995 – 2003
Regional accounting (System of National Accounting) – Value added of forestry (*V*) – Percentage of forestry in the total gross value added (*For*) – Employment of forestry (*L*) Deflator index (*D*)	Time series, annual	Statistics Finland	1985 – 2005
Demographic data – Population (*Pop*)	Time series, annual	Statistics Finland	1985 – 2005
Forest inventory data – Mean growing stock volume (*Vol*) – Mean age (*Age*) – Tree species structure (as percentages in volume) o *Pine* o *Spruce* o *Birch* o *Other deciduous* – Forestry land structure o Total forestry land o Percentage of productive forest land (*Site*)	Cross section	Finnish Forest Research Institute	1996 – 2003
Flying squirrel population – Relative density of flying squirrel population (*FS*)	Cross section	Finnish Museum of Natural History, University of Helsinki	2003 – 2005

The graphs of the timber harvesting and sustainability indicator variables are presented in Appendix in Fig. 3-6.

The approach of the study is as follows: First, the trade-offs in quadrants I and II, based on time-series data, are analysed separately. Then the cross-section data and time-series data are joined together by taking proper averages from the time-series data. Finally, conclusions are drawn from the approach laying particular stress on the relevance of finding solutions in matters concerning sustainability trade-offs.

Trade-off models based on time-series data

The pooled data consist of 9 (years) x 39 (regions) observations for each variable. Timber harvesting behaviour is analysed as an aggregate (common) exogenous process in which μ_{HT} = autoregressive deviation, ε_{HT} = random error.

$$H_T = e^{\alpha_0} \cdot \mu_{HT}$$
$$\mu_{HT} = \mu_{HT-t}^{\rho_0^t} \cdot \varepsilon_{HT} \qquad (1)$$

It is operationalized as a second order autoregressive equation as follows:

$$\log(H_T) = \alpha_0 + [\rho_{01} = AR(1), \rho_{02} = AR(2)] + \varepsilon_{HT} \qquad (1')$$

The estimation results are presented in Table 2 (Eviews). At the aggregate level timber harvesting is a stationary process and its stationary point $e^{1,018} = 2{,}8$ m^3 per hectare can be interpreted to be the realised aggregate: sustainable timber harvesting.

Tab 2. Estimation results of $\log(H_T) = \alpha_0 + [\rho_{01} = AR(1), \rho_{02} = AR(2)] + \varepsilon_{HT}$ (1')
W = Weighted Statistics; U = Unweighted Statistics
t-values in brackets (coefficient significant t ≥2)

$\alpha_0 = 1{,}018[10{,}724]$
$\rho_{01} = 0{,}326[7{,}106]$
$\rho_{02} = 0{,}596[13{,}145]$
$R_W^2 = 0{,}95 \;\; Adj.R_W^2 = 0{,}95 \;\; D-W-stat. = 2{,}24$
$R_U^2 = 0{,}78 \;\; Adj.R_U^2 = 0{,}78 \;\; D-W-stat. = 2{,}19$

The trade-off models in quadrants I and II in the graph in Fig. 1, are presented as a recursive equation system

$$V_T = e^{\alpha_1} \cdot H_T^{\beta_1} \cdot \mu_{VT}$$
$$\mu_{VT} = \mu_{VT-t}^{\rho_1^t} \cdot \varepsilon_{VT} \qquad (2)$$

$$L_T = e^{\alpha_2} \cdot V_T^{\beta_2} \cdot \mu_{LT}$$
$$\mu_{LT} + \mu_{LT-t}^{\rho_2^t} \cdot \varepsilon_{LT} \qquad (3)$$

in which β_i are the trade-off coefficients. The gross value-added figures are converted into money value for the year 2005. On the right-hand side in (2), the first term represents the common constant for all observations and the second term the common or cross specific effects of timber production on the gross value added of forestry. The third term represents common or cross specific adjustment of the dependent variable on random events, price shocks, technological changes, etc. The parameters of (2 and 3) are solved from the following logarithmic first order autoregressive equations.

$$\log(V_T) = \alpha_1 + \beta_1 \cdot \log(H_T) + [\rho_1 = AR(1)] + \varepsilon_{VT} \qquad (2')$$
$$\log(L_T) = \alpha_2 + \beta_2 \cdot \log(V_T) + [\rho_2 = AR(1)] + \varepsilon_{LT} \qquad (3')$$

The trade-off coefficients β_i and $AR(1)$-coefficients ρ_i are estimated as common and cross section specific coefficients. The estimation results are presented in Tables 3 and 4. The cross section

specific coefficients are reported as histograms in Charts 1 – 4. There are 39 cross specific coefficients.

The results can be interpreted that the formation of the gross value added of forestry (2') has been exposed to time dependent variation during the period 1995 – 2003. There are 26 cross specific β_1-coefficients with t-values less than two and only 5 ρ_1-coefficients with t-values below two. The coefficients of timber production are also relatively low. On the other hand, all coefficients of (3') are significant. The value of production and the time dependent phenomena as technological change as well as the externalisation of functions from forestry have had an effect on labour in forestry.

Tab 3. Estimation results of $\log(V) = \alpha_1 + \beta_1 \cdot \log(H) + [\rho_1 = AR(1)]$ (2')

W = Weighted Statistics ; U = Unweighted Statistics

t-values in brackets (coefficient significant t ≥2)

$\alpha_1 = 4{,}83[114{,}2]$

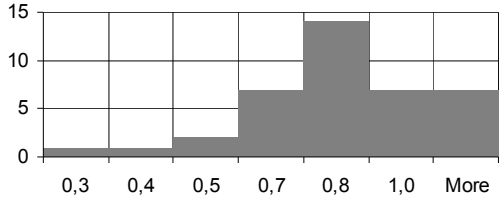
$\beta_1 = 0{,}27[7{,}9]$

$\rho_1 = \text{cross section specific, c.f. Chart 1}$

$R_W^2 = 0{,}997 \quad Adj.R_W^2 = 0{,}997 \quad D-W-stat. = 2{,}465$

$R_U^2 = 0{,}825 \quad Adj.R_W^2 = 0{,}799 \quad D-W-stat. = 2{,}411$

Chart 1



ρ1

Average 0,76; 5 t-values < 2

$\alpha_1 = 4{,}88[121{,}0]$

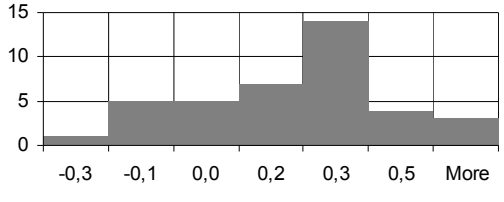
$\beta_1 = \text{cross section specific, c.f. Chart 2}$

$\rho_1 = 0{,}70[19{,}6]$

$R_W^2 = 0{,}997 \quad Adj.R_W^2 = 0{,}997 \quad D-W-stat. = 2{,}356$

$R_U^2 = 0{,}832 \quad Adj.R_W^2 = 0{,}807 \quad D-W-stat. = 2{,}287$

Chart 2



β1

Average 0,18; 26 t-values < 2

Tab 4. Estimation results of $\log(L) = \alpha_2 + \beta_2 \cdot \log(V) + [\rho_2 = AR(1)]$ (3')

W = Weighted Statistics; U = Unweighted Statistics

t-values in brackets (coefficient significant t ≥2)

$\alpha_2 = -2{,}44[-16{,}9]$

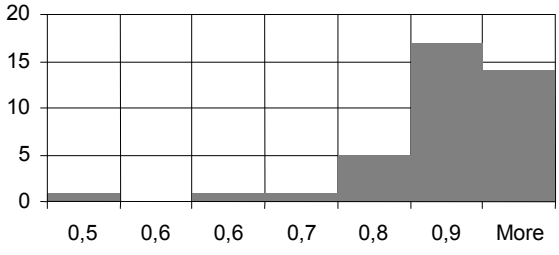
$\beta_2 = 0{,}51[17{,}2]$

$\rho_2 = \text{cross section specific, c.f. Chart 3}$

$R_W^2 = 0{,}906 \quad Adj.R_W^2 = 0{,}901 \quad D-W-stat. = 2{,}265$

$R_U^2 = 0{,}892 \quad Adj.R_W^2 = 0{,}886 \quad D-W-stat. = 2{,}276$

Chart 3



ρ2

Average 0,83; no t-values <2

Tab 4. cont. Estimation results of $\log(L) = \alpha_2 + \beta_2 \cdot \log(V) + [\rho_2 = AR(1)]$ (3')

W = Weighted Statistics; U = Unweighted Statistics

t-values in brackets (coefficient significant t ≥2)

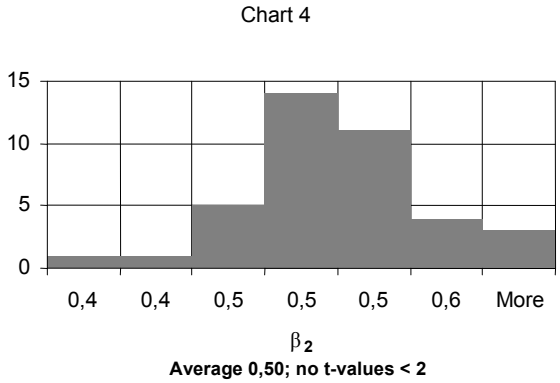
$\alpha_2 = -2{,}38[-15{,}3]$

$\beta_2 =$ cross section specific, c.f. Chart 4

$\varepsilon_2 = 0{,}84[47{,}0]$

$R_W^2 = 0{,}909 \quad Adj.R_W^2 = 0{,}94 \quad D-W-stat. = 2{,}310$

$R_U^2 = 0{,}895 \quad Adj.R_W^2 = 0{,}889 \quad D-W-stat. = 2{,}343$



Trade-offs based on the cross-section model

The starting point for the cross-section model is the equation system with three endogenous indicator variables:

$$\overline{V} = f_V\left(\overline{L}, F\overline{S}, H, Vol, Pop, For, Site, Age, Tree\_species\right) \quad (4.1)$$

$$\overline{L} = f_L\left(\overline{V}, F\overline{S}, H, Vol,, Pop, For, Site, Age, Tree\_species\right) \quad (4.2) \qquad (4)$$

$$F\overline{S} = f_{FS}\left(\overline{V}, \overline{L}, H, Vol, Pop, For, Site, Age, Tree\_species\right) \quad (4.3)$$

in which the relationships between the endogenous variables form the actual trade-offs.

In order to simplify the analysis the dimensions of the tree species structure are reduced by means of a factor analysis (Statgraphics). In the forest inventories four tree species are reported in the sample regions: pine, spruce, birch, and other deciduous tree species. The structure is presented as percentages of the total volume of the growing stock. The varimax-rotated factor matrix is presented in Tab. 5. Its graphical illustration is presented in Fig. 7 of the appendix. The first extracted factor is named *Others*. It indicates that the percentage of pine is negatively correlated with the percentage of spruce and other deciduous tree species. The percentage of birch forms the second factor *Birch* and is independent of the first factor. The analysis explains about 88 percent of the total variability, and 0,72 – 0,96 percent of the variability by tree species. For the above reasons, the factor scores of *Others* (Factor 1) and *Birch* (Factor 2) are used as variables for tree species.

Tab 5. Varimax-rotated factor matrix of tree species structure

Tree species	Factor 1	Factor 2	Comm.
log (*Pine*)	**-0,96**	0,02	0,92
log (*Spruce*)	**0,92**	-0,29	0,93
log (*Birch*)	-0,01	**0,98**	0,96
log (*Other deciduous*)	**0,82**	0,21	0,72
Percent of variance	61,40	27,04	
Explained of total variance	88,44		

In order to make sure of the mutual relationships between the exogenous variables *H, Vol, Pop, Site* and *For,* their collinearity is tested by means of a factor analysis. Its factor matrix is presented in Tab. 6 (illustrated graphically in the appendix in Fig. 8). It shows that both the population and forestry variables are linearly dependent, where the population increases the

importance of forestry decreases. This dimension is independent of the second factor dimension that is determined by highly collinear forest variables *H, Vol* and *Site*.

Tab 6. Varimax-rotated factor matrix of land structure variables

Variables			Comm.
	Factor 1	Factor 2	
log (*H*)	**0,89**	0,23	0,85
log (*Vol*)	**0,96**	0,08	0,92
log (*Site*)	**0,95**	-0,12	0,91
log (*For*)	0,05	**-0,98**	0,97
log (*Pop*)	0,18	**0,97**	0,97
Percent of variance	55,00	37,30	
Explained of total variance	92,30		

The trade-off model is estimated by means of Generalized Methods of Moments (Eviews). It is a robust estimator unlike maximum likelihood estimation, because it does not require information of the exact distributions of the disturbances. By testing different combinations of variables the following system of equations (4') proves to fulfil best the interpretational and statistical requirements.

$$\overline{V} = e^{-0,08[-0,1]} \cdot Vol^{1,072[6,6]} \cdot Birch^{-0,05[-2,3]} \qquad (4.1')$$
$$R^2 = 0,46 \quad Adj.R^2 = 0,42$$

$$\overline{L} = e^{-4,35[-13,3]} \cdot V^{0,83[13,86]} \cdot Pop^{0,14[4,4]} \qquad (4.2') \qquad (4')$$
$$R^2 = 0,80 \quad Adj.R^2 = 0,79$$

$$F\overline{S} = e^{-22,58[-6,3]} \cdot Age^{6,21[7,0]} \cdot Others^{0,10[3,1]} \qquad (4.3')$$
$$R^2 = 0,51 \quad Adj.R^2 = 0,48$$

Correlation matrix of residuals

	$\log(\overline{V})$	$\log(\overline{L})$
$\log(\overline{V})$		
$\log(\overline{L})$	0,12	
$\log(F\overline{S})$	0,17	0,05

(5)

The estimation results show that the original interdependent equation system breaks down into a recursive system of single-equations. The sustainability indicators are dependent on structural exogenous variables, and they could be solved separately. The sustainability indicators represent some kind of rationality of forestry based on structural characteristics of the forests and realisation of action based on communication (c.f. Sitton, 43-59). (Ministry of Agriculture and Forestry; Ministry of Agriculture and Forestry & Ministry of the Environment) The matrix (5) shows the correlation matrix residuals. All correlations are close to zero.

The first equation (4.1') reveals that the gross value added of forestry is dependent on the mean volume of growing stock and on the percentage of birch. Also the mean timber production gives a reasonable regression coefficient (0,67 [5,84]) but the value of R^2 is significantly weaker. Compared to the pooled data estimation the coefficients of timber production are much higher (c.f.

Tab 3). The gross value added of forestry has apparently been so much dependent on factors other than timber harvesting that it can be taken into consideration only in the time-series estimation within the framework of this study.

The second equation (4.2') depicts the labour demand in forestry. Its results are comparable to the dynamic analysis of Tab. 4 but the effect of the gross value added of forestry on employment is more moderate. In the most populated, also, the most economically developed regions, forestry needs more labour than in the less developed regions. The reasons are the low productivity of forestry due to the small size of forest estates and perhaps the tighter competition for labour in society.

The third equation (4.3') represents the relative density of the flying squirrel populations. It depends on the mean age of the forests and tree species structure. The flying squirrel seems to favour forests having spruce and other deciduous species as dominant species. The most dense flying squirrel populations are in the uplifted regions on the coast and in the regions that border them. There are old forests, and traces of the pre-industrial utilisation of forests are noticeable. If it is supposed that older forests mean smaller timber production, an indirect conclusion is that ecological and economic values are or may be contradictory in this framework.

Conclusions

The purpose of this study was to consider and demonstrate possibilities and difficulties drawing conclusions about trade-offs between different types of sustainability in Finnish forestry. Demonstratively, the number of variables is minimal. The first conclusion is that it is a difficult task to identify the effects between different sustainability indicators and to derive unequivocal trade-offs. It is relatively easy to derive trade-off indicators between production-based sustainability indicators as gross value added and employment. It seems that Finnish forestry fragments into three seemingly separate value spheres: economic, ecological and social. Indirectly, these value spheres are in communicative connection with each other through the structural factors of forestry. It seems that the economic values are in contradiction to the ecological ones, and that the contribution of forestry to social sustainability in the form of employment is positively dependent on economic values. But the time path of the employment effect is declining due to the increasing productivity of labour and institutional changes in forestry.

The relevant empirical data are the crucial data for estimating sustainability indicators and their trade-offs. The theoretical knowledge, i.e. the ability to choose the right indicators, is a fundamental cornerstone. For example, it is problematic to choose the right ecological variables. It is important to find a balance between the number of sample regions and variables because in this kind of statistical study the degree of freedom can be a problem. Long historical series could help analysis but it is difficult to find a long compatible series. Autocorrelation and collinearity can cause problems in very simple problem formulations. Even the content of production data changes with time due to technological and institutional changes. The quantitative considerations are always partial in respect of time, place, other phenomena, etc. The best that this kind of study can give is to offer guidelines and information to the communicative and political treatment of trade-off problems in forestry.

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Data sources

Finnish Forest Industries Federation

Finnish Forest Research Institute

Finnish Museum of Natural History, University of Helsinki

Statistics Finland. Regional accounting. www.tilastokeskus.fi [17.8.2007]

Appendix

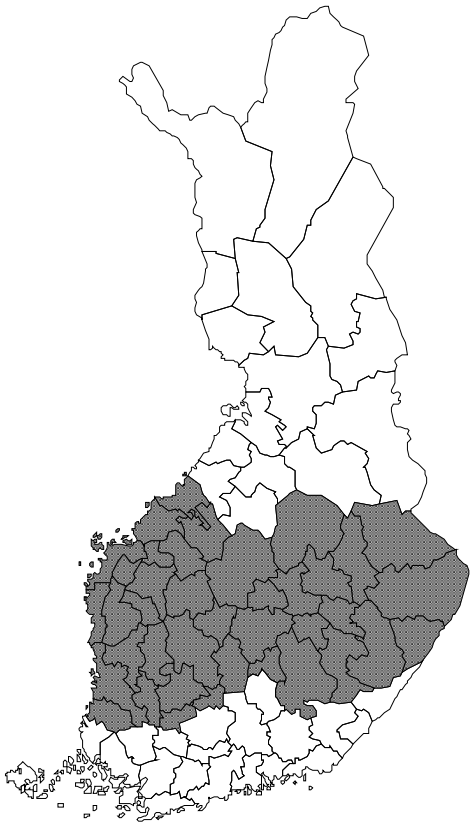

Fig. 2. Sample regions in the study

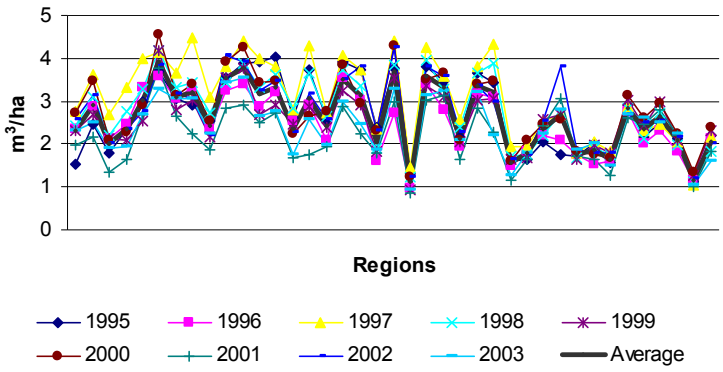

Fig. 3. Timber harvesting per hectare

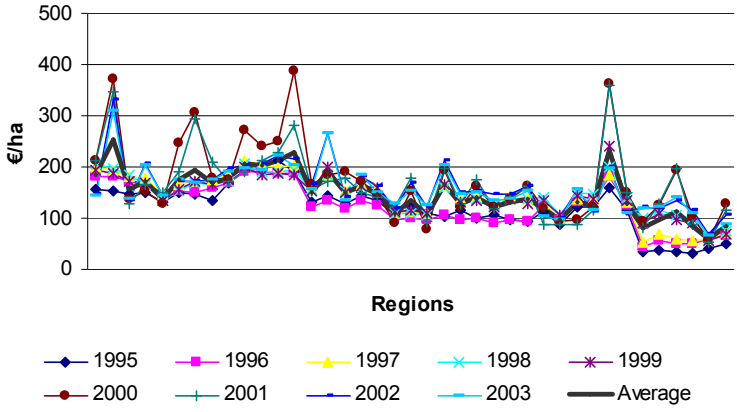

Fig.4. Value added of forestry

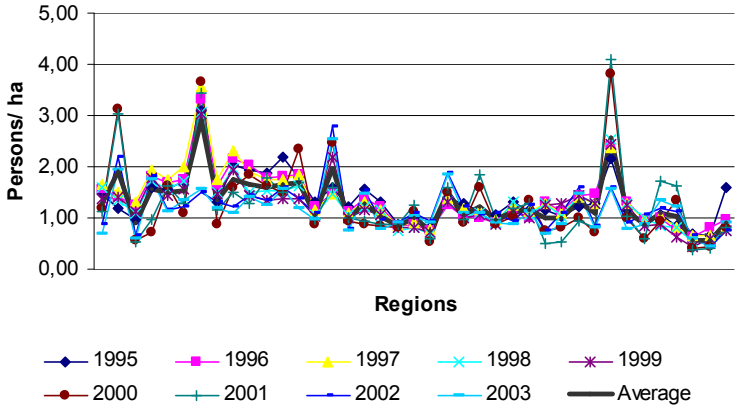

Fig.5. Employment in forestry

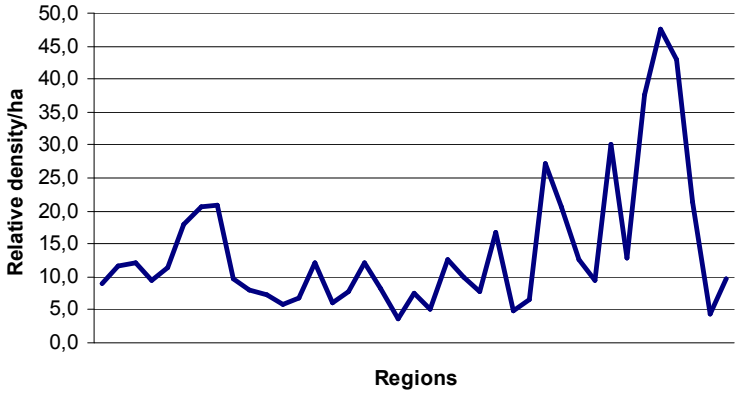

Fig.6. Relative density of flying squirrel populations

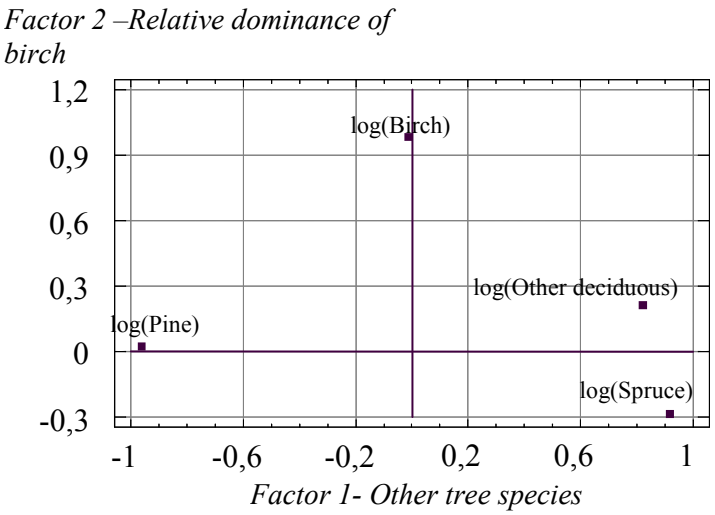

Fig.7.Graphical illustration of the varimax-rotated factor matrix of tree species structure (Tab. 5)

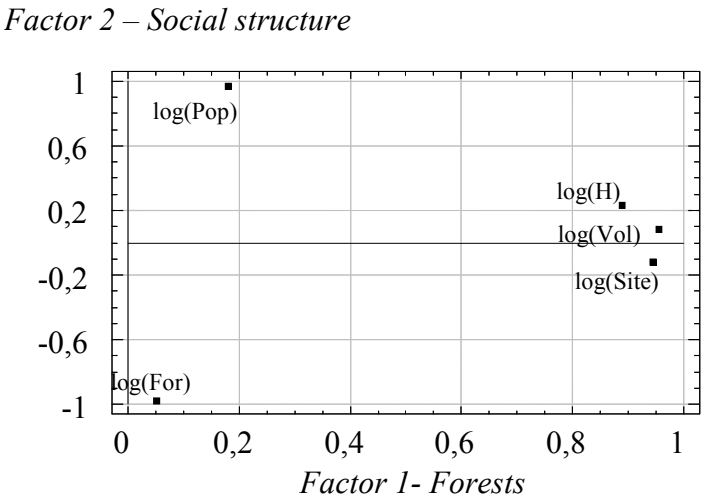

Fig.8.Graphical illustration of the varimax-rotated factor matrix of structural variables (Tab. 6)

3. Model for estimation of flat sum income from forestry on family farms in Slovenia

Andrej Udovč
University of Ljubljana - Biotechnical Faculty, Jamnikarjeva 101. SI-1000 Ljubljana, **Slovenia**
tel: +386 1 423 1161, fax: +386 1 423 1088

Dragan Matijašić
Slovenia forestry service, Večna pot 2, SI-1000 Ljubljana, **Slovenia**

Abstract
For the needs of developing a new methodology for income estimation on Slovenian family farms separate models were developed for agricultural production based income estimations and forestry production based income estimations. For the estimation of incomes from forestry production the model only the information collected by public institutions are used. This are on information on natural characteristics of forest land (pedological characteristics, inclination, altitude) which are expressed with the system of bonita points, production potential of the forests (structure of trees varieties, age of trees), harvesting conditions, average timber stock and market prices. Income calculation is performed with the use of deterministic production economic model and results are in the first iteration calculated for individual land units (parcel) and then in the next phase summed together with the calculations for the agricultural production to the whole farm income.
In the proposed paper we intend to present the structure of the developed model and an example of the income calculation procedure.

Keywords: model, family farms, income estimation, agriculture, forestry

Contact: Andrej Udovč, email: andrej.udovc@bf.uni-lj.si

4. Economic consequences of storm and other natural disasters to forest companies

Tzschupke Wolfgang
University of Applied Forest Sciences Rottenburg am Neckar, Schadenweilerhof, D 72108 Rottenburg, **Germany**
Tel. ++49 7472 951 250 or ++49 171 703 4308, Fax. ++49 7472 951 200

Abstract
As a consequence of the ongoing climate change forest owners are more often than ever confronted with severe hurricanes causing manifold considerable damage. As a rule this damage is only partly economically evaluated and balanced – at least in Germany. Whereas a fall in prices is always immediately realized, other economic damages are often ignored or underestimated. Therefore the short and long term effects of such disasters on the returns and the assets will be evaluated based on empirical data from a few selected German forest-units.

Thus it can be shown that the medium- and long-term-effects on returns and assets can be significantly more severe than the short-term losses caused by the temporary fall in prices.

Keywords: forest companies, climate change, economic evaluation, prices

1. Introduction

Natural disasters provoke in general very serious consequences for the concerned forest-owners. Such disasters can be caused by several reasons:

- Infestations by insects, e.g. by bark-beetles,
- Infestations by fungi or other organisms,
- Forest fires,
- Snow- and,
- Ice-damage and
- Hurricanes.

Of course each of the listed events can have serious economic consequences for the forest-owners concerned. On the regional or national level however hurricanes are generally of greatest significance as is clearly indicated by the amount of timber thrown and damaged by storms within the last decades (s. table 1).

Table 1: Volume of timber thrown by the last three greater storm-disasters in Central Europe

Hurricane	German blowdowns	European blowdowns
„Kyrill“, 2007	**25 bis 27 Mio. m³**	**50 bis 60 Mio. m³**
„Lothar“, „Martin“ u.a. 1999/2000	**ca. 35 Mio. m³**	**ca. 190 Mio. m³**
“Vivian” u. “Wiebke”, 1990	**72 Mio. m³**	**103 Mio. Fm m³**

With respect to the economic consequences the Baden-Wurttemberg-forestry-research-station estimated that after “Lothar” in 1999/2000 the overall financial damages for all forest-owners affected within the state of Baden-Wurttemberg were more than one billion Euros. This sum was however only based on the short-term loss of income and additional harvesting costs.

One billion € corresponds to between 30 and 50% of the normal annual turnover of the whole of Germany's forestry. However this impressive sum represents only a part of the total damages caused, in particular because of the omission of the long-term reduction in the value of the forest-assets.

Based on some empirical data I will therefore try to describe and value – as far as possible - all the short- and long-term economic consequences of storm-damage and analogous disasters.

2. Economic consequences of storm-blowdowns

When we discuss the effects of hurricanes on the assets of forest-companies it is necessary to distinguish between direct and indirect damages[8]:

1. **Direct effects** of storm and other disasters can result from
   - Reduction of timber-stocks,
   - Disturbance of the structure of age-classes,
   - Additional delayed damages e.g. by bark-beetles,
   - Possible damages to existing understorey or natural regeneration,
   - Damages to forest-roads and other forestial facilities,

2. **Indirect effects** of storm to the annual operating account can arise from
   - Sales of premature timber („Hiebsunreifeverluste),
   - Losses because of decline in timber-prices,
   - Losses because of compulsory harvesting of timber-sorts with unsufficient prices,
   - Increased volume of timber remaining on the terrain, („DS-Holz")
   - Quantitative losses due to broken and splintered timber,
   - Deterioration of timber-quality,
   - Increased harvesting costs,
   - Possible additional costs for the storage of blowdowns and therefore additional capital-fixing costs
   - Increased replantation-costs,
   - Repair-costs for destroyed or damaged facilities and – above all -
   - Mid- or long-term reduction of the annual operating result because of the reduction of the sustainable cutting-rate.

However, the practical relevance of the effects of heavy hurricanes listed above depends of course on the individual conditions in the forests concerned and the respective situation in the timber-market.

2.1 Direct effects of severe hurricanes on the assets of a forest-unit

Greater calamities, above all large-scale windthrows, are nearly always linked with a significant loss of stumpage-values. However these losses usually remain unvalued as in Germany it is not necessary to include the value of stands and soils in the balance-sheet.

This is also the reason why we have no legal or commonly accepted regulations for the valuation of stands in Germany[9]. In spite of this I would like to present the results of some approximate calculations giving an indication of the extent of losses in the asset-values of selected forest-units in

[8] s. HOLTHAUSEN, N., 2006, S. 5ff.
[9] s. TZSCHUPKE, 2008

the Northern Black-Forest - a region which was seriously affected by hurricane "Lothar" on the 26th of December 1999.

For these calculations I have used three different approaches: The first approach is based on the decrease of standing timber-volume and the sort-related contribution-margins; the second estimates the loss of assets according to the German Federal valuation-rules (WaldR2000) which are based on the age-related market-values of the main-species; and finally the third approach is based on the expected future reduction in net returns (net present-value method).

The first unit investigated is a small municipal forest dominated by Norway-spruce and Silver-Fir in mostly even-aged stands. During Hurricane "Lothar" this 379 ha-forest lost 75.600 m³ or approx. 200 m³ per hectare within a few minutes - this was nearly half of its former stumpage.

As revealed by figures 1 and 2 „Lothar" did not only damage the older stands but also the young 21 to 40 year old stands of age-class II and even the selection-forests were severely damaged.

The second object of this investigation is the much larger state-owned forest of the former Pfalzgrafenweiler forest-district with nearly 4.000 ha. In this case "Lothar" caused blowdowns of 565.000 m³ or 142 m³ per hectare. This forest-unit was also and remains dominated by Norway-spruce and Silver fir but with a greater percentage of uneven-aged stands. With the natural conditions being similar to the small municipal forest it is not surprising that figure 3 shows a similar damage characteristic as figures 1 and 2.

The unexpected increase in surviving old-stands with more than 140 years can easily be accounted for: This increase is the result of the aging of the remaining part of the former 130 to 140 year old stands.

As the three figures show it is clear that the heaviest damage occurred within the 80 to 120 years old stands, i.e. in stands which normally allow intensive thinning with optimally renumerated sort-classes. It is therefore obvious that the losses of a large part of these stands are very likely to handicap the future cutting-rates and its composition of sort-classes.

In the long-term however the future exploitation-possibilities will not only be influenced by the alteration of the age-classes but also by the decrease in the percentage of Norway-spruce and the increase in broadleaved-trees (s. table 2 and 3).

Table. 2: Change of total timber-stock and stock-shares of the most important species

	Municipal Forest		State Forest District Pfalzgrafenweiler	
	1992	2003	1992	2003
Volume per ha	494 m³	250 m³	497 m³	269 m³
percentage of Norway-Spruce		72%	76%	64%
Percentage of Silver Fir		15%	18%	24%
Percentage of other species (deciduous-trees)		13%	6%	12%

Table 3: Change of the share of area of the most important species (without stands younger than 20 years)

	Municipal Forest		State Forest District Pfalzgrafenweiler	
	1992	2003	1992	2003
Norway-Spruce	71%	65%	68%	58%
Silver Fir	14%	18%	19%	24%
Scotch Pine	10%	9%	5%	6%
Other Coniferous	1%	1%	0%	2%
Deciduous trees	3%	8%	7%	10%

Already these few figures and in particular the loss of 46 and 49% of the standing timber-volume indicate the dramatic consequences of this one natural disaster.

The total depreciation of the stand-values based on the decrease in standing volume and a cautiously assumed average future net contribution margin of 25 € for all sort-classes amounts to

- 4.800 € per hectare or 1,8 Mio.€ in total for the small municipal forest and
- 4.550 € per hectare or 18 Mio.€ in total for the state forest district.

The calculation according to the German Federal valuation-rules (WaldR2000) reaches a similar conclusion for the larger state-forest-direct with 18,2 € Mio. For the smaller municipal forest however, this approach indicates a much higher depreciation with 3,3 Mio.€. This difference can easily be explained by the increase in percentage of regenerated surfaces, which is less extreme in the state-forest.

A third method of estimating the change in value of forest-assets is based on the net returns (i.e. the net present-value method). In the case of the investigated forest-units it was necessary to compare the expected future net present-values after “Lothar” with the expected net present-values before.

This approach however is handicapped by two severe problems: First – nobody is able to foresee the development of the future earnings for the next 50 or even 100 years. The second problem is the choice of an adequate interest rate for the capitalization of the future earnings. For my calculation I ignored these problems by supposing a permanent equal annual earning and by calculating one variation with an interest rate of 4% and another variation with 1,5%. This last interest rate corresponds to the actual profitability of well managed German forest-companies.

Based on these assumptions the net-present-values are reduced by a margin of between 1.200 € and 6.600 € per hectare depending on the reduction of the cutting-rates and the interest rate applied (s. table 4).

Table 4: Change of net-present-values after „Lothar“

	State Forest District Pfalzgrafenweiler		Municipal Forest	
	1992	2003	1992	2003
Cutting rate per hectare	10,2	8,6	9,9	6,6
Net profit per m³	30 €	30 €	30 €	30 €
Net Profit per hectare	306 €	258 €	297 €	198 €
Net-present-value with 4%	7.650 €	6.450 €	7.425 €	4.950 €
Net-present-value with 1,5%	20.400 €	17.200 €	19.800 €	13.200 €
Reduction of value per hectare with 4%		-1.200 €		-2.475 €
Total reduction of value with 4%		-4.755.600 €		-938.025 €
Reduction of value per hectare with 1,5%		-3.200 €		-6.600 €
Total reduction of value with 1,5%		-12.681.600 €		-2.501.400 €

As expected the calculated damages differ more or less according to the approaches used. Especially the net-present-value when calculated with an interest-rate of 4% was significantly lower than the other results. Thus the commonly known fact that no true and objective values exist is confirmed yet again. Taking this knowledge into consideration the average amount of wind-thrown losses amounts to 15 Mio. € in the case of the state-forest-district and 2,5 Mio. € in the case of the smaller municipal forest (s. table 5).

Table 5: Synopsis of the different damages calculated with the different approaches

	State Forest District Pfalzgrafenweiler	Municipal Forest
Loss of market-value of timber-stocks	18.031.650 €	1.834.880 €
Loss of age-related values according to WaldR2000	18.217.026 €	3.377.440 €
Loss of net-present-value with 4%	4.755.600 €	938.025 €
Loss of net-present-value with 1,5%	12.681.600 €	2.501.400 €
Estimated average loss	15.000.000 €	2.500.000 €

2.2 Indirect effects of storm-disasters on the operating-profit of forest-companies

Although the reduction in the value of forest-assets after a severe storm-disaster is of significant importance in the long-term, forest-owners are generally more concerned by the indirect effects on the operating-profit, which are almost always reduced and which often even turn into losses.

This effect can be impressively demonstrated by statistical data (s. figure 4 and 5). The main reason for the reduction of the annual operating results is a mostly severe drop in timber-prices. Within two years after “Lothar” and also after “Vivian and Wiebke” timber-prices were reduced to 50% of the price level before these events. Additionally the bark-beetle gradation which occurs over the three or four years directly preceding larger-scale blow downs and which is impossible to prevent results in the continuing degradation of prices for some further years.

Besides this general price-decrease, additional effects may also reduce the operating net-results. In particular an increase in the amount of sort-classes with reduced quality (class C and D) as well as the share of unprocessed timber that remains in the stands (s. table 6)[10] [11].

Table 6: Effects of storm „Lothar“ to the sort-structure of the harvested timber und the sales prices of a state-forest-district in the Black Forest

Reduction of the sales prices 2000/2001 compared to 1999	30,16 € per m³= 44,7%
Reduction of percentage of timber	1992 – 1999 = i.D. 98%; 2000 – 2001 = 72%
Reduction of sort-class B of spruce and silver fir	1992 – 1999 = i.D. 82%; 2000 – 2001 = 57%
Increase of percentage of not processed timber	1992 – 1999 = i.D. 4%; 2000 – 2001 = 11 %

However even with the afore-mentioned factors the list of possible consequences of storm-disasters for the annual accounts is not yet complete: In some cases the facilities and infrastructure of forest-enterprises, e.g. buildings, forest-roads, fences etc. may also be damaged or even destroyed.

As the amount of harvested and transported timber is far above average, forest-roads are worn out much faster. After all, the costs for the road-repair may increase by more than 50% compared to normal years.

On the other hand harvesting-costs decrease in general within the first months of the utilization of wind blows. However as soon as the larger areas have been cleared and the utilization of smaller areas or even individual trees begins, the costs increase significantly again. Such was the case in another investigated state-forest-unit in the northern Black-Forest where harvesting-costs decreased in the first year after “Lothar” from 25 to nearly 20 € per cbm, but only one year later increased to 37 € per cbm.

In the following years forest-owners further have to finance expenditures of greater or lesser importance: for plantations as well as for the protection of the regenerated areas and still later for the weeding and tending of the stands.

The economic effects of storm-disasters described above will normally be over within a few years – mainly depending on the recovery of the timber-market.

The loss of stumpage however may cause economic detriments for a much longer period. If the loss of standing timber exceeds more than 20 or 30%, then a reduction in the annual cutting-rate is unavoidable. It is if course possible to maintain the normal cutting-rate for a period of time if there are enough remaining mature stands or stands ready for thinning[12]. Sooner or later however the disturbed distribution of age-classes (s. fig. 1 to 3) will force a reduction in the cutting-rate and – beyond that – the structure of sort-classes will shift to smaller, less profitable dimensions.

Incidentally it has to be remembered that the effects of a reduced cutting-rate to the annual operating-result depend on the size and the cost-structure of the forest-unit in question. The expectation that a reduction in the selling prices of x% may also induce a reduction in the net-result of x% is only justified in those cases where the forest-unit has no fixed-costs. Larger forest-units

[10] SCHMIDT, A., 2003
[11] s. MELR BW, 2004, S. 389 ff.
[12] s. TZSCHUPKE, W., 2005

which have their own personnel and other sources of fixed costs however must be aware that even minor reductions in selling prices can soon provoke larger deficits – as shown clearly in the following calculated models.

1.) Smaller forest-unit:

- 25 ha, fixed costs can be ignored,
- cutting-rate before storm = 8 cbm/year/ha;
- operating result before storm = 40 €/cbm = 320 €/year/ha = 8.000 €/year (total)
- cutting-rate after storm = 5 cbm/year/ha
- **operating result after storm = 40 €/cbm = 200 €/year/ha = 5.000 €/year**
- deterioration of the net-result therefore = 3.000 €/year

2.) Greater forest-unit:

- 500 ha, fixed costs = 200 €/year/ha = total 100.000 €/year
- cutting-rate before storm = 8 cbm/year/ha;
- operating result before storm = 15 €/cbm (40 € - 25 € fixed costs) = 120 €/year/ha = total 60.000 €/year
- cutting-rate after storm = 5 cbm/year/ha
- contribution margin (selling price – harvesting costs) before and after storm = 40 €/cbm
- **operating result after storm = 0 €/cbm = total 0 €/year**
- deterioration of the net-result therefore = 60.000 €/year

3. Final remarks

I intended to prove that forestrial disasters as caused by the most recent hurricanes may indeed have very important economic consequences for the forest-units concerned. However as our experience shows it is not only those forest-owners that are directly affected by a hurricane that have to bear more or less considerable financial losses but, as a result of market-disturbances also those forest-owners whose forests are not directly hit by the storm. Insofar severe storms may also be of regional or even national economic importance.

With respect to the ongoing climate change and the predicted increase in frequency of severe hurricanes every forest-owner should check whether his stands and his management-objectives and –principles are optimally prepared for these future challenges.

4. Literature

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Figure 1: Change in % of the age-classes of the investigated municipal forest 2003 compared to 1993

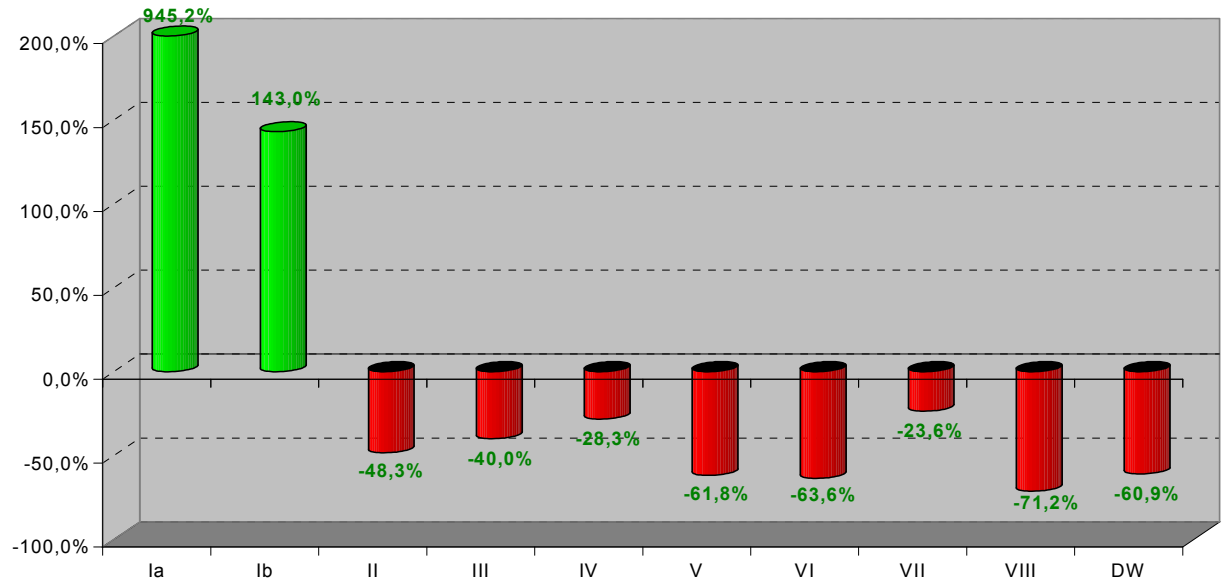


Figure 2: Change in ha of the age-classes of the investigated municipal forest 2003 compared to 1992

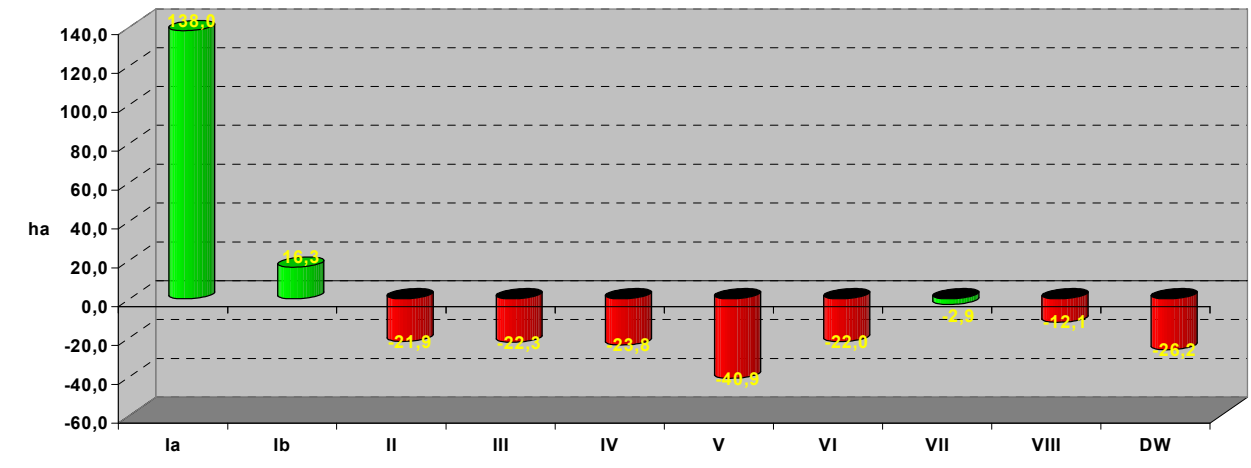


Figure 3a: Change in ha of the age-classes of the investigated state-owned forest-district 2003 compared to 1992

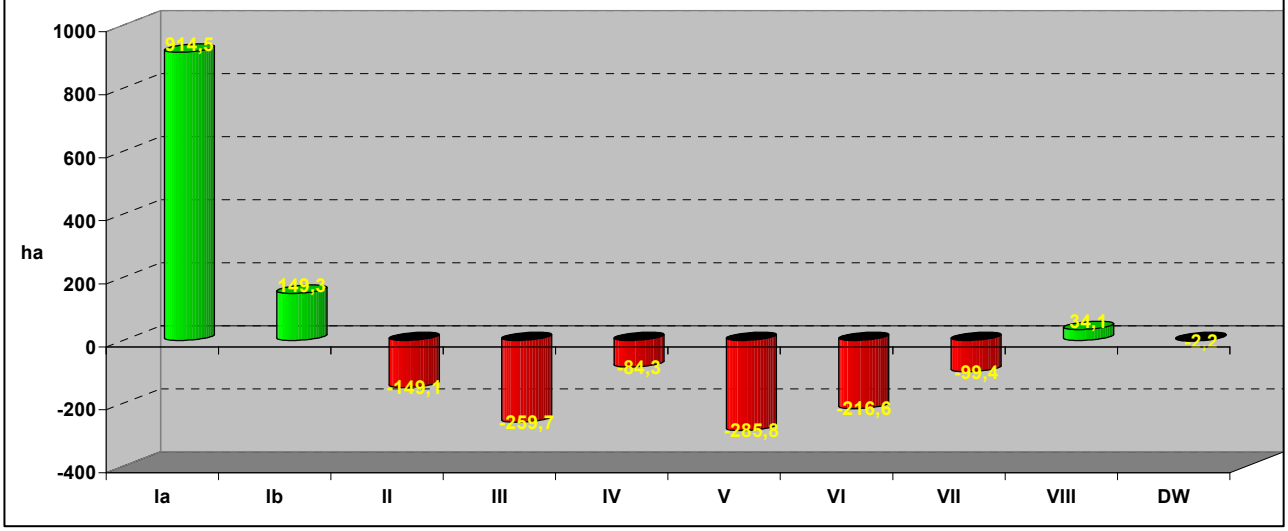


Figure 4: Development of the annual net-results of private forest-companies in Baden-Württemberg (> 200 ha) compared to the cutting-rates

(Datensource: FVA-TBN)

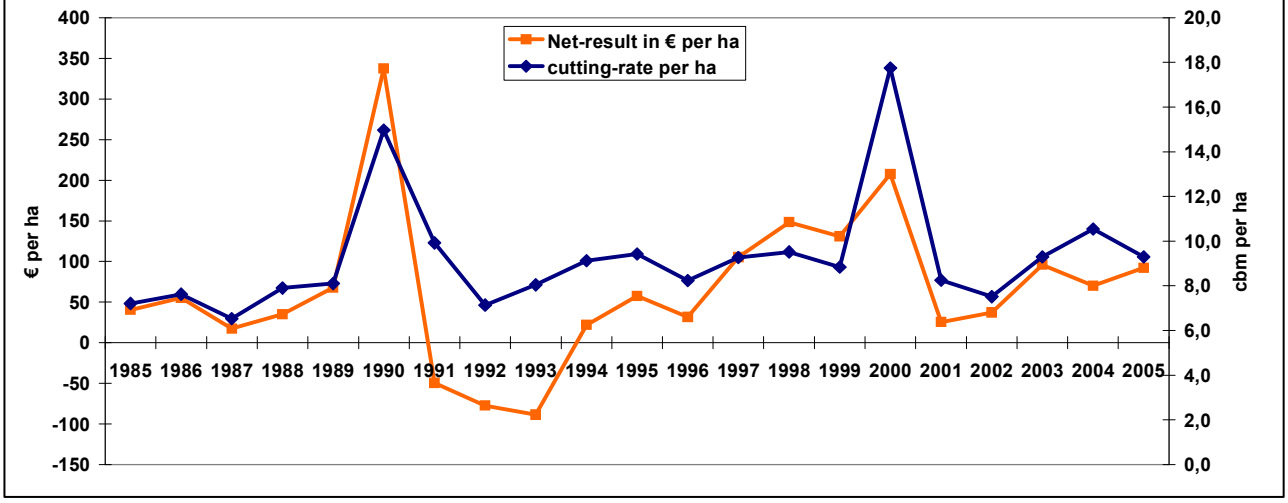
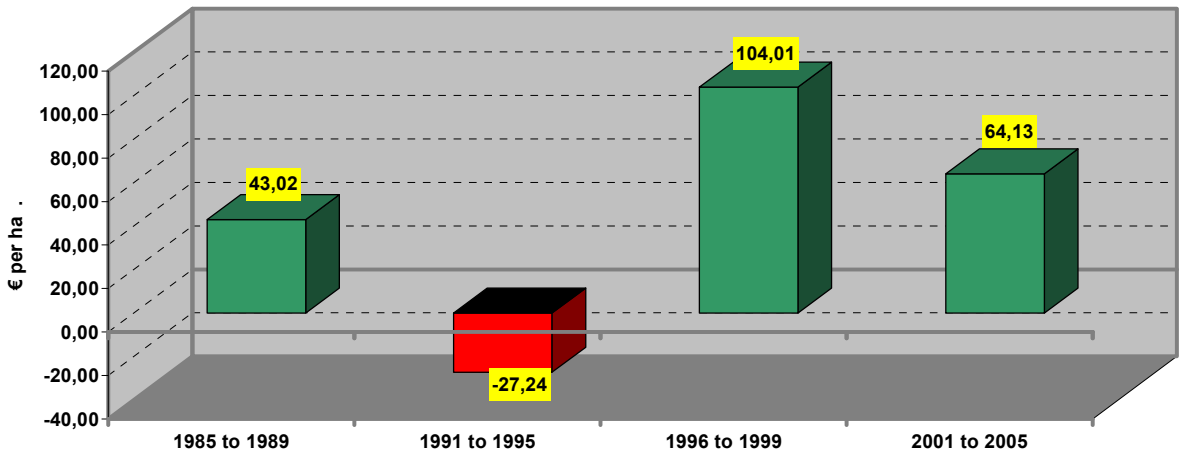


Figure 5: Periodic net-results of private forest-companies in Baden-Württemberg (> 200 ha)
(Data source: FVA-TBN)



5. *Private income gains from Stone Pine (Pinus pinea L.) afforestation of marginal cereal crop fields in Valladolid, Spain*

Paola Ovando[1ζ], Pablo Campos[1], Rafael Calama[2] and Gregorio Montero[2]*
[1] Institute of Public Goods and Policies (IPP), Consejo Superior de Investigaciones Científicas (CSIC). [ζ]Corresponding author: C/ Albasanz, 26-28. 28037 Madrid, Spain. Tel. +34 91 602 2790. Fax: +34 91 602 2971. E-mails: povando@ieg.csic.es.
[2] Centre of Forestry Research (CIFOR), Instituto Nacional de Investigación Agraria y Agroalimentaria (INIA),

Abstract
This article compares the landowner private capital income gains present discounted value (PDV) of Stone pine afforestation with those of marginal dry-land cereal farming in the Portillo and Viana areas (Valladolid, Spain). We estimate the private commercial capital income PDV, which includes government grants, the latter of which has been extended by adding the revenue PDV from a hypothetical payment for net carbon sequestration. The results show that the stone pine afforestation tends to offer positive commercial capital income gains PDV in Portillo, except when a low density silviculture model is applied. Both in Portillo and in Viana the revenue PDV for net carbon sequestration generates positive capital income gains PDV, although where Viana is concerned, carbon sequestration prices would have to be in excess of €35 tC^{-1}.

Key words: extended cost-benefit analysis, forest plantation, silviculture models, commercial benefits, carbon sequestration, government grants.

1 Introduction

The Stone pine (*Pinus pinea* L.) is one of the most widely spread conifers in the Iberian Peninsula and it grows in enclaves in almost all of the countries of the Mediterranean basin. In Spain, the stone pine covers a surface area of over 400,000 ha, which represents around 50% of its total worldwide surface area (Montero and Cañellas, 2000). In the province of Valladolid (Castilla-León, Spain), the stone pine is the dominant species in around 48,000 ha, which represent 39% of the total forest of this province (STMA, 2008). The previous years have seen a significant increase in the number of stone pines in Valladolid[13]. This is due to afforestation schemes using stone pine and, above all, the replacement of aging resin pine (*Pinus pinaster*) plantations with new plantations of stone pines (STMA, 2008). 43% of the surface area covered by stone pines in Valladolid is classified as *montes de utilidad pública* – forests under a special Spanish forest law regulation– (MUPs), which are owned by different public entities, with the remaining 57% being privately owned (DGCN, 1996). The characteristic to be underlined of the privately owned forestland is that it is divided up into extremely small plots, which in Valladolid results in 96% of private forestlands occupying less than 10 ha (STMA, 2008), namely a size of woodland that hinders the application of those forestry works employed by private industrial landowners with commercial concerns.

[*] P. Ovando and P. Campos share the first authorship of this article.

[13] In the period of ten years between the Third and Second Spanish National Forestry Inventory, stocks of *Pinus pinea* (the number of standing trees belonging to diametrical classes equal to or greater than 10 cm) have increased by 37% (STMA, 2008).

The stone pine was traditionally grown to obtain commercial crops such as resin, bark (for the production of tannins), pine cones, timber and firewood, and to use the forestland for hunting and grazing purposes (Campos, 1998; Mutke et al. 2000; Calama et al., 2008). Resin and bark are no longer harvested, while the demand for timber, firewood and grazing is in decline (Mutke et al., 2000; STMA, 2008). More recently, the aim of the active stone pine management being carried out by governmental entities in the MUPs is to encourage the production of a higher quality cone. In addition to being justified by the drop in forest owner commercial benefits experienced by the majority of the traditional uses mentioned above, this change in the production emphasis is due to sustained growth in the international demand for pine nuts for human consumption. This governmental response adapts to the supply needs of the Spanish industry, which is now the world's largest processor of pine nuts, with an approximate share of 45% of pine nut world total production (Barranco and Ortuño, 2004).

We must point out that as well as the government's interest in ensuring the industrial supply of pine nuts, its stone pine management policy aims to include measures that favour the joint production of goods and public services to be enjoyed by those entitled to free access of the forests, such as recreational uses and the gathering of wild mushrooms. Governmental entities are also seeking to improve other environmental services associated with stone pine plantations, such as carbon sequestration, land protection against surface erosion, and provision of shelter and food for local wildlife (Campos, 1998; Mutke et al, 2000; Montero et al., 2004, STMA, 2008).

This change towards productive preference as regards stone pine management is the driving force behind replacing the traditional manual method of gathering pine cones with a mechanised alternative in Valladolid (Martínez-Zurimendi et al., 2006; Barranco and Ortuño, 2004). We can also see that the mechanised gathering of pine cones is enabling harvesting on a commercial scale in areas which for years have been abandoned by their owners due to the cost of manual harvesting eliminating any stumpage rent to be gained from the extraction of this resource.

The stone pine commercial benefits of both the mature and the more recently established stone pine plantations has scarcely been analysed (e.g. Campos, 1998; Mutke et al., 2000). Progress with respect to economic analysis has been hindered by the scarce quantitative modelling of stone pine growth and production. The recent advances made regarding the modelling of productive stone pine management in Spain enable us to undertake an extended cost-benefit analysis of the industrial private landowner economic benefits of stone pine afforestation and expand it to encompass a full cycle (e.g. Montero et al., 2004; Calama et al., 2007). In this study we simulate the application of three production (silviculture) management models. These are differentiated by the intensity of thinning and the preferred production orientation (cone or wood) in the two areas analysed of *Portillo* and *Viana de Cega* (hereafter Viana), which are located in Valladolid province (Spain), and by the natural productivity of each area, namely pine cones (Portillo) and wood (Viana).

The main aim of this study is to estimate the landowner capital income gain at factor cost, in terms of its present discounted value (PDV), that the landowner might earn by replacing the marginal dry-land cereal that is currently farmed in Portillo and Viana with stone pines. We undertake the analysis of the capital income gain of stone pine afforestation from the point of view of the landowner of the pine plantation (who might be a public landowner or a private industrial landowner[14]) using three different types of silviculture models we have simulated specifically for the afforestation scenarios in the two pine growing areas under consideration.

[14] Both the private industrial landowner (non-family landowner) and the public landowner benefit from the income generated by the tradable goods and services provided by the pine plantation and from the subsidies net of taxes on government products. For both industrial and public landowners we assume there is no private amenities consumption (Campos et al., 2007).

For this purpose, we firstly quantify the commercial capital income gains PDVs that the landowner would make by investing in stone pine afforestation. Secondly, we extend this private capital income gain analysis by accounting for the potential revenues that the landowner would obtain from being eligible for a hypothetical government payment for net carbon sequestration within the forested area. Furthermore, we estimate the incomes PDVs of the enterprises awarded the rights to fell timber and collect pine cones. Adding together the commercial incomes of the landowner and of the aforesaid enterprises enables us to know the private total commercial incomes PDVs generated by stone pine afforestation considering repeated cycles in an infinite time horizon-frame.

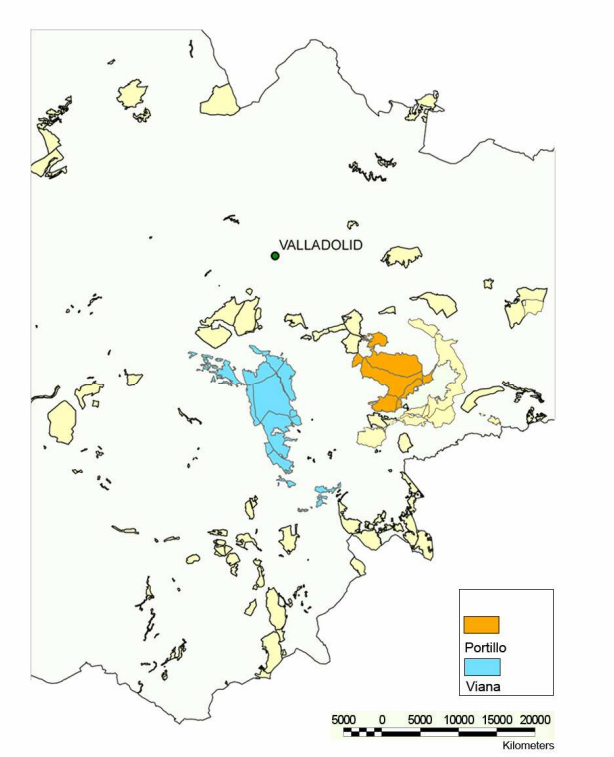
This article is organised as follows. In section 2, we describe the two case studies where the stone pine afforestation models are simulated; continuing with the methods, data and valuation criteria used to carry out the extended cost-benefit analysis we apply. In section 3, we analyse the private income PDVs results of the six simulated stone pine afforestation scenarios. Finally, in section 4, we discuss and conclude regarding the stone pine afforestation results policy implications.

2 Methodology

2.1 The Portillo and Viana case studies

The two pine growing areas studied are Portillo[15] and Viana, both of which are situated in the south of Valladolid province (see Figure 1). Portillo lies in the Limestone Western Plains whose marly and clayey tertiary slopes separate it from the surrounding sandy areas. Portillo lies at an average altitude of 845 m above sea level and has a surface area of 4,757 ha covered by stone pines forest. Viana lies in the open sandy areas of the *Meseta Norte* (Northern Plateau) upon quartz-sand soils formed by windblown and sedimentary fluvial deposits at an average altitude of 707 m above sea level, and has a total surface area of 7,211 ha of stone pine forest (Calama et al., 2008).

Figure 1 Case study locations



As well as lying in different locations and having different soil conditions, these two areas also differ with respect to the natural productivity of pine cones and timber of their pine plantations. The natural productivity of pine cones in Portillo is greater than the estimated productivity in Viana. The latter, however, enjoys a greater natural productivity of timber. The fact that Portillo produces more pine cones is fundamentally due to a higher clay content in the soils, which gives them a greater capacity for water retention, and a higher average annual rainfall (485 mm) in comparison to Viana (369 mm). Both these environmental resources mean that there is more water available in the soil –which is one of the main factors governing the production of pine cones– of the Portillo area (Calama et al., 2008).

[15] Portillo is the name of the most representative municipality of the forestland area known as Limestone Plain West.

2.2 Stone pine silviculture models simulated in Portillo and Viana

In this article, we apply the PINEA2 model (Calama et al., 2007), which is an integrated single tree-level model developed for the management of stone pine even-aged stands (including plantations) within the Northern Plateau of Spain. This model enables us to simulate the development of a stand of stone pine over time and predict its yields using a small number of variables (age, dominant height, normal diameter). The PINEA2 model also enables us to compare different stone pine afforestation scenarios based on controlling the length of the productive cycle and the density of the forested area throughout the cycle by way of the scheduled thinning of the pines over time.

We simulate three alternative silviculture models for an even-aged stone pine stand (Table 1). The first silviculture model (*SIL 1*) is heavily thinned and it is designed to favour the production of pines cones per single tree, which occurs in a given production cycle (exogenous to this analysis) of 120 years. The *SIL 1* model maintains an average density of 110 pine trees per hectare (of the 10 or more centimetre diameter class) throughout its commercial production cycle (Table 1). The second silviculture model (*SIL 2*) is less heavily thinned than the first and is designed to produce both timber and pine cones without favouring either during a 100-year cycle. The average density of *SIL* 2 is 175 pine trees per hectare throughout its commercial production cycle. The third silviculture model (*SIL 3*) is characterised by the fact that it is only lightly thinned, thereby enabling a higher density of pine trees to be maintained throughout its production cycle (213 trees per hectare). The *SIL* 3 model is designed to favour wood production over a production cycle of 80 years. Each of the aforementioned silviculture models shares a series of pine tree forestry treatments (thinning out, pruning and clearcuts), whose frequency, and the sequence in which they are applied, varies in each of the silviculture models (Ovando et al., 2008).

Table 1 Selected physical indicators of stone pine afforestation scenarios (average annual data)

Class	SIL 1		SIL 2		SIL 3	
	Portillo	Viana	Portillo	Viana	Portillo	Viana
Cycle length (years)	120	120	100	100	80	80
Thinning intensity	high	high	medium	medium	low	low
Main productive orientation	pine cones	pine cones	pine cones - timber	pine cones - timber	timber	timber
Average density [(1)] (trees ha^{-1})	110	110	175	175	213	213
Saw timber (m^3 ha^{-1} y^{-1})	0.09	0.14	0.07	0.13	0.12	0.2
Pulpwood (m^3 ha^{-1} y^{-1})	0.47	0.67	0.64	0.96	0.69	1.01
Firewood (t ha^{-1} y^{-1})	0.36	0.43	0.47	0.56	0.52	0.63
Branches > 7 cm Ø	0.13	0.16	0.17	0.21	0.20	0.23
Branches from 2 to 7 cm Ø	0.23	0.27	0.29	0.35	0.32	0.39
Pine cones (kg ha^{-1} y^{-1})	223.79	89.35	267.42	85.87	270.56	73.4
Pine cones (kg $tree^{-1}$ y^{-1})	2.03	0.81	1.53	0.49	1.27	0.34
Average net carbon sequestration [(2)] (tC ha^{-1} y^{-1})	0.59	0.69	0.69	0.82	0.90	1.09

[(1)] Trees of a diameter equal to or higher than 10 cm. [(2)] Refers to carbon sequestration in forest biomass net of carbon emissions due to fossil fuel consumption.

Table 1 shows the average annual physical production of pine cones per hectare and tree estimated using the pine cone production estimates provided by the PINEA2 model for the entire commercial cycle of the simulated silviculture models (for more details, see Ovando et al., 2008). The PINEA2 model also provides data regarding the volume of commercial timber that can be harvested from a

stand of stone pine in accordance with its location and the silviculture process developed (Table 1). We break down the volume of timber felled into saw timber and pulpwood. In addition to the felling of timber to supply industry, the felling of complete pine trees for thinning purposes and final off cuts result in a relevant production of firewood. We estimate the quantity of firewood obtained by using Montero et al. (2006) functions, which associate the diameter of a stone pine with the weight of the biomass in branches, which in turn are classified into two groups: those of over 7 cm in diameter and those of between 2 and 7 cm in diameter. We assume that the wood of branches with a diameter of more than 7 cm is destined for the timber industry as pulpwood, while the wood derived from branches whose diameter is 7 cm or under will be used as firewood, thereby replacing fossil fuels.

2.3 Outputs and costs valuation criteria

For the purpose of this article we value the private commercial outputs and costs of a plantation of stone pines using the 2007 observed local market prices (without including subsidies and taxes), and a range of imputed prices we use to value the net carbon sequestration service (Table 2). The operating subsidies (grants) net of taxes on products and costs (OST) received by the landowner are included when measuring the landowner's capital income at factor cost, thereby enabling us to estimate the true income obtained by the landowner for the stone pine afforestation and dry cereal crop uses being compared. In this article, we include the grants for financing the first planting out of a plot of arable land with stone pine and the subsequent 5-year maintenance cost premium and 20-year income losses cover premium, as well as, grants for different forestry treatments offered by the Regional Government of Castilla-León for the process of managing the stone pine stand throughout their entire production cycle (Table 3).

2.3.1 Commercial private outputs and costs

The private commercial outputs we consider in the stone pine afforestation scenarios are the final sales at stumpage and forest gate prices (industry sales in the case of the pine cones) associated with the tree (pine cones, timber and firewood), the rents from leasing grazing and hunting rights, and the government grants net of taxes. The data we use to value the private commercial outputs and costs generated by stone pine afforestation are gathered using structured postal surveys (prior to telephone interviews) and face-to-face interviews held with the owners of enterprises that harvest the pine cones, fell the timber and manage the stone pine forestry works. We also interview foresters charged with managing the stone pine plantations in the two case studies areas. Finally, we also take into account the information gathered when reviewing the specialised scientific literature (for more details, see Ovando et al., 2008).

Table 2 Stone pine goods and services prices (year 2007)

Class	Unit	Price (€/unit)	Prices range [1] (€/unit)
Timber stumpage prices [2]			
Logs lower than 30 cm Ø	*m^3*	*12.5*	*7.5 – 17.4*
Logs of 30-40 cm Ø	*m^3*	*17.5*	*10.5 – 24.4*
Logs higher than 40 cm Ø	*m^3*	*21.1*	*12.6 – 29.5*
Timber farm gate prices			
Saw timber	*m^3*	*42.1*	*25.3 – 59.0*
Pulpwood	*m^3*	*25.0*	*15.0 – 35.0*
Firewood stumpage price	t	6.0	
Branches >7 cm Ø	*t*	*8.1*	
Firewood farm gate price			
Branches of 2-7 cm Ø		*5.0*	
Branches >7 cm Ø		*18.0*	
Cone			
Stumpage price	*kg*	*0.3*	*0.15 – 0.55*
Industry gate price	*kg*	*0.8*	*0.50 – 1.10*
Hunting rent	ha	4.7	
Grazing rent [3]	ha	5.5	
Agricultural land rent	ha	109.2	
Carbon sequestration	tC	20.0	10.0 – 70.0

[1] Price range used for sensitivity analysis.
[2] Timber stumpage price depends on the diameter of logs.
[3] Grazing is not allowed for the first 20 years of the afforestation cycle, as a condition for receiving the income loss cover premium (Table 3).

Table 3 Government grants for stone pine afforestation and forestry treatments (year 2007)

Class	Unit	Unitary value (€/unit)	Observations
Afforestation grants			
Planting cost	*ha*	*2,200*	*Maximum amount*
Maintenance cost premium	*ha*	*180*	*Arable land (during 5 years)*
Income loss cover premium	*ha*	*121*	*Land owner not farmer (during 20 years)*
Forestry management grants			
Thinning	*ha*	*344*	*70% of total expenditures until the maximum amount is reached*
Pruning	*ha*	*414*	
Forestry residues removal	*ha*	*240*	

The term commercial *silviculture* activity encompasses the private outputs and costs derived by applying our six simulated stone pine afforestation scenarios. We include the following as silviculture derived outputs: final sales of pine cones, timber and firewood at stumpage prices; the rents earned by the landowner leasing out of hunting and grazing rights; and the operating grants net of taxes that the landowners qualify for when engaging in stone pine afforestation and stand management. The values we place on hunting and grazing rents correspond to the leasing prices stated by the different local information sources surveyed in the two stone pine forest locations analysed.

We compare the private economic results of the silviculture models simulated in the six stone pine afforestation scenarios with the alternative of maintaining the way the land is currently being farmed, namely for the cultivation of dry-land cereal crops. In this case, we assume that the only commercial capital income that the landowner earns is that which he receives from leasing his property out to other farmers for the dry-land cultivation of cereals. The average annual rate of rental of dry-land fields in Castilla-León updated to 2007 prices reached a value of €109.2 ha^{-1} (MAPA, 2007; 2008).

Enterprises, that acquire the standing pine cones and timber from the forest owner, carry out the activities of *pine cone harvesting* and *timber felling*. We estimate the income of the pine cone harvesting enterprises by considering the price paid by at the industry gate, which is why, for this activity, our analysis includes the cost of transporting the pine cones from the loading hopper at the plantation to the pine cone processing plant which, for the purposes of this article, we take to be an average distance of 40 km. We measure the income of the enterprises responsible for felling the timber taking into account the forest gate price of the timber and firewood.

We consider the private commercial costs to be incurred by the landowner whilst carrying out the silviculture activity, which includes the initial planting out and the subsequent management of the stone pine required until the standing sale of the pine cones (annually) and the timber (and the associated firewood), and the extraction costs of the enterprises commissioned to harvest the pine cones and fell the timber. We assume that the commercial benefits derived from grazing and hunting rights, and from the carbon sequestration service, are generated alongside those of the silviculture activity and, therefore, at no additional cost to the landowner. The concepts of total commercial cost (TC) are the same as those used by the system of national accounts (SNA) (Eurostat, 2000). The SNA classify these costs as intermediate consumption (IC) (which refers to expenditure in raw materials and services), labour costs (LC) and fixed capital consumption (FCC). The standing values of the pine cone and the timber (and associated firewood) form part of the intermediate consumption of the pine cone harvesting and timber felling activities, respectively.

2.3.2 Net carbon sequestration

We estimate the hypothetical revenue PDV ($ECId_{carb}$) that the landowner could receive from the government for net carbon sequestration with respect to the simulated stone pine afforestation scenarios. In order to do this, we consider the sequestration of carbon as being the growth of the forest biomass, the carbon accumulated in residues and forestry products and its decay, the carbon dioxide emissions saved by replacing fossil fuels with firewood, and the carbon dioxide emissions caused by the use of fossil fuels during the management of the stone pine, the aggregation of which enables us to estimate the amount of net carbon sequestration (for more details, see Ovando et al., 2008).

As net carbon sequestration is considered to be a public environmental benefit, we value this service by dealing with the marginal cost of the damage caused by the increase in the concentration of carbon dioxide (CO_2) in the atmosphere (equivalent to the damage avoided). Recent literature includes numerous estimates of this marginal cost of the carbon, displaying a greatly variability. We simulate the net carbon sequestration revenues PDVs for carbon prices ranging from €10 to €70 tC^{-1} (€3 to €19.1 tCO_2^{-1}), which falls within the range of the estimates of marginal costs available (Tol, 2005) and, at its lower limits, of the prices that have been frequently observed in the emerging carbon trading markets (CCPO, 2006).

The cost of family self-employed labour and of the machinery used to harvest pine cones

In the public stone pine forests of the province of Valladolid, the pine cones are harvested by family enterprises of cone collectors who use their own machinery and tools. The unitary cost of hand-harvesting pine cones tends to eliminate the stumpage rent generated by the pine cones and, at the same time, causes non-competitive remuneration for the family labour work carried out by the cone collectors. These economic reasons have led to the widespread introduction and use of shaking and vibrating-harvester machines by the family enterprises of cone collectors in Valladolid (Martínez-Zurimendi et al., 2006). We assume that the pine cones are mainly mechanically harvested whenever the density of the pine plantation is less than 500 trees per hectare. With higher densities, the pine cones would be harvested by hand.

The fact that the pine cones are harvested by family enterprises makes it impossible to objectively estimate the self-employed labour costs and the costs of the machinery used to mechanically harvest the pine cones. In the absence of a vibratory machine hire market, we calculate the cost of this type of machinery using the annual cost incurred, which gives us an average unit cost of €26.3 per hour used. This cost includes the depreciation (fixed capital consumption: FCC_{pin}) of the machinery –in light of the 2007 replacement prices– and the running expenses (intermediate consumption), namely fuels, lubricants and mechanical repairs (Ovando et al., 2008).

The imputation of a cost per hour of self-employed labour equal to that of the employee's labour is highly controversial, given that, were we to accept this, we would be implying that the marginal productivity of employee and self-employed workers have the same marginal prices. Against this, we objectively measure the cost of the self-employed labour of the cone collectors (SLC_{pin}) using the residual accounting value method. This objective self-employed labour residual accounting value corresponds to the difference between the earnings generated by selling the pine cones at industry gate (B_{pinf}) and the costs borne by the family enterprise for carrying out this activity. These costs include the cost of labour of the employee hired by the family enterprise (ELC_{pin}), the intermediate consumption of raw materials (which includes the expenses on cone stumpage price, fuels, lubricants, etc.) and services (IC_{pin}), the cost of replacing the machinery (FCC_{pin}) and the opportunity cost of family immobilized capital (NOM_{pin}):

$$SLC_{pin} = B_{pinf} - ELC_{pin} - IC_{pin} - FCC_{pin} - NOM_{pin}.$$

We justify acceptance of an opportunity cost of the family investment in mechanical equipment by the relative high value that this cost reaches. We are assuming a normal remuneration of the immobilized capital (IMC_{pin}) by the family enterprise of cone collectors of 5%: $NOM(t)_{pin} = 0.5 \cdot IMC(t)_{pin}$. We estimate the average annual immobilized capital of a single family enterprise of cone collectors by taking an entrepreneurial unit equipped with a vibratory machine (fixed capital), the market price of which in 2007 is approximately €84,000, and which (during the months the pine cone harvesting season lasts) keeps a working capital of around €3,750 immobilized.

We arrive at the family total commercial income of the cone collectors (TCI_{pin}) generated by the mechanised harvesting of the pine cones by adding the income of the family self-employed labour cost and the imputed remuneration to the immobilized capital ($NOM_{pin} = CCI_{pin}$)

$$TCI_{pin} = SLC_{pin} + CCI_{pin}.$$

2.4 Stone pine afforestation income gains present discounted values

We estimate all of the private final economic outputs and costs generated by one hectare of stone pine plantation assuming that the afforestation of a piece of agricultural land will result in a permanent stone pine forest, whereas the application of silviculture treatments that induce the natural regeneration of the pine stand are repeated indefinitely with a frequency of T_j. The T_j production cycle is defined by the age of the pine trees at which the simulated silviculture model prescribes the onset of the seedling cuttings process in the stone pine stand resulting from the initial afforestation or from successive natural regenerations.

We distinguish two production cycles. The first production cycle of a stone pine plantation is the result of the initial afforestation (f) with stone pines of an agricultural plot of location *i* (*i*=1,2), and in which we consider the outputs and the costs of the stone pine plantation, and of the subsequent application of silviculture model *j* (*j*=1,2,3). This first afforestation cycle is followed by a second production cycle (*n*) –known as induced natural regeneration– during which the application of the same silviculture model *j* will, in each area *i,* result in identical and successive cycles of assisted natural regeneration of a stone pine plantation.

The present discounted value (PDV) for an infinite time horizon ($V^{f}_{ij,\infty}$) of an economic variable (y_{ij}) associated with the afforestation of an agricultural plot with stone pines, and with a cycle length T_j, corresponds with the sum of the capital values of the afforestation cycle ($V_{ij,f}$) and the successive cycles of assisted natural regeneration ($V_{ij,n}$) which, we assume, will be repeated indefinitely:

$$V_{ij,f} = \sum_{t=0}^{T_j} \delta^t y_{ij,f}(t),$$

$$V_{ij,n} = \sum_{t=0}^{T_j} \delta^t y_{ij,n}(t),$$

$$V^{f}_{ij,\infty} = V_{ij,f} + \delta^{T_j+1}(1 + \delta^{(T_j)} + \delta^{(T_j)x2} + \delta^{(T_j)x3} + ...)V_{ij,n},$$

$$V^{f}_{ij,\infty} \cong V_{ij,f} + \delta^{T_j+1}\left[\frac{1}{1-\delta^{T_j}}\right]V_{ij,n}.$$

Where δ is the discount function defined by 1/(1+r), with *r* being the annual rate of discount; $y_{ij,f}$ an economic variable associated with a pine plantation that is the result of afforestation; $y_{ij,n}$ an economic variable associated with the assisted natural regeneration production cycle.
We disaggregate the present discounted value of the private commercial capital income (CCId)[16], not only at market prices ($CCId_{MP}$), but also at factor costs ($CCId_{FC}$), bearing in mind if said income is earned by the silviculture ($CCId_{MP,sil}$), felling of timber ($CCId_{timb}$) and harvesting of pine cones ($CCId_{pin}$) activities (Table 4). We calculate the $CCId_{MP}$ as the difference between the total commercial output PDV (CBd) and the total commercial cost PDV (TCd) of managing the stone pine plantation. In order to estimate the $CCId_{FC}$ –which is the income that is certain to be of most interest to the landowner–, we include the PDV of the operating subsidies (grants) net of taxes (OSTd) as an additional benefit to the landowner.

We compare the PDV of the private commercial capital income of the silviculture activity at factor cost ($CCId_{FC,sil}$) with the PDV of the landowner's income from leasing out the land for its current use, namely the cultivation of dry-land cereals, with the aim of estimating the landowner commercial capital income gain or loss PDV of the stone pine afforestation ($CCIGd_{FC,sil}$) (Table 5). We also estimate the capital income gain or loss PDV ($CIGd_{FC,sil+carb}$) that the landowner would get

[16] The letter *d* after the capital and total income figures indicates the present discounted value of the capital or total income flows. Whenever this letter is omitted, we are referring to annual income indicators.

in the event of a hypothetical payment ($ECId_{carb}$) for the net carbon sequestration in the afforested plot (Tables 5 and 6).

The private total commercial income PDV (TCId) is the result of aggregating the commercial capital income (CCId) and the labour cost (LCd), both from employees (ELCd) and self-employed (SLCd) labour. We also estimate the private total commercial income PDV at market prices ($TCId_{MP}$) and at factor cost ($TCId_{FC}$). Likewise, we measure the family total income PDV ($CTId_{pin}$) of the enterprises devoted to the harvesting of pine cones (Table 7).

3 Stone pine afforestation extended cost-benefit analysis results

Tables 4 to 7 show the extended cost-benefit analysis results of the stone pine afforestation scenarios in the growing pine areas under consideration. These results come when applying a discount rate of 4%, a price of carbon of €20 tC^{-1} (€5.4 tCO_2^{-1}), and in the supposition that the pine cone collection is mainly mechanised. Figures 2 to 6 show the sensitivity of the results obtained to variations in the discount rate, the stumpage or industry gate prices of the pine cones, and the price of carbon. There are no differences in the present discounted values resulting from leasing hunting and grazing rights, given the fact that in this article we consider these two rents to have the same value in all the simulated silviculture scenarios.

3.1 Afforestation scenarios private capital income gains present discounted values

Without considering government grants, that is, under pure market conditions, afforestation of agricultural land using stone pines generates a negative capital income PDV ($CCId_{MP}$), in the six analysed scenarios (Table 4). This occurs irrespective of location and the simulated silviculture model, and for a landowner that requires, at least, a real profitability rate from the silviculture activity of 4%. In both the Viana and Portillo case studies areas, the silviculture model with a high degree of thinning to favour the production of pine cones per individual tree (SIL 1) is that which results in the greatest commercial losses among all the afforestation scenarios analysed (Table 4).

Table 4 Private commercial capital incomes PDVs from stone pine afforestation scenarios (2007 euros per hectare)

Class	Portillo			Viana		
	SIL 1	SIL 2	SIL 3	SIL 1	SIL 2	SIL 3
Commercial capital income at market prices ($CCId_{MP}$)	-3,176.2	-2,756.0	-2,783.2	-3,767.0	-3,727.1	-3,708.7
Silviculture ($CCId_{MP,sil}$)	-3,268.4	-2.831.3	-2,848.3	-3,840.4	-3.820.7	-3,783.3
Other forestry uses	92.2	75.3	65.1	73.4	93.7	74.6
Net operating subsidies (OST)	5,839.2	5,763.7	5,781.4	5.798.5	5.764.2	5,782.5
Commercial capital income at factor costs ($CCId_{FC}$)	2,663.0	3,007.7	2,998.2	2,031.5	2,037.1	2,073.8
Silviculture ($CCId_{FC,sil}$)	2,570.7	2,932.4	2,933.1	1,958.1	1,943.4	1,999.2
Timber felling ($CCId_{timb}$)	15.6	26.1	17.0	30.5	56.3	43.7
Pine cones harvesting ($CCId_{pin}$)	76.7	49.2	48.0	42.8	37.3	30.9

(1) Discount rate 4%.

If the current government grants are taken into account, the stone pine afforestation gives a positive capital income PDV ($CCId_{FC}$) (Table 4). The differences between the natural productivity of timber and pine cones of the two areas under study are more acute than those shown by the simulated silviculture models compared within the same area. The stone pine afforestation generates a total private commercial capital income PDV at factor cost ($CCId_{FC}$), in Portillo, which are significantly higher than those produced in Viana (Table 4). These differences are mainly due to the pine cone productivity. The latter generates in Portillo a commercial capital income PDV at factor cost of silviculture activity ($CCId_{FC,sil}$) and of the harvesting of pines cones activity ($CCId_{pin}$), that are, on average, 43% and 57%, respectively, greater than those of Viana (Table 4).

In Viana, which is an area that is naturally better suited to the production of timber, the commercial capital income PDV ($CCId_{timb}$) associated with timber felling represents somewhat more than twice the values estimated in Portillo (Table 4). However, the occurrence of the revenues and expenditures of felling timber is delayed in time, since this product is obtained as a result of selective thinning or clearcutting, and this only take place at least 30 years after the plantation is first established.

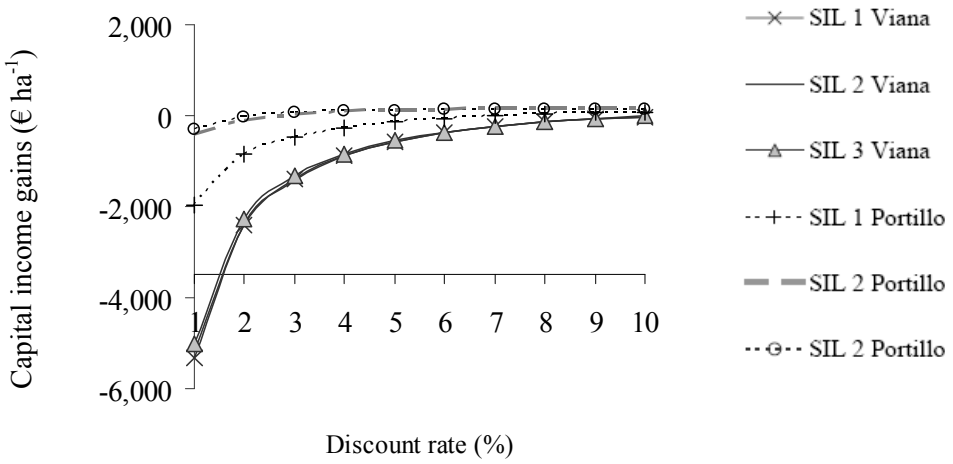
We estimate that the PDV –at the infinite time horizon and using a discount rate of 4%– of the commercial capital income that a landowner receives for leasing out his land for dry-land cereal farming is €2,840.5 ha^{-1}. Compared with this agricultural landowner capital income PDV ($CCId_{FC}$), the afforestation of a dry-land cereal field using stone pine in Portillo tends to be a profitable alternative for the private industrial landowner (Table 5). This is so when we simultaneously apply: (i) high-stocking (SIL 3) or medium-stocking (SIL 2) silviculture models, (ii) we include the current grants available for afforestation, and (iii) we allow for a real discount rate of the forestry investment of at least 3% (Figure 2). The application of intensive thinning scheme (SIL 1) aimed, in the main, at the production of pine cones, could be competitive with respect to plots with a rate of rental equal to or less than €98.8 ha^{-1}. However, any upward variation of 3.2% or over in land rental prices would render any afforestation scenario unprofitable in Portillo when, in the best case scenario, we apply a medium-stocking (SIL 2) silviculture model. In Viana, on the other hand, the afforestation of a dry-land cereal plot would generate negative commercial capital income gains (losses) with respect to the agricultural use of the land ($CCIGd_{FC,sil}$) (Table 5). In this case, the SIL 3 silviculture model, which presents the best economic results, can only be competitive with agricultural lands with a rate of rental equal to or less than €76.8 ha^{-1}.

Table 5 Private capital income gains PDVs from stone pine afforestation scenarios (2007 euros per hectare)

Class[2]	Portillo			Viana		
	SIL 1	SIL 2	SIL 3	SIL 1	SIL 2	SIL 3
Commercial capital income gains ($CCIGd_{FC,sil}$)	-269.9	91.8	92.5	-882.5	-897.2	-841.4
Capital income gains ($CIGd_{FC,sil+carb} = CCIGd_{FC,sil} + ECId_{carb}$)	37.3	433.6	471.4	-539.5	-464.4	-364.9

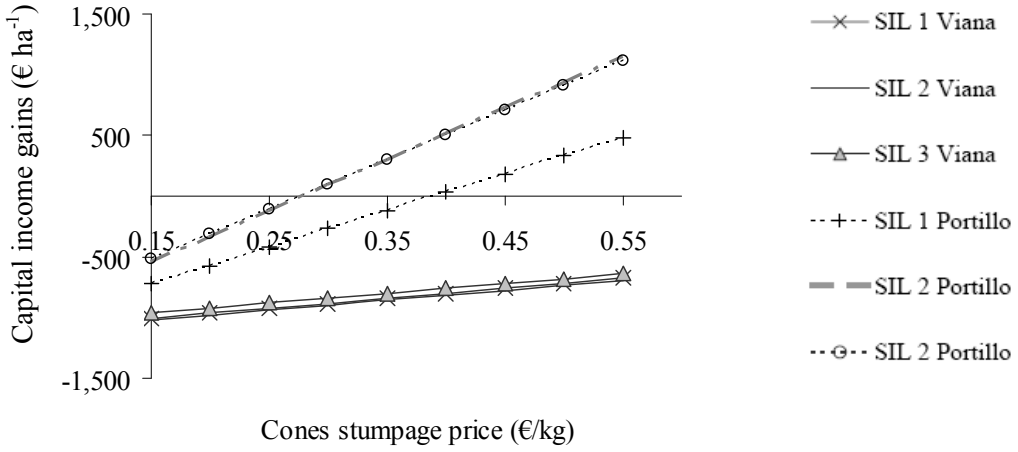
[1] Discount rate 4%; carbon price 20 € tC^{-1}.

Figure 2 Sensitivity of landowner's commercial capital income gains PDVs to discount rates (2007 euros per hectare)



The growing demand of the pine nut industry has led to pine cone harvesting being expanded to areas whose stone pine plantations offer a lower natural productivity of pine cones, as is the case with the Viana area. In Viana, the quantity of pine cones harvested during the production cycle in any of the types of silviculture models we are comparing here is notably lower than the quantity harvested in Portillo (Table 1). In Viana, the annual distribution of the production of pine cones within the cycle tends to increase when the pine trees are over 40 years old, which explains why the commercial capital income gains of the landowner are practically insensitive to variations in the cones stumpage prices (Figure 3). On the contrary, in Portillo, capital income gain PDV can be significantly affected by variations in the cones stumpage price. In this area, a cones stumpage price of less than €0.27 kg^{-1} (equivalent to a drop of 10% against the 2007 price) would significantly reduce the landowner's profitability from a stone pine plantation (Figure 3). In particular, in Portillo, increases in the cone stumpage price would most favour the application of the SIL 2 and SIL 3 silviculture models.

Figure 3 Sensitivity of landowner's capital income gains PDVs to pine cone prices (2007 euros per hectare)



The inclusion in the analysis of a hypothetical payment made to the landowner for the net carbon sequestration in the stone pine forest could alter preferences with respect to a change in agricultural land use in favour of the afforestation investment. The results obtained from the extended cost-

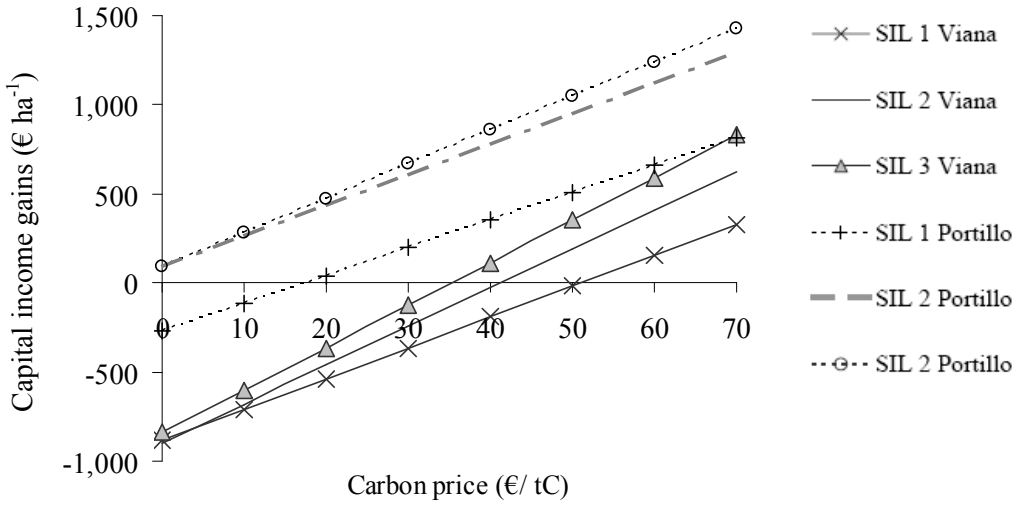
benefit analysis show that carbon sequestration can convert the stone pine plantation in which we simulate a silviculture model that keeps tree density relatively low (SIL 1) into a comparatively profitable option in Portillo when the per tonne of carbon is equal to or greater than €18 tC^{-1} (Table 6 and Figure 4). It goes without saying that the effect on economic results of the net carbon sequestration service is extremely sensitive to the prices paid for it. In the case of the simulated afforestation scenarios in Viana, carbon prices in excess of €51 tC^{-1} would change the preferences of an agricultural landowner in favour of a stone pine afforestation scenario if the SIL 1 model is applied, and between €35 tC^{-1} and €41 tC^{-1}, respectively, when the SIL 3 and SIL 2 models are simulated (Figure 4).

Table 6 Net carbon sequestration service PDVs from stone pine afforestation scenarios (2007 euros per hectare)

Class	Portillo			Viana		
	SIL 1	SIL 2	SIL 3	SIL 1	SIL 2	SIL 3
Net carbon sequestration service ($ECId_{carb}$)	307.2	341.8	378.9	343.0	432.7	476.5
CO_2 emissions saving	3.0	3.8	3.9	3.7	4.6	4.8
Carbon sequestration in forest biomass and products	311.0	344.1	382.1	345.3	434.8	477.6
Emission from fossil fuels consumption	-6.7	-6.1	-7.1	-6.0	-6.7	-5.8

(1) Discount rate 4%; carbon price 20 € tC^{-1}.

Figure 4 Sensitivity of landowner's capital income gains PDVs to carbon prices (2007 euros per hectare)



3.2 Stone pine afforestation scenarios total private incomes present discounted values

Together, the silviculture, felling timber and harvesting pine cones activities contribute to positive total labour costs PDV (LCd) (Table 7) that do not manage to counteract the landowner's negative commercial capital income PDV at market prices ($CCId_{MP}$) (Table 4) except in Portillo for the SIL 2 and SIL 3 scenarios. These two later scenarios display in Portillo a positive total commercial income at market prices PDV ($TCId_{MP}$) (Table 7).

Table 7 Private total commercial incomes PDVs of stone pine afforestation scenarios (2007 euros per hectare)

Class[2]	Portillo			Viana		
	SIL 1	SIL 2	SIL 3	SIL 1	SIL 2	SIL 3
Labour cost (LCd)	2,680.0	3,402.9	3,262.7	1,858.9	2,036.8	1,918.0
Employees (ELCd)	1,864.1	2,013.1	1,910.4	1,734.20	1,891.0	1,744,3
Self-employed ($SLCd_{pin}$)	815.8	1.389.8	1,352.2	124.7	145.8	173,6
Family total income from pine cones harvesting ($TCId_{pin} = SLCd_{pin} + CCId_{pin}$)	892.5	1,439.0	1,400.3	167.6	183.1	204.5
Total commercial income at market prices ($TCId_{MP} = LCd + CCId_{MP}$)	-496.2	646.9	479.5	-1,908.1	-1,690.3	-1,790.8
Total commercial income at factor costs ($TCId_{FC} = LCd + CCId_{FC}$)	5,342.9	6,410.6	6,260.8	3,890.4	4,073.9	3,991.7

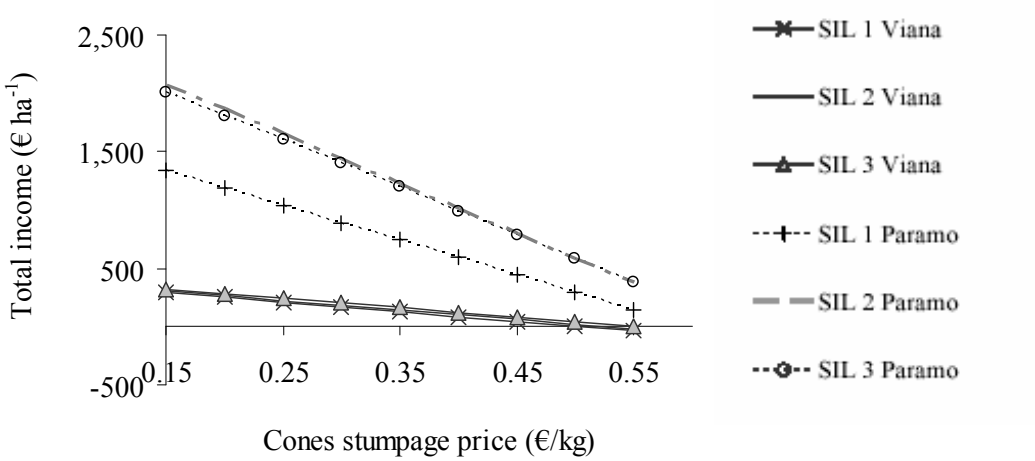
[1] Discount rate 4%.

As we mention above, in the future landowners might receive a government grant for net carbon sequestration. In this simulated situation, and assuming that the price reaches €20 tC^{-1}, the sequestration of carbon via the growth of the stone pine forest biomass and the emission savings due to the replacement of fossil fuels represent a positive environmental capital income PDV ($ECId_{carb}$) of €307 ha^{-1} in Portillo and of €343 ha^{-1} in Viana (Table 6). These PDVs values do not offset the private total commercial income losses at market prices due to the simulated stone pine afforestation scenarios in Viana and to the SIL 1 scenario in Portillo (Table 5). These $TCId_{MP}$ losses would be offset with payments for the net carbon sequestration service in excess of €32 tC^{-1} when we simulate the SIL 1 silviculture model in Portillo, and of between €75 tC^{-1} and €111 tC^{-1} in Viana, with the latter case depending on the types of simulated silviculture model used.

Although the government has not, as yet, drawn up a specific policy incentive with respect to compensating landowners for net carbon sequestration in forest plantations, it has provided grants for the afforestation of agricultural lands and for forestry treatments over the last fifteen years (Table 3). The operating subsidies net of taxes (OSTd) granted for planting and managing of stone pines stands reached a PDV of nearly €5,800 ha^{-1} in our six simulated afforestation scenarios (Table 4). The value of the government grants make for a positive private total commercial income at factor cost PDV ($TCId_{FC}$) in the six scenarios we are analysing, which fluctuate between €3,890 and €6,410 ha^{-1} (Table 7).

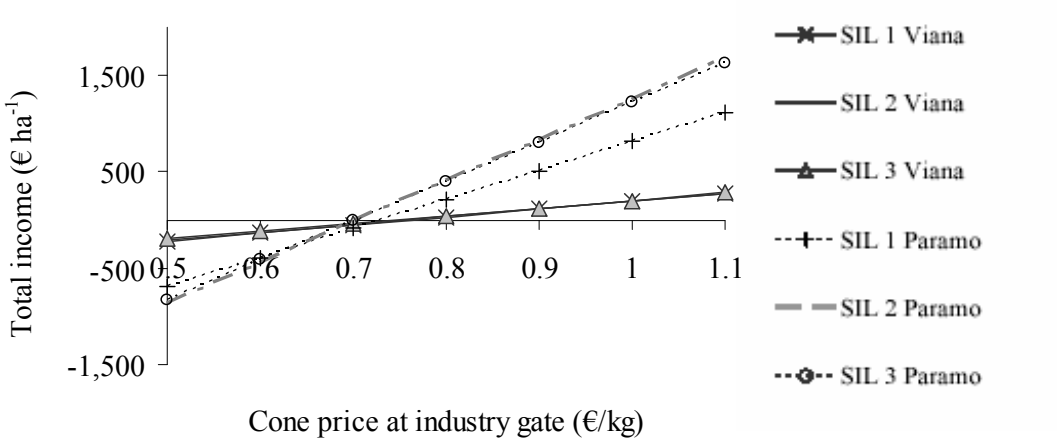
In areas of greater natural pine cone productivity, such as Portillo, a family enterprise of cone collectors can receive a significant part (between 17% and 22%) of the private total commercial income PDV at factor cost ($TCId_{FC}$) generated in the stone pine stand (Table 7). This relative share of the family income of the cone collectors falls dramatically in areas of low natural pine cone productivity. Therefore, in Viana, the total income of the cone collectors barely manages to reach between 4% and 5% of the $TCId_{FC}$. As is only to be expected with respect to all harvesting activities involving a scarce commercial raw material, such as the stone pine cone, its price can be relatively high and be subject to drastic changes, which is why the family total commercial income of the cone collectors ($TCId_{pin}$) is extremely sensitive to variations in the cone stumpage prices, as buyers of the resource, and in the industry gate prices, as suppliers of this product to the pine nut industry (Figures 5 and 6).

Figure 5 Sensitivity of cone collectors' total incomes PDV to pine cone stumpage prices (2007 euros per hectare)



In both Viana and Portillo, cone stumpage prices of above €0.45 kg^{-1} and €0.60 kg^{-1}, respectively, would make harvesting the pine cones an activity of no interest whatsoever to the cone collectors (Figure 5) at current industry gate prices for pine cones. The results show that a feature common to all six of the scenarios analysed is that a drop in the order of 13% in the industry gate price of pine cones (€0.70 kg^{-1}) reduces the interest of family cone collection enterprises in harvesting the pine cones (Figure 6).

Figure 6 Sensitivity of cone collectors' total incomes PDVs to cone prices at industry gate (2007 euros per hectare)



4 Discussion and conclusions

The results of this study show that, given the current conditions regarding market prices and government subsidies in the two areas studied, changing the use of a dry-land cereal field in favour of stone pine afforestation is not profitable, generally, for an industrial private landowner. The exception to this is applying, in Portillo, high-stocking (SIL 3) or medium-stocking (SIL 2) silviculture models, that present slightly positive silviculture activity private commercial capital

income gain at factor costs PDVs ($CCGd_{FC,sil}$) (Table 5). Meanwhile, the SIL 1 model in Portillo and the three simulated afforestation scenarios, in Viana, would result in a significant loss of private commercial capital income PDV for the landowner were he to change the use of his land from cereal farming to stone pine forestry (Table 5).

On the other hand, it is worth pointing out that the capital income gain PDV that the landowner could obtain from investing in stone pine afforestation is extremely sensitive to variations in cone stumpage prices and, to a lesser extent, given the length of time before it can be felled, to variations in the prices of timber. A drop in the order of 10% in pine cone stumpage prices would have a significant negative effect on the profitability of the stone pine afforestation schemes both in Portillo and in Viana. Our results also show that increases in agricultural land rental prices equal to or greater than 3.2% would tend to dissuade the landowner from investing in stone pine afforestation schemes. However, the income earned from leasing land for dry-land cereal farming must be influenced by expectations that government farming subsidies will continue. In this sense, an expected drop in farming subsidies would result in landowners earning more by changing the current use to which their farm land is put in favour of stone pine afforestation in the areas studied.

In expectation of a future development of the greenhouse gas emission rights market, governments could well establish direct compensations to landowners for the net carbon sequestration within the stone pine plantation and for the use of the firewood products derived from silviculture management procedures. Carbon sequestration might provide an incentive to landowners to invest in stone pine afforestation schemes, especially with respect to those afforestation scenarios that would result in a loss of income if all that is booked is the private income PDV derived from the commercial goods and services. However, the landowner's decision depends, to a great degree, on carbon prices. In the case of Viana, carbon would, at the very least, have to reach a price of €35 tC^{-1} in order to make it profitable for an industrial private landowner to invest in a stone pine plantation that will result in a permanent forest dominated by this species.

In this article, we show the results of separated silviculture and harvesting (the felling of timber and the harvesting of pine cones) activities, in order to estimate the incomes generated both by the landowner and by the enterprises commissioned to extract and harvest these forestry products. The industrial owners of the land, as well as the enterprises that exclusively use employees, take their managerial and product development decisions with respect to a pine plantation with a view to maximising their private capital income at factor cost. Conversely, the objective of cone collector family enterprises in Valladolid, which use self-employed labour to carry out a significant part of their activity, might be to maximise family total income, with a chance that the latter may involve a possible profit against the investment of family capital involved in the activity. Although this enterprise capital income will not always be demanded by the cone collectors, in order to ensure that they continue to harvest the pine cones, their self-employed labour income must reach the threshold level expected by the family of cone collectors.

We must highlight that it is the stone pine forest owners who receive more than 95% of the private commercial capital income at factor cost PDV ($CCId_{FC}$) from the afforestation analysed scenarios, and almost 50% of the private total commercial income at factor cost PDV ($TCId_{FC}$). In areas more naturally suited for the production of timber, such as Viana, the timber extraction enterprises merely receive a modest share of between 2% and 3% of the $TCId_{FC}$ generated by the pine plantation. In contrast, in areas such as Portillo, which are more naturally suited to pine cone production, the harvesting of this product can result in a contribution of between 17% and 22% of the $TCId_{FC}$ generated by the stone pine plantation, which is several times higher than the percentages achieved by the timber fellers of Viana.
The usefulness provided by the private extended cost-benefit analysis of stone pine afforestation when it comes to offering information to help policy-makers decisions must be highlighted in terms

of tolerable government subsidies and the profitability thereof. We have observed that, even though the six stone pine afforestation scenarios currently receive a similar PDV grants that rise to over 1.6 times as much as the lower limit of market price for marginal agricultural land[17] in the two areas studied (Table 4), the stone pine would generate extremely different private commercial incomes according to the simulated silviculture models used and the natural endowments of each of the two areas studied. In the case of the stone pine, the current agricultural policy of continued subsidies for cereal cultivation makes changing over to afforestation difficult if not impossible. If the expected changes are made with respect to the subsidising of agricultural activity within the European Union in favour of afforestation and forestry management, then we can well expect that the industrial landowners in those stone pine growing areas more naturally suited to the production of timber might also, as opposed to what is happening today, prefer to use their land for forestry in detriment to the use to which it is currently being put.

In our extended cost-benefit analysis, we have not estimated the public income generated by the stone pine afforestation schemes, except for carbon sequestration. This perspective is necessary in order to carry out a full economic analysis of stone pine afforestation. Furthermore, the fact that 43% of the stone pine forests in the province of Valladolid are publicly owned justifies the interest in knowing the whole public benefits and costs of stone pine afforestation as well as the private ones we have analysed in this article. It shall be worth completing this private income measurement as and when new information becomes available regarding recreational values, the conservation of the natural environment (option and existence values) and the collection of wild mushrooms associated with both the public and private usage of stone pine plantations, and regarding the structure and amount of direct public spending on this type of forest in the province of Valladolid, among others that might be of interest in specific cases.

Acknowledgment

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[17] In the province of Valladolid in 2006 the dry- agricultural land market price stood at between €3,600 ha^{-1} (lower limit) and €5,700 ha^{-1} (upper limit) (Junta de Castilla y León, 2006). The large difference observed between the stone pine silviculture capital income PDV ($CCId_{FC.sil}$) and the lower limit market price of dry- agricultural land might be due, almost partially, to the non-industrial private forest owner environmental amenities consumption, the later might lead to increase the market price of the land in the two analysed areas (e.g. Campos et al., 2007).

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Session 7
Energy planning and biomass

1. Decision support system for biomass and energy planning in mountain areas: the case of Tuscany Apennines[18]

Prof. Iacopo Bernetti*, Dott. Roberto Fratini*, Dott. Sandro Sacchelli*, Dott. Claudio Fagarazzi**, Dott. Christian Ciampi***
Department of Urban and Territorial Planning – University of Florence, Via Micheli, 2 50121 Florence, **Italy**

(*) Dipartimento di Economia Agraria e delle Risorse Territoriali – University of Florence, P.le delle Cascine, 18 50144 Florence
(**) Department of Urban and Territorial Planning – University of Florence, Via Micheli, 2 50121 Florence
(***) Dipartimento di Scienze e Tecnologie Ambientali Forestali – University of Florence, Via S.Bonaventura,13 Quaracchi 50145 Florence

Contact details: e-mail addresses
Dott. Roberto Fratini: roberto.fratini@unifi.it
Dott. Claudio Fagarazzi: claudio.fagarazzi@unifi.it

Abstract
At the present time it is a matter of fact that the renewable energies sector is in a period of strong expansion. The extremely rapid diffusion of thermal and electric power stations fed by renewable resources demonstrates that the production of energy from those resources is attractive. Among the renewable resources, biomasses, especially the forestry ones, seem to have the greater developing potentialities. The use of this resource, and consequently the developing of that specific market, is also determining positive effects on the agricultural and forest field, which in numerous European countries is no longer competitive in the global markets.
In order to cope with this exponential interest, it is necessary to carry out an accurate setting of the interventions and of the investments in the sector, in order to avoid impoverishment phenomena both of the environmental and financial resources.
The suggested study, developed in a forest district located in the Apennine Mountains of central Italy, has the aim of assessing both the sustainability of the supply of agro – forest biomasses in the territory under study and the potentially sustainable energy demand of those resources. This assessment means to set the interventions coherently with the development of a wood-energy chain able to guarantee the achievement of the objectives of economic and environmental sustainability of the chain.
As regards the assessment of the supply of the forest biomass, the suggested approach is based on the theory of the renewable resources (Pearce e Turner, 1989, Dasgupta, 1982) that is on models which assess the supply of biomasses in the long term, with relation to both the natural capital stock and the sustainable drawing rate.
This approach, developed on a territorial base thanks to the setting up of a Geographic Informative System with ecological, geographic, orographic and physical information, allowed also the assessment of the economic sustainability of the presumed drawings (Bernetti, 1999).
On the other hand, the need to acquire information useful to evaluate the potential demand for dry timber biomass (wood chips) in the analysed territory, together with the analysis of the possible

[18] Author-study contributions are as follows: Prof. I. Bernetti for paragraphs: 1, 4.4; Dr C. Fagarazzi for paragraphs: 4.3, 5, and 6; Dr Fratini for paragraphs: 2.1, 2.2; Dr. S. Sacchelli for paragraphs 4.2, 4.5 ; Dr. Christian Ciampi for paragraphs 3, 4.1.

dynamics of that same demand in the future, led this work to structure a research methodology capable of quantifying, with territorial detail, the potential demand for residual biomasses for thermal power use and the potential dynamics which can occur in the medium-long term. In particular, it has been possible to get to a classification of the buildings located on the territory in terms of their suitability to the installation of district heating planting fed with vegetal fuel of forest origin.
The methodology does consider numerous factors which influence these dynamics, such as the thermal need of each building, the accessibility of the edifice, the contiguity with other buildings, the presence of a gas methane network, etc.; thus there is need of developing an approach capable of assessing jointly a set of complex multi-dimensional indexes and of adopting a pluralistic and "active" approach which considers the expressed preferences of the local community.
For this reason, the most promising approach for these issues seems to be the 'decision analysis' models of environmental matters based on geographic multicriteria techniques (Munda, 1995 and 1997).

Keywords : *Bio-energy district, multicriteria spatial analysis*

1. Introduction

In several European countries, agriculture and forestation have not been competitive on the global market for several years. The survival of the enterprises of the sector depends mainly on public support, which however will continue to decrease progressively. Thus, it is necessary to revitalize these sectors, which otherwise are destined to decline rapidly. The developing of a biomass-energy chain can surely represent a very interesting opportunity. In fact, if we examine the global energy market, it is possible to notice that there is only one product for which the price increases more rapidly than we would like it to: oil. Hence comes the interest in producing a substitute – biomass – whose value should be linked with the increasing price of the substituted product.
From studies conducted by ENEA, in Italy the energy supply which could come from the uses of the forest biomass, without an impairment of the forest resources, can reach 5% of the final energy consumption, while at the present moment wood fuel covers only 1,5% (AA.VV. 1996). This means that a supervised increase in the forest cutting can represent a flexible type of management able to favour also, in the long term, the qualitative improvement of the yields. In order to promote the development of this market, parallel to the traditional one of timber assortments, it is necessary, however, to develop a demand for the residual biomass, that is for wood chips. This demand, at the present time still very small in the Tuscan territory, is in fact not finding a favourable market, due to the intrinsic characteristics of the wood chips. The product, which comes from the recovery of forest residues, has technical and qualitative characteristics which have not allowed, until now, its use by small residential customers, but only in plants with power equal to or greater than 100 kW. Thus, the demand should gather several small residential customers, who decide to install a centralized system, or large users, such as hospitals, public institutions, etc.
In order to efficiently plan the investments in the wood-energy sector, it seems necessary to have a schedule of the interventions, which will jointly assess both the sustainable supply of forest biomasses and the potentially sustainable energy demand coming from those resources. For this reason, this study has developed a conjoint analysis of the supply and demand for residual biomasses, in a predefined context, by implementing methodologies starting from the Geographic Multi Criteria Analysis and arriving at the definition of long term supply models on renewable resources, with the aim of also assessing the economic sustainability of the local chain.

2. Regulation aspects in the bio-energy chain

2.1. Regulation aspects favouring the development of the forest biomass market for energy purposes

The production of biomass for energy as an additional product from conventional forestry systems is becoming increasingly common. A number of conventional silviculture and harvesting practices can be modified to benefit from utilisation of this additional product.
These practices include intermediate cuttings designed to improve growth and quality of existing stands, increased utilisation of tree and stand components in modified harvesting, and recovery of residual material in post harvest / stand establishment treatments, such as salvage and site preparation. Where markets for biomass for energy exist or are anticipated, considerable forest improvement benefits can be realised from large scale application of such treatments (Manley. and Richardson, 1995).
As previously stated, the strong environmental pressure for energy production is leading countries to promote development of alternative energy sources, especially renewable ones. These political actions turn to the implementation of support measures and to the promotion of project actions for the creation of chains in the agro-energy sector. In particular, at the present time, the main actions characterizing the energy policy linked with the promotion of the forest-energy sector in the Tuscan regional context are as follows:

- Rural Development Plan (PSR) of Tuscan Region (2007-2013) which provided for, through the measure 122, the improvement of the agriculture and forest sector's competitiveness. The main aim is to *"consolidate and develop the farms in the territory and on the markets through the promotion and spread of innovation and through the increase in competitiveness, strengthening* the agricultural and forest productive chains, promoting energy saving and the use of renewable energies (allowing the purchasing of systems for the production of renewable energy).

Scheduled interventions:

- Creation or improvement of the infrastructure facilities for forest formations;
- Improvement of forest area conditions;
- Optimization of forest resource management and increase of wood chain efficiency.

- Measure 227 of PSR pursuant to the aim of *"sustaining non productive investments"*.
Scheduled interventions:

- Capital financing up to 100% of the total expenditure (for public entities), up to 70% for private ones, for interventions dealing with the improvement, protection and development of the forests, in order to strengthen biodiversity, preservation also of high value forest eco-systems and consolidation of the protective function of the forests.

With the two examined PSR measures, it is intended to substantially favour interventions usually characterized by a negative stumpage value and potentially giving timber assortments not suitable for traditional uses (lumber, firewood, etc.), but to be used as wood chips for the production of heat energy.

2.2 Actions for the promotion of developing technologies for energy production and/or bio - fuels from renewable resources

The national regulations, in particular the *December 4, 2007 law, n. 244* (the so called Finance Act), ratified the creation of a Revolving Fund, to be assigned to public or private entities[19], for the financing of measures dealing with the implementation of the Kyoto Protocol; for the three-year period 2007-2009 the eligible measures are as follows:

[19] Art. 1, Paragraph 1110 L. 296/2006

- Installation of small plants for the use of renewable sources for the production of electricity and heat, in the cases in which the whole biomass-energy chain is within the municipal territory or the Upland Authority border (55 million euro);
- Pilot research projects and development of new technologies and of new sources of energy characterized by low or zero emissions.

Along with this regulation, other measures must be added, being provided for in the PSR, which are as follows:

- Measure 125 of PSR, which has the aim of improving the farms' infrastructures, also through the creation of inter-farm works dealing with energy supply and the increase in power for production needs;
  - Scheduled intervention:

  Grant for up to 60% of the total admissible cost.
- Measure 311 of PSR, which has the aim of diversifying rural economy by supporting investments dealing with diversification of farm activities towards non-agricultural activities, even if the agricultural activity must remain the prevailing one.
  - Scheduled intervention:

    Financing for single or associated farmers, for the implementation of systems for the production and sale of energy derived from renewable resources, with a maximum power of 1 MWt. The grant is equal to 40% of the total eligible cost, which can be increased up to 50%, in the case that the investment is done in mountain areas (Dir. 75/268 CEE).

- Measure 321 of PSR, which has the aim of promoting the interventions for the creation or adaptation of energy production plants which use agro-forest biomasses. The plans can be boilers and/or district heating of collective interest settled for the reduction of the energy costs in order to create a benefit for the rural populations and to reduce the environmental external costs linked with the supply/transportation of the traditional commodities (fossil fuels). In particular, plants for the production of heat and cogeneration energy can be created. The recipients of the energy produced are exclusively the private citizens and the public services structures, localized in rural areas, as long as the resident population of the built up area is not more than 5000 inhabitants. Public entities are eligible for the financing, but the plants must not have a power greater than 1 MWt.

Finally, with the Finance Act of 2007, it is interesting to note that the production of heating, electric and thermal energy from agro-forest renewable sources, or from agricultural products deriving from the farmers' lands, is considered to be an income generating activity.
This fact has a tax consequence both for the structures used during the energy production process, which are classified as rural buildings and thus will not be taxed by the municipal property tax (ICI), and on the income generated by the energy production, which will also not be taxed.
Therefore, the regulation aspects promoted at European, national and regional level are towards the accomplishment of a careful policy regarding the promotion and development of agricultural and forest energy resources, compatibly with the objectives of rural development and environmental protection of the less favoured areas.

3. Area Description

The case study consists of an area of about 440 km^2 across the Emilia-Tuscan Apennines (Fig. 1). The territory is almost completely covered by woodlands, having a wood index of 82%.
The analysis of the wood component, carried out on the basis of the land use map of *Corine Land Cover* V level, highlights the prevalence of some species, such as Chestnut (*Castanea sativa* Mill.)

and Beech (*Fagus sylvatica* L.), while among the most widespread conifers it is possible to find Silver fir (*Abies alba* Mill.), Norway spruce (*Picea abies* Kartstens), Douglas fir (*Pseudotsuga menziesii* Franco) and Black pine (*Pinus nigra* Arnold).
The most common silvicultural system (with more the 80%) is coppice.
As for the market of wood products, it is possible to notice that the chestnut woods had a strong relevance for the local economy in the past, both for the wood products derivable from them (timber, round timber, pulpwood bolt and tannin production) and for the fruit. As a consequence of several phytosanitarian problems on behalf of this species, such as cortical cancer and ink disease, chestnut and coppice woods have been progressively abandoned as cultivations.
Instead, the production of firewood plays still a very important role. Among the most relevant production vegetations are coppices of beech, Turkey oak (*Quercus cerris* L.), European hophorn-beam (*Ostrya carpinifolia* Scopoli) and Common acacia (*Robinia pseudacacia* L.), while it has almost disappeared the production of coal, widespread until a few decades ago in beech woods.

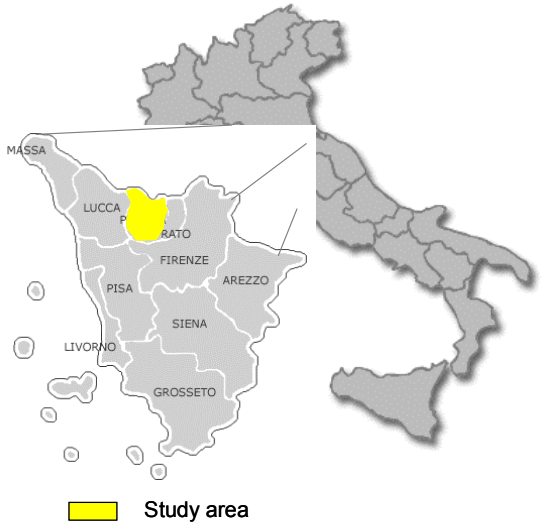

Fig.1 Study area

4. Methodology to define the potential demand for wood chips and the potential supply of forest biomasses

4.1 The potential demand for wood chips

The need of acquiring useful elements in order to assess the potential demand for dry wood biomasses (wood chips), together with the analysis of the feasible dynamics that this demand could activate at local level, orientated the research towards the structuring of a survey methodology able to classify the actual built-up area in the study area, in function of suitability to the installation of collecting heating plant fuelled by wood chips.
In order to define *sets* of specific indexes for each question, and in order to guarantee the "participation" of the local communities, it has been use an approach developed on environmental decision-making analysis models, based on multi-criteria techniques. The main important benefit in using multi-criteria evaluation (MCE) consists on the chance of considering at the same time a big amount of information and models belonging to different disciplines, thus giving a helpful support to not completely structured decision-making questions (Munda, 1997). In the formalisation of these geographic multi-criteria analysis models it is firstly necessary to specify that each decision-making criterion is represented by a specific thematic map called *layer*. Thus, decision-making variables of the model (in a Geographic Information System raster) are the different *pixels*, which

show the potentiality of the territory in respect to a specific characteristic. For this reason, and for the biomass supply analysis, it has been set up a GIS raster (75x75 meter) of the examined area, made up of:

- Land use map drawn from the database of the *Corine Land Cover*, level 5th, from which the data on forest areas have been derived;
- Regional Technical Cartography (RTC), in scale 1:10,000, from which the data regarding the major roads and the residential and productive (industrial and commercial) areas have been derived;
- Regional Technical Cartography (RTC), in scale 1:2,000 (where available), from which the data regarding the civil and administrative building volumes have been derived;
- Digital elevation model DEM (75x75 meter) from which the data on slope and barrier have been derived;
- Methane distribution system cartography (operators working in the study area: *Fiorentinagas*, *AMAG – CIS* , *Toscana Energie*).

In order to get to a classification of the built-up area to be used to determine the degree of suitability, it has been defined a set of indexes capable (tab.1) of representing a series of aspects through linear functions (fig.2, fig.3), among which:

- **Volumes of the buildings** (factor directly proportional to the heating needs of the building);
- **Distance from the methane distribution system**; methane represents, nowadays, a competitive fuel compared with wood chips both in terms of economic efficiency and of flexibility in the use. For this reason it has been considered a "membership function", which takes into account the closeness of the methane distribution system;
- **Road accessibility of the area**; the distance from the major roads gets a relevance, in fact, mainly on the aspect of the accessibility to the distribution system and, thus, to the supplying costs of the raw material;
- **Density of the built-up area**; the density of the buildings represents an important factor for the definition of the in the heating plant conversion. The opportunity of creating a collective heating system increases proportionally to the increase in the number and in the density of the buildings. In order to assess this aspect, it has been introduced another index, which is able to evaluate the density of the built-up area. (*The index is the density coefficient H, which, for each pixel of the study area, shows the density of the buildings depicted for a surrounded squared area of 7x7 pixels. In the specific case, because the pixels had the dimensions of 75 meters, the mobile window frame has an area of 5.625 m^2).*

During the process of aggregation of the different indexes, the relative importance of each of the indexes has been, then, defined thanks to the use of a multicriteria geographic analysis (AMC), based on the analysis of the hierarchies (Analytical Hierarchy Process - AHP) (Saaty, 1980). In this specific case, the application has been adapted to the determination of the priority/relevance that the different factors (presence of a methane distribution system, accessibility, heating needs, etc.) have in the accomplishment of the objective (*goal*), which is the determination of the suitability of the buildings in the installation of collecting heating plant fuelled by wood chips.

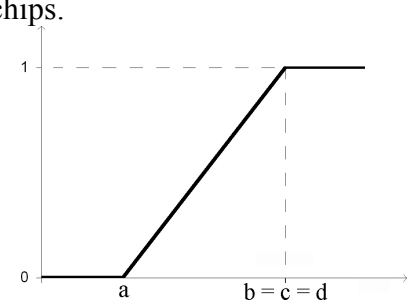

Fig. 2.Linear monotonically increasing function

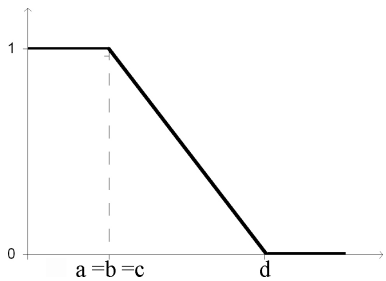

Fig. 3. Linear monotonically decreasing function

Function	*Weight*	*Function Type*	*Control points*				*C.I.*
			a	*b*	*C*	*d*	
Volumes of the buildings (m^3)	0,1858	Linear increasing	0	22.628	-	-	0.01
Distance from the methane distribution system (m)	0,2405	Linear increasing	200	1.000	-	-	
Road accessibility (m)	0,2405	Linear decreasing	-	-	0	1.000	
Density of the built-up area	0,3331	Linear increasing	0	1	-	-	

Tab. 1. Built - up area suitability: evaluation parameters

4.2 Forest biomass supply

On the theoretical and methodological point of view, the modelling of the forest biomass supply must consider at the same time biological-ecological, economic, technical and institutional factors. In this specific case, biomass being a renewable resource, its "sustainable" management must consider the natural capital *stock* required in order to guarantee the survival, reproduction and resilience of the ecosystem. Moreover, the maximum tax of taking out allowed must not be higher than the growth rate of the forest cover at the detected *stock* level (Pierce e Turner, 1991). Numerous are also the economic variables which influence the forest production, among which it is possible to recall the price of the products, the production costs, the farmer's objectives. The forest production, in addition, has its root on complex ecological processes and this implies the need for considering, during the analysis of the supply, the bonds due to the silvicultural systems, to the forest management and to the adoptable technologies in relation to the orographic conditions.
Therefore, it is evident that the complexity of the phenomena involved has led to the development of different forest product supply models.
In this study, two supply models have been developed, each of which derive from two different approaches:

- Optimal supply models for area unit (through the detecting of the optimal rotation[20]);
- Long term cumulative supply models, which work on the basis of the steady state balance and, thus, on approaches deriving from the renewable resources theory (Pearce e Turner 1989).

Relative to the supply model per surface unit, three different supply typologies have been defined, in relation to three different development hypotheses for the wood chain:

1. Production of traditional timber assortments as the existing chain model in the area of the Tuscan Apennines;
2. Production of only wood chips, through chipping of the whole plant and loss of the traditional market;
3. Production of traditional timber assortments to which are associated the production of wood chips deriving from the residues of the forest uses.

4.3 Supply model for surface area unit

The model used in order to assess the optimal supply of wood product for area unit refers to evenly aged forests in which the production is assessed considering the ordinary rotation for the different forest species and for the different managing forest systems. Even if the traditional model used for the definition of the unit supply refers to rotation optimization models (Reed and Errico, 1989; Bernetti 1999), this study considers the commonly used rotation of the area, because it is more typical of the local social-economic situation and of the productive aptitudes of the forest areas. The

[20] In this specific study, the optimal rotation considered is the one commonly used in the examined area.

definition of the rotation and of the corresponding resource *stock* (stumpage) allowed the evaluation, for each type of wood, of the annual average supply for area unit.
Such a condition is obtainable, for instance, in the case of normal evenly aged forests, through the application of area regulation methods. The application of this method consists of a subdivision of the forest *S* in *T* areas of width equal to *S/T*, where *T* represents the rotation period of the tree species in the forest. This means that if the woods will be structured in a certain number of compartments with the same area and of an increasing age until the maximum age *T*, they will provide for an annual product per hectare, which will be derived from the ratio between the stumpage of the T_q- compartment which is yearly cut and the rotation period T_q of each wood typology *q*, and they will have a resource *stock* per hectare deriving from the summation of the average increment of the *$(T_q$ -1)-tee* compartments. Formally:

$$x_q(t) = \sum_{i=1}^{T_q - 1} x_{i,q} \qquad with = T_q - 1 \qquad (1)$$

where:

$x_{i,q}$ = yearly average increment per hectare for the particle of the *q* forest typology *q* at the age *i*-

$x_q(t)$ = *stock* of biomass per hectare of forest cover of *q* forest typology at moment *t*;

T_q = usual rotation period of the forest typology *q*.

Being the resource *stock* $x_q(t)$ function of the rotation period applied for each typology of forest cover T_q and being the annual yield per hectare x_q^* function of the *stock*, consequently x_q^* will be the function of the rotation period T_q

$$x_q^* = \frac{x_q(t)}{t} \quad with\ t = T_q \qquad (2)$$

x_q^* = annual yield per hectare of *q* forest typology area

In order to evaluate the value of the available assortments from each forest typology it was necessary to define:

- Annual yield productivity (per hectare), that is the annual yearly average increment of each forest typology relative to the usually adopted rotation period in the examined area (Bernetti et all., 2003);
- The assortment table of each forest typology, (tab.2);
- The price indicative of each available assortment (AA.VV., 2007), (tab.2).

Wood Typology[21]	*Roundwood*		*Pulp wood and for packaging*		*Post*		*Firewood*		*Residues*	
	% on total	*Price €/t*	*% on total*	*Price €/t*	*% on total*	*Price €/t*	*% on total*	*Price €/t*	*% on total*	*Price €/t*
Woods with prevalence of chestnut	0	0	0	0	79	88	0	0	21	60
Woods with prevalence of beech	0	0	0	0	0	0	72	100	28	60
Prevalence of mesophyte broad leaved woods	0	0	0	0	0	0	88	100	12	60
Woods with prevalence of fir	65	135	25	135	0	0	0	0	10	60
Woods with prevalence of mountain pine	0	0	90	73	0	0	0	0	10	60
Woods with prevalence of Medit. pine and cypress	0	0	77	59	0	0	0	0	23	60
Woods with prevalence of oak.	0	0	0	0	0	0	77	100	23	60
Woods with prevalence of exotic broad leaved species	0	0	0	0	0	0	74	100	26	60
Woods with prevalence of exotic conifers	65	152	25	76	0	0	0	0	10	60

Tab. 2. Available assortments from each wood typology and their average prices.

4.4 Geographic model of cumulative supply

The model of cumulative supply used in this paper is a long period model in which it is considered at the same time the desired natural capital *stock* and the sustainable drawing rate (Bernetti, 1999, Panichelli and Gnansounou, 2008). In this specific case, the model represents a long term planning tool which is capable of answering several concerns, such as the capability of supporting definite production costs, both marginal and average, and the exploration of the optimal width of the forest cover able to efficaciously answer to a precise level of demand for wood products (Bernetti, 1999). In particular, thanks to the creation of a Geographic Informative System with a raster basis, it has been possible to define a cumulative supply model which is characterized by a good level of accuracy, of detail and of correspondence with the real situation.
The model can be syesized with the following algorithm:

The forest area is represented through a raster geographic database. To each pixel a set of variables (q) is linked. The variables are ecological (species, fertility, sustainable silvicultural system, etc.) geographic (slope, distance to the market, accessibility, etc.) and productive (sustainable drawing, assortment allocation, etc.);

[21] The detected wood typologies refer to the ones represented in the 5th level Corine Land Cover. Since the categories are quite wide, in a few cases it has been necessary to refer to a mean of the yearly average increment of species belonging to the same gender.

Assuming that the distribution of the forest cover age of the *q*- forest typology is approximately regular between 0 and T_q, it is possible to define the total quantity of product which in theory can be used each year in correspondence of the usual rotation period T_q, such as the productivity x_q^*, defined for each pixel through the supply model per area unit;

If the total production costs $ctu_j(q)$, calculated for each pixel, are less than or equal to the price of biomass ($ctu_j(q) \leq p$), this means that pixel can be used with a profit;

The total supply obtainable in correspondence to a specific price, is then defined as the sum of the yearly average optimal productions, derived for the wood typologies *q*, placed in the class of distance *j*:

$$S^*(p) = \sum_{j \in J(p)} A_j(q) x_q^*(p) \qquad (3)$$

$$s.a.$$

$$J(p) \mid ctu_j(q) \leq p$$

where:

$A_j(q)$ = total area with a forest cover of typology *q*, placed in the *j*- class of distance;

$x_q^*(p)$ = yearly average optimal production for area unit of the forest cover of typology *q* at price *p*;

$J(p)$ = total of the in production compartments at price *p*;

$ctu_j(q)$ = total production costs per 100 kg of extracted biomass from the forest cover of typology *q* placed in the class of distance *j*;

p = price of biomass.

The greater the prices, the greater the area of the different forest cover typologies with a positive stumpage value, which will also go to increase the total supply quantity.

4.5 Unit production cost

The unit production cost represents the parameter of the model that is more dependent on the geographic characteristics.

In the forest sector, in fact, the production costs depend on the following aspects:

- *in situ* characteristics of the soil and of the forest cover;
- location of the wood in respect to the market;
- cost of the production inputs.

In this study, the production costs for each pixel of the examined territory have been calculated with a geographic cost model which led to the creation of "cost maps", which are representative of the *in situ costs* (felling and outfit costs) and of the *location costs* (wood logging and transportation to the stock centres), but also of the feasible chipper in the brow (Fig. 4). The model cost, relatively to wood logging, also took into account the presence of natural barriers, such as catchment areas or ridges. The wood logging has been presumed done with skidder or with aerial cableway (depending on the slope, on the distance to the main roads and to road density) as it is illustrated in the model in equation 4.

$$C = \begin{cases} C_{i,skid} \begin{cases} \text{if forestal road density} \geq 20\, m/ha \\ and \\ \text{if slope} \leq 30\% \end{cases} \\ C_{i,tel} \begin{cases} \text{if main road distance} \leq 600\, m \\ and \\ \text{if } 30\% < \text{slope} \leq 70\% \end{cases} \end{cases} \qquad (4)$$

Where:
C_i = wood logging cost of pixel *i*--;
$C_{i,\ skid.}$ = wood logging cost of pixel *i*-- with skidder;
$C_{i,\ tel.}$ =wood logging cost of pixel *i*-- with aerial cableway;

As for transportation, considering that the distances to be routed in the examined case have been always less than 10 Km, only the use of tractor trailer has been hypothesized.
Thus, the total cost model arrived at the definition of the total production cost $ctu_j(q)$ of wood assortment and/or wood chips for each pixel of the geographic database.
Finally, the comparison among the production costs of each pixel and the market prices of the traditional assortments and of the residual biomasses arrived at the definition of the biomass supply of the examined area.

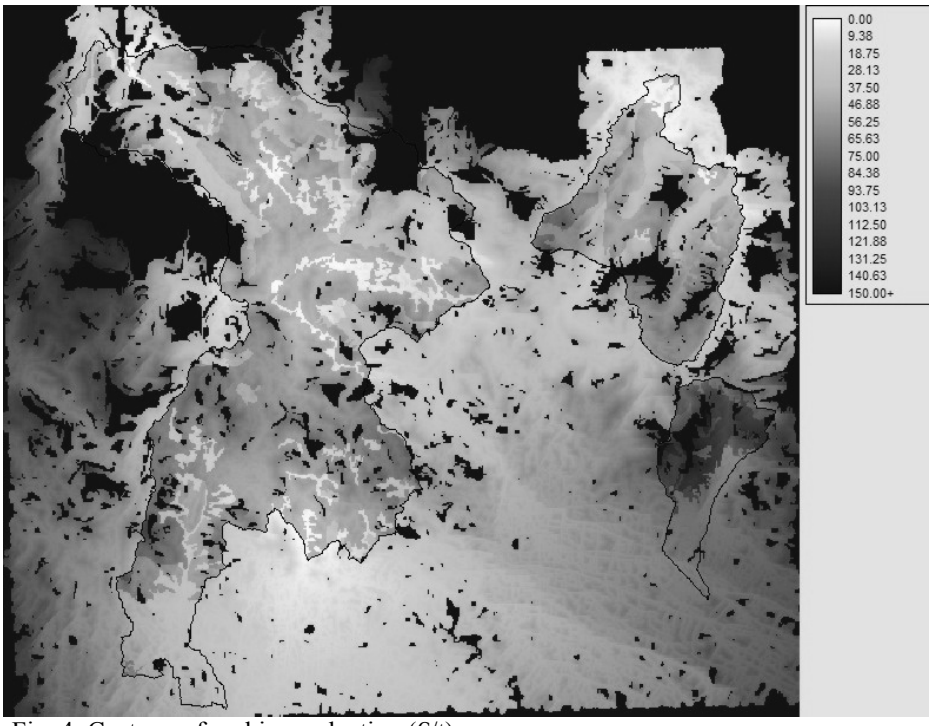

Fig. 4. Cost map for chip production (€/t)

5. Results

The application of MCE methodology, in order to assess the potential demand for dry wood biomasses, led up to the classification, on the basis of the suitable degree from low to high (fig.5), of the civil and administrative buildings of the study area. The final result of the analysis showed that the volumetry of suitable conditions of buildings (residential and administrative buildings) is equal to 19.121.746 m^3, subdivided into:

proper

- High suitable conditions = 5.687.867 m^3
- Medium-high suitable conditions = 3.119.832 m^3
- Medium suitable conditions = 5.353.339 m^3
- Medium-low suitable conditions = 4.243.736 m^3
- Low suitable conditions = 716.972 m^3

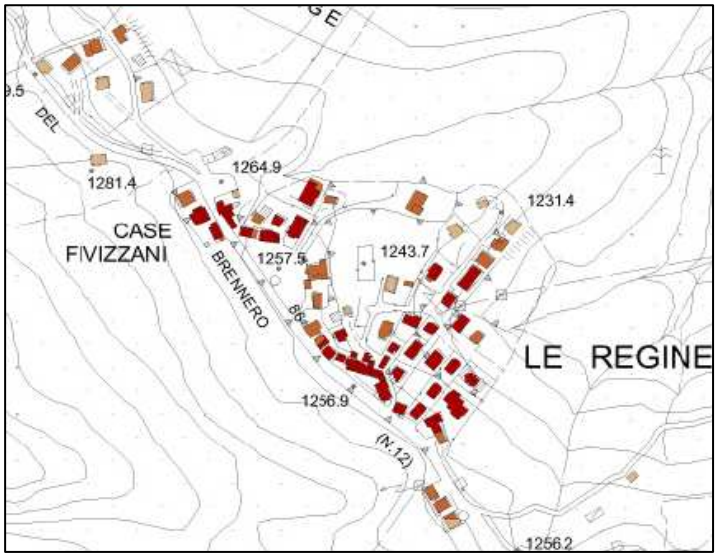

Fig. 5

Map's detail, on the built – up in the whereabouts *Le Regine* – Abetone; suitable conditions in a red scale (increasing vocation from pink to dark red).

As for the forest biomass supply (wood chips), the analysis came to the definition, for each hypothesis, of the positive stumpage value areas and of their attainable quantities of wood biomass. Considering that the total forest area of the examined case study is 36,367 hectares, achieved results are as follows:

- **First Scenario**: production of traditional assortments
  - Potential area of positive stumpage value: 16,341 ha
  - Amount of traditional assortments economically usable: 48,163 t of which 15,252 t are of firewood.
- **Second Scenario**: production of wood chips only
  - Potential area of positive stumpage value: 23,539 ha
  - Amount of wood chips economically usable: 84,050 t.
- **Third Scenario**: production of traditional assortments and wood chips deriving from the residues of the forest harvesting
  - Potential area of positive stumpage value: 22,208 ha
  - Amount of traditional assortments economically usable: 62,804 t of which 17,936 t of firewood
  - Amount of attainable wood chips: 16,826 t.

If we consider an average net calorific value (PCI) of wood equal to 3.5 kWh/kg, and an average yearly heating requirement of the construction, for the area of the case study, of about 45 kWh/m^3, the volumes which could potentially be heated, thanks to the local resources, for the different scenarios will be:

- **First Scenario**: firewood only;
  heating requirement coverage equal to 21% of the highly suitable volumetry.
- **Second Scenario**: wood chips only;
  heating requirement coverage equal to 100% of the highly suitable volumetry and to 27% of the medium-high one.
- **Third Scenario**: firewood and wood chips; heating requirement coverage equal to 25% of the highly suitable volumetry, with firewood;

heating requirement coverage equal to 23% of the highly suitable volumetry, with wood chips.

6. Discussion and conclusion

The territorial approach proposed in this study came to the definition of an extremely detailed informative frame, both on the side of the wood biomass (chips), through the classification of each building in the examined area, and to the side of the wood product supply (traditional assortments and/or chips).
As for the heating demand, the classification to which this paper arrives at allows a more efficient planning of the investments linked to the development of technologies capable of using renewable energy resources, thanks to the identification of residential areas which are more suited to the implementation of collecting heating plants fuelled with wood chips.
As for the assessment of the demand, the data regarding the production costs, thus the data concerning the adopted techniques for timber felling, wood logging and transportation of the materials, are the more relevant ones. Even if those values are known for the production of traditional assortments, they represent an experimental case study for the production of wood chips (these being techniques not commonly used).
As for the supply of wood products, by doing a comparison between the scenario regarding the production of traditional assortments and the one regarding the production of wood chips only, it results that the second hypothesis is more convenient in respect to the production of the traditional assortments, for an area of about 22,200 ha.
The production of wood chips only is more convenient for the areas in which the woods produces assortments of very low value; this is the case of chestnut woods, in which timber and firewood are of lesser value. The technique of chipping from the full tree system, as proposed in the model of cost, allows, in fact, a greater reduction in the production costs if compared with the costs introduced in the wood chipping phase. The elimination of the bucking and lumping operations (de-branching and depreciation) determines, in fact, a reduction of the labor time of about a 70%.
In conclusion, the results of the study highlight that the local production of forest biomasses could meet the heating requirement of a high number of residential customers. As for the projected scenario, the supply could cover the requirements of 1.200.000-6.500.000 m^3 of residential and commercial construction. They represent important customers that, within a process of local economic development, could ensure the creation of a rare synergy between economic development and environmental sustainability.

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2. *The sustainable exploitation of forest logging residues for energy purposes in France*

Astrid Genet[a*22] and Manuel Nicolas[b]
[a] Lehrstuhl für Forstliche Wirtschaftslehre der TUM, Am Hochanger 13, 85354 Freising, Germany
[b] INRA UR 1138 Biogéochimie des Ecosystèmes Forestiers, 54280 Champenoux, France

Abstract
As a reaction to climate change issues and in order to help reduce the amount of carbon dioxide in the atmosphere, populations have to enhance the use of renewable energies in their fuel share. Under these conditions, biomass and especially wood is a promising source of energy.
In France in 2005 the use of wood biomass for energy purposes represented 9.3 Mtoe and this figure could be increased by 50% by 2010 (ADEME).
Considering the physical and economical constraints of wood harvesting, an intensification of the exploitation is expected. Intensified harvest for energy purposes should mostly take the form of the exploitation of the forest logging residues that could have consequences on the long-term sustainability of forest ecosystems by endangering soil fertility.
As a matter of fact, nutrient contents of fine branches and foliage are higher those of stems. Exporting these fine compartments out of forest can severely increase nutrient removal. The definition of the exact impact of an additional nutrient export on soil fertility requires an analysis of nutrient cycling within the ecosystem. Mineral budgets reveal that poor nutrient inputs by mineral weathering make acid soils very sensitive to intensified harvests without compensatory fertilization. Calcium, Phosphorous and Nitrogen seem to be the most concerned elements. Moreover slash removal can modify other soil properties by depleting woody litter and increasing compaction constraint. Thus unreasonably intensifying harvest for energy may degrade soil biodiversity, forest health and wood production.
A handbook was published to help forest owners to define sustainable slash management depending on local soil sensitivity. These guidelines must now be included in quantifying slash potential for energy on a wider scale to improve national policies for sustainable wood energy development.

Keywords: Energy wood, forest residues, slash harvesting, nutrient budget, soil fertility

Introduction: context and problematic

The energy bill of the 02/05/2004 proposes to reduce France's energy intensity (i.e. the ratio of energy consumption to Gross Domestic Product (GDP)) by 2% each year until 2015, and then by 2.5% until 2030. This involves tackling three key issues: the fight against climate change, the protection of resources and the conservation of our environment. France is now extremely dependent on imported fossil fuels, which are by no means an unlimited resource. According to some experts (French Institute of Oil (IFP), Association for the Study of Peak Oil (ASPO)), if energy consumption remains at current level, oil could run out in only 40 years time. Added to this is the risk of soaring oil prices, which would in turn severely impede economic competitiveness. The major challenges set within the scope of France's energy policy are to manage energy demand by extending the range of technological sources of production and supply. Research in the clean energy sector has then to be developed in order to guarantee a supply adapted to consumption and environmental requirements.
In France, wood in all its different forms covered 4% of the total energy needs of the country in 2005 and France is the first wood energy consumer in Europe (Figure 1).

[22] Corresponding author. Tel. (49) 8161714635; Fax. (49) 8161714631; e-mail: genet@tum.de

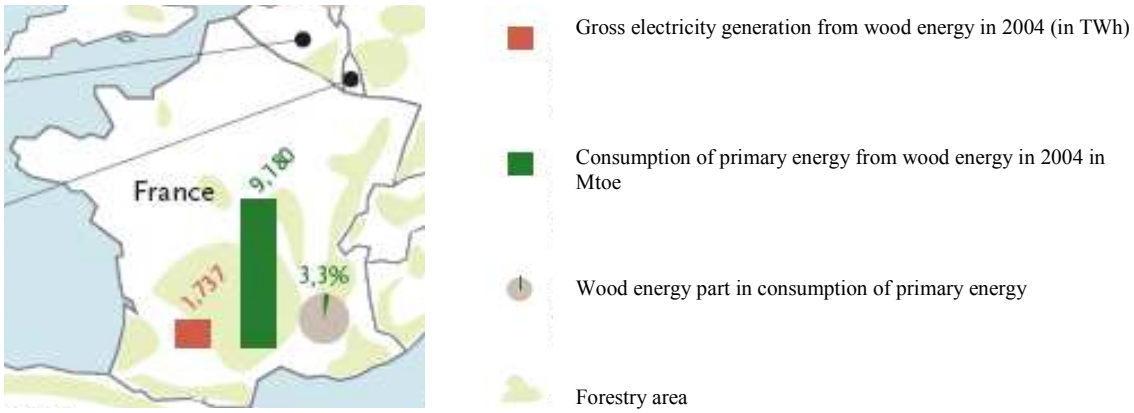

Figure 1: Consumption of primary energy and gross electricity generation from wood-energy in 2004.

The consumption of wood energy in France reached 9.3 Mtoe[23] in 2005 (French Environment and Energy Management Agency, ADEME / Centre of Economic Study and Research on Energy, CEREN) and this position of European leader in wood energy consumption is essentially due to the use of wood in domestic heating (approximately 7.4 Mtoe). In terms of the individual habitat, more than 5 million households are equipped with wood heating (45% inserts and closed fireplaces, 27% open fireplaces, 13% heating stoves, 9% cooking stoves and 6% individual boilers, Source: Wood Energy Barometer, 2005).

The ADEME's missions and the tax law on apparatus using renewable energies (40% tax credit) aims to accelerate installation replacements with high-efficiency wood heating apparatus as well as to increase the size of total national installed capacity.

The "Wood Energy Plan 2000-2006" implemented by the ADEME also included an important section for development of wood energy in the industrial, collective and tertiary sectors. This plan resulted in an implementation of +1400 collective boilers and +480 industrial boilers. This means an increase of +376% of the national amount of wood-fired boiler plants i.e. an additional wood energy production of 45.000 toe/year.

A new plan has been implemented for the years 2007-2010 which objective is to allow the saving of an other 0.3 Mtep. This would mean the substitution of an additional 80.000 toe/year by the end of 2010 (Fig. 2).

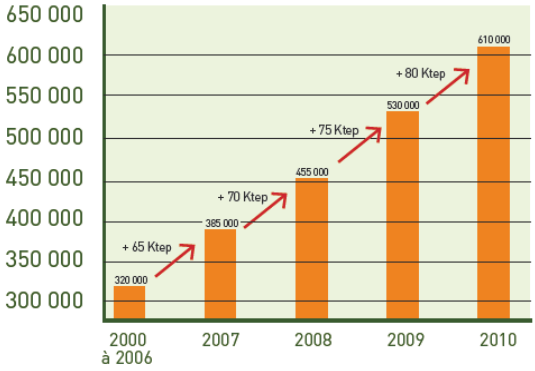

Figure 2: Objectives of the "Wood Energy Plan 2007-2010".
Evolution of the quantity of substituted fossil fuel (tep)

The wood energy sector is clearly booming currently in France, but the renewal of the sector asks the question of the fuel supply. The growing number of boiler plants will lead not only to an increased competition between them, but also with the paper industry. Then in order to keep the transportation costs as low as possible (the raw material's price has to remain competitive), boiler plants are expected to try to cover their needs in fuel in a reduced supply area. This expected

[23] Million Tons of Oil Equivalent

evolution towards an intensification of the exploitation of the combustible biomass resources augments the interest for the field of logging residues harvested for energy purposes.
Within this framework, the National Forest Inventory (IFN) led a study (2004) in order to evaluate the availability of wood-energy resources at both national and regional levels. Loggings residues appeared to be a reserve of 34 millions of m^3, i.e. 7.3 Mtoe on the French territory. Figure 3 shows the geographic distribution of the theoretical wood-energy supply.

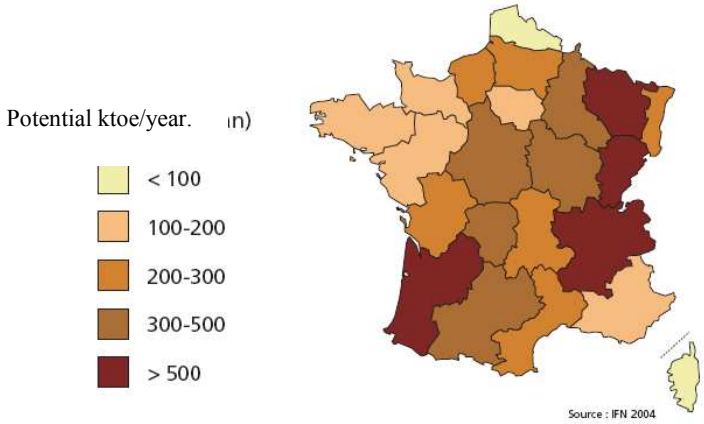

Figure 3: Logging residues of the current forest exploitation in France
Source: EurObserv'ER 2005

However we know that slash removal can have a negative impact on soil fertility. As a matter of fact, it is now well established that the concentration of nutrients in fine branches, bark and foliage is higher than in stem wood. The increase in biomass harvested from a site (whole tree harvesting, or logging residues extracted in a separate operation after conventional harvesting) increases therefore disproportionately the removal of nutrients and could threaten the fertility of the soil.The question then is to know if and how an intensification of the forest exploitation by slash removal could be tolerated by the forest ecosystems.
Not every type of soil has the same sensitivity to nutrient uptake. Forests are generally located in areas in which soil would not be appropriated for agricultural purposes: shallow calcareous soils or with a high proportion of rocks or acid soils on siliceous bedrock. Calcareous rocks contain a high amount of nutrients (except Nitrogen) whose export can easily be compensated by alteration. But forest ecosystems located on acid soils are far more sensitive to nutrient uptake due to harvesting.It is then interesting to compare the IFN map of the geographic distribution of the logging residues (Fig. 3) and the map of bedrock alteration capacity and French soils (Party, 1999) (Fig.4).

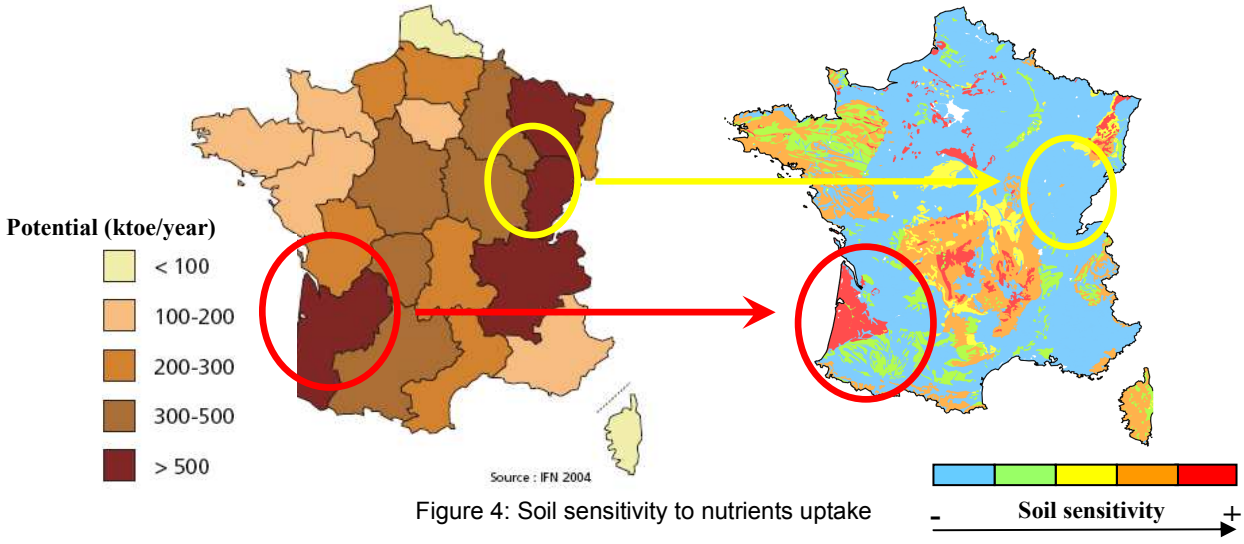

Figure 4: Soil sensitivity to nutrients uptake

It appears that for example the French administrative region Franche-Comte has a potential of 517.000 toe/years located on low sensitive calcareous soils, whereas the very important potential (917.000 toe/year) in the Aquitaine region is mostly located in highly sensitive sandy soils.

In order to ensure the durability of forest ecosystems over the time and through the development of wood-energy fuel, we really have to take into consideration the consequences of slash removal on soil fertility.

Nutrient dynamics in forest ecosystems

In a forest ecosystem, trees take up nutrients from the soil system. Those nutrients are then reallocated within the different tree portions (trunk, branches, leaves and roots) during stand growth. Most of this nutrient uptake is returned every year to the soil through litter fall (Ranger *et al*., 2003). Then litter is decomposed and nutrients are available again for the vegetation. This very efficient internal cycling process is the main source of nutrients for the stand and the whole ecosystem is based on it. The important needs of trees for nutrients can then be satisfied in the long run, even if the available reserve in soils would only account for some years or dozens of years of root uptake. But this quite efficient model can easily be disturbed by external interventions in the recycling process, mostly induced by harvesting practices.
However, this cycle is not closed and nutrients permanently come into and go out of the forest ecosystem (Ranger & Turpault, 1999), carried out by the following fluxes (Fig. 5):

- Contributions through atmospheric deposition;
- Contributions through bedrock alteration (except for Nitrogen), since mineral dissolution releases mineral elements – contribution will then be low for siliceous bedrocks like sandstone and high for bedrocks like limestone or basalt;
- Loss by leaching below the rooting zone in the direction of underground water;

Loss by exportations, essentially due to biomass harvesting.
When more nutrients go out of the ecosystem than come into it, it becomes unbalanced and could fail to function. The stock of bio-available elements will diminish and in the long term deficiencies could appear and some nutrients could even fail. Mineral budgets indicate that Calcium is the most susceptible nutrient to be depleted by intensive harvesting on acid soils (Freedman *et al*., 1986 ; Hornbeck *et al.*, 1990 ; Ranger *et al*., 2002). Phosphorous and Nitrogen are also concerned by depletion (Cacot *et al.*, 2003).

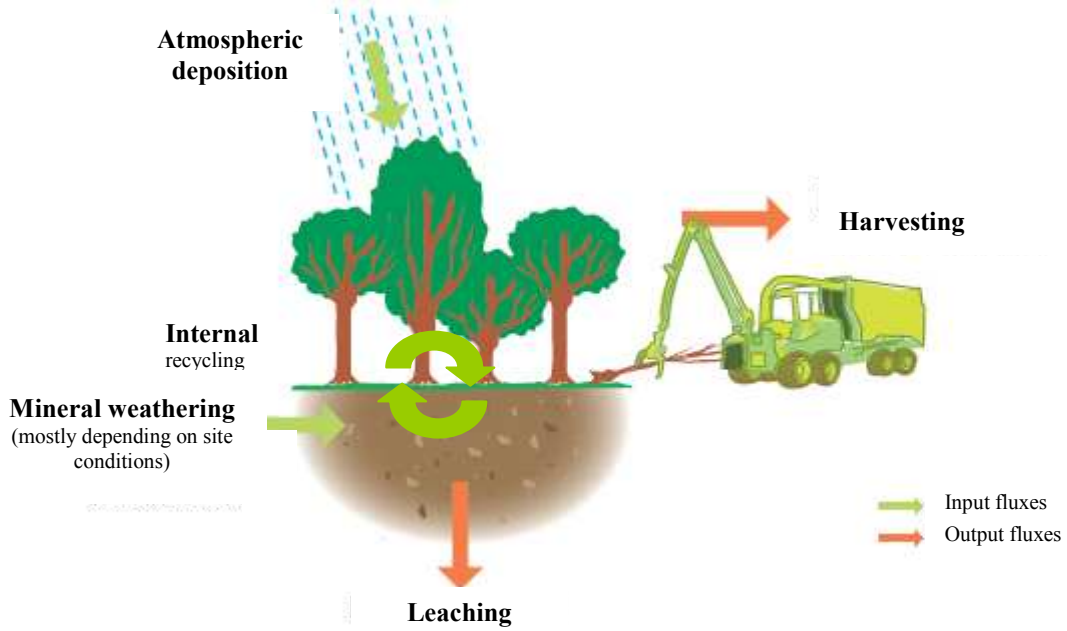

Figure 5: Nutrient cycling in forest ecosystems

The ability of a given ecosystem to tolerate consistent and permanent nutrient output closely depends on the external contributions it gets, mainly on mineral weathering from bedrock (Moucoulon *et al*., 2004).

The question to be now precised is: in what ways the logging residues harvesting for energy purposes can worsen the mineral balance of a forest ecosystem?

Potential impact of logging residues harvesting on soils and ecosystem

Whatever the species and whatever the site, small branches and leaves/needles contain the major part of tree nutrients whereas their biomass is very low (less than 10% for the added needles and branches in a Douglas fir stand older than 40 years) (Ranger *et al.*, 1995). Figure 6 shows an example of the nutrient distribution between aerial tree portions (needles, branches and stem) in a Douglas fir stands at different ages. Experimentations were conducted on the site of Vauxrenard (Beaujolais Mountains, France).
Thereby we can deduce that logging residue harvesting induces an important removal of nutrients from the ecosystem. In some cases (N, P or Ca under 20 years), this nutrient removal can be up to three times higher than it is with conventional harvesting, when the quantity of added biomass is very small in regard (30% for a 20 years old Douglas fir).
Additionally, Figure 7 illustrates the fact that the decomposition process is much faster for leaves and twigs than it is for bigger branches or stems. That means that the smallest and youngest tree parts are the most quickly and easily mineralizable ones to available nutrients.
In summary, harvesting logging residues results in the removal of a huge amount of quickly re-available nutrients whereas it brings limited biomass for energy. Therefore it can severely affect fertility and forest health on acid soils by strongly depleting the nutrient cycling process.
From Cacot *et al.* (2003), harvesting logging residues has other consequences on soil properties. First, whole tree harvesting logically reduces fresh woody litter fall that feeds a huge diversity of soil fauna and microorganisms. Moreover logging residues act as a thermal insulation material, and their removal modifies the microclimate on the ground level – temperature, moisture, wind speed (Proe *et al.*, 2001). These modifications to soil properties may explain consequences on other aspects:

- the flora: roots mycorhization is reduced because of the reduction of symbiotic species (Mahmood *et al*., 1999). The flora is then modified to the profit of non-forested herbaceous species,
- the stand growth and production which are both reduced (Nzila *et al*., 2002),
- the forest regeneration: microclimatic changes result in a higher mortality for the young seedlings of certain species to the profit of "pioneer species" (Cacot *et al*., 2003)
- the soil fauna: some fauna groups (collemboles, spiders, dipterous larvaes) are impoverished on the long run (Bengtsson *et al*., 1997).

Slash removal is sometimes presented as a way to reduce nitrogen leaching (nitrate) and loss of nutrients, especially after clear cuts. In fact, the effect of clear felling and slash removal on leaching losses is not so obvious and studies show that there is no relation with the quantity of nutrients left on the site after harvesting (Cacot *et al*., 2003). Weeds booming and vegetation control on nitrification process could probably explain the differences observed between the results (Jussy *et al*., 2004).
As for the physical properties of soils, slash removal also has a significant impact. Indeed, harvesting branches increases forwarder load or traffic frequency. In addition residues offer protection (brash mats) to soil against erosion and compaction by machines (Hutchings *et al*., 2002 ; Eisenbies *et al*., 2005) but then they become improper to be exploited. Hence removing logging residues can accentuate physical impacts of machines on soil.
However slash removal has a positive effect on fire prevention in Mediterranean areas, even if this effect seems less efficient than understorey and brush cleaning (Cacot *et al*., 2003).

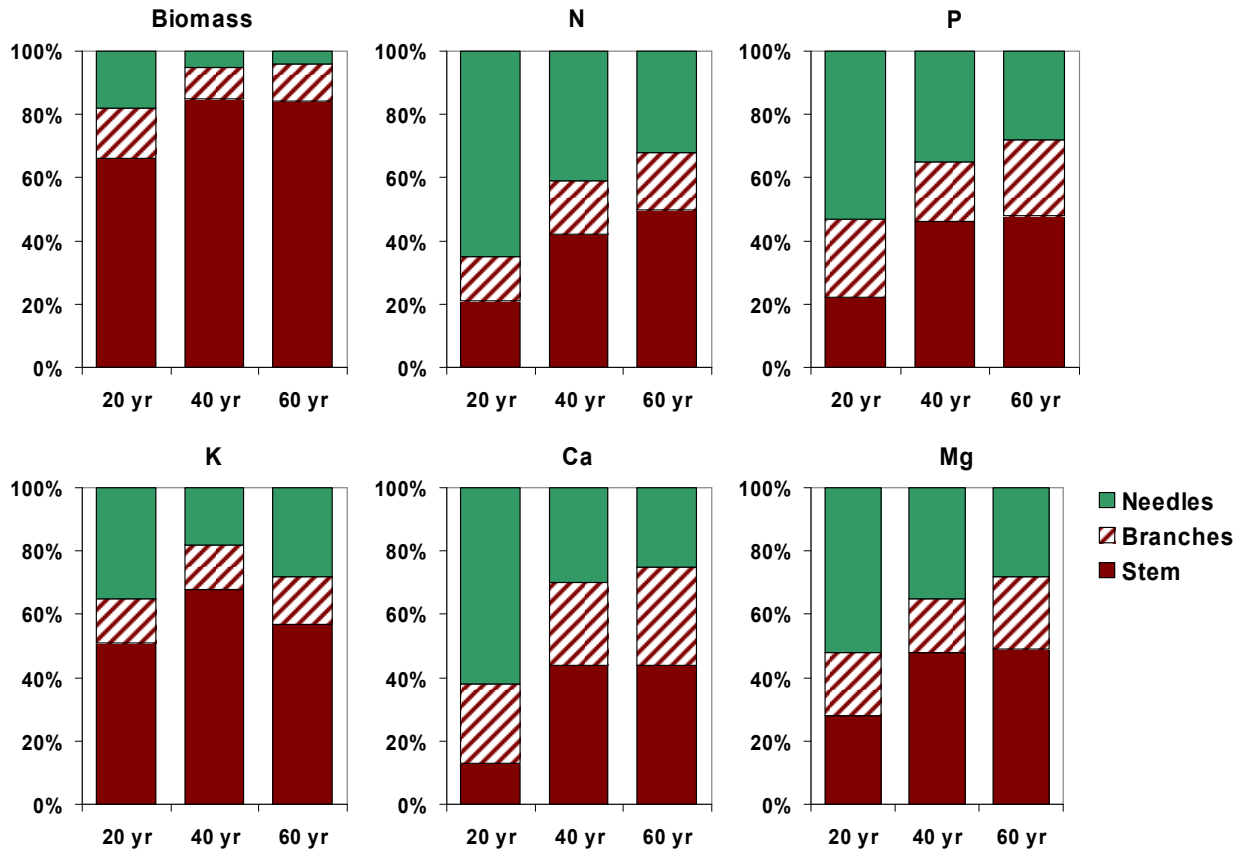

Figure 6: Biomass and nutrient distribution between aerial tree compartments (needles, branches and stem) in 20-, 40- and 60-year old Douglas fir stands in Vauxrenard site. From Ranger *et al*., 1995.

Sustainable slash management

As we saw before, logging residues are at the heart of the nutrient recycling process and then of the chemical fertility of soils. Their removal and even more when exporting the needles/leaves with the branches can lead to a durable impoverishment of the ecosystem.

Then potential harvest intensification must be reasonably restricted in order to satisfy the growing demand for wood-energy while ensuring the sustainability of forest ecosystems over the time. Limits must be fixed depending on ecosystem sensitivity before definitely quantifying slash biomass deposit for energy.

To this aim, ADEME published a technical handbook for reasonable slash management in forests (Cacot *et al*., 2006). The principle is quite simple. The first step is to define soil sensitivity to nutrient removal with a 3-class typology based on easy criteria: pH of top mineral soil layer or at least humus type and broad soil texture (mostly sandy, silty or clayic). Then potential frequency of slash removal is indicated according to soil sensitivity class (from 0 to 2 slash harvests during stand lifetime) and fertilisation amount is prescribed in case of exceeding the frequency limit (Fig 8).

In any case leaves must be left on the forest floor, by harvesting broadleaved branches in winter or by leaving logging residues between 4 and 6 month on forest floor before removal. And slash harvest frequency cannot exceed 2 times during stand lifetime, even on calcareous soils, in order to keep some fresh wood litter fall and preserve decomposer biodiversity.

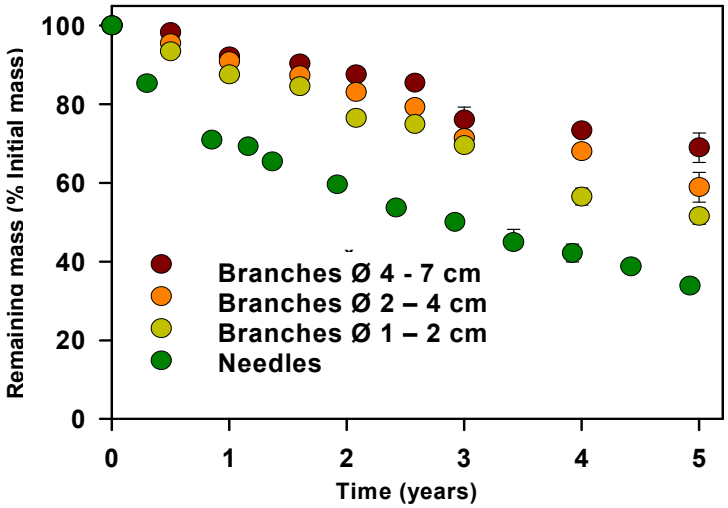

Figure 7: Needles and branch decomposition in a Douglas fir stand, Site of Vauxrenard, France. From Zeller, personal communication.

	Top mineral soil pH	Stand type	Maximum harvest frequency without fertilisation
Low sensitivity	**pH ≥ 5,5**	Standard	2 slash or whole-tree harvests in stand lifetime
		Coppice	15-20 years between successive whole-tree harvests
Medium sensitivity	**4,5 < pH < 5,5**	Spruce forest	2 slash or whole-tree harvests in stand lifetime
		Hardwood and conifer (but spruce) Standard	1 slash or whole-tree harvest in stand lifetime
		Coppice	30 years between successive whole-tree harvests
High sensitivity	**pH ≤ 4,5**	All types	No slash or whole-tree harvest

Figure 8 : Recommandations of ADEME handbook by class of soil sensitivity

From Nambiar *et al.* (2007), sustainable forest management required to conciliate productivity, environmental value, socio-economical value and management intensity.
Those components can converge, sometimes even quite largely, and some other times they happen to be quite divergent. In every case, one has to make compromises and try to find an equilibrium between forest exploitation, resource use, population needs and ecological sustainability.
If logging residues nowadays presents a strong economical interest, their harvesting however has to respect the forest ecosystem in all its aspects. The national and international knowledge on the topic permitted forest managers to define some measures to be observed when harvesting logging residues in order to ensure the sustainability of the ecosystem and the conservation of the soils fertility on the long term.
Very generally, the main practices to be observed are:

- To adapt the exploitation intensity to soils nutrient reserves,
- When harvesting on sensitive soils, counterbalance the nutrient losses by fertilisation
- In all cases, never remove the needles/leaves from the cut area.

Locally ADEME Handbook is an easy method to apply these practical principles. But criteria of sustainable management must now be included in quantifying slash potential for energy at regional and national scales in order to be sure that wood boiler development can be effectively supplied.

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3. An approach for estimating the availability, production costs, and implications of bioenergy development in the United States Mid-South

Donald L. Grebner*, Associate Professor, Gustavo Perez-Verdin, Postdoctoral Research Associate, Changyou Sun, Assistant Professor, Ian A. Munn, Professor, Emily B. Schultz, Associate Professor and Thomas A. Matney, Professor
Department of Forestry, College of Forest Resources, Mississippi State University, Mississippi State, MS 39762, **USA**
tel: (662)325-0928, Fax (662) 325-8726, Box 9681

Abstract
Bioenergy, in its various forms, is becoming an increasingly important energy source for many areas around the world. This study evaluates woody biomass production from logging residues, small-diameter trees, mill residues, and urban waste as a feedstock for bioenergy conversion in the United States Mid-South. Supplies and production cost of woody biomass were derived from Forest Inventory Analysis (FIA) database, a recent forest inventory conducted by the Mississippi Institute for Forest Inventory, and other sources of local information. Given the variability of cost information, Monte Carlo simulations were performed to estimate the marginal costs of each woody biomass type. According to our analysis, about 4.0 million dry tons of woody biomass is available for production of up to 318 million gallons of ethanol each year in Mississippi. The feedstock consists of 69% logging residues, 21% small-diameter trees, 7% urban waste, and 3% mill residues. Logging residues can be produced and delivered for $40 per dry ton; small-diameter trees for $49 per dry ton; mill residues for $31 per dry ton; and urban waste for $36 per dry ton. Sensitivity analysis indicates that current technological efficiency, stumpage price, and procurement distances are factors with the largest impacts on biofuel costs. The results provide a valuable decision support tool for resource managers and industries interested in the development of bioenergy in the Mid-South region.

Keywords: Woody biomass; Bioenergy; Logging residues; Mill residues; Production costs; Small-diameter, trees; Urban waste

Contact: Donald L. Grebner, email: dgrebner@cfr.msstate.edu

Session 8:
Forest Technology and Operations; Wood Technology and Industry

1. Forests functions development and problems with innovations in forestry in the Czech Republic

Ludek Sisak
Faculty of Forestry and Wood Sciences, Czech University of Life Sciences Prague
Kamycka 129, 165 21 Prague 6 – Suchdol, Czech Republic
Tel.:+420224383705, FAX: +420224383701
e-mail: sisak@fld.czu.cz

Abstract
Forest management is a multi-faceted and multi-functional discipline which has both commercial and non-commercial aspects since the field includes economic, social, production and environmental issues. Forest management is therefore a focus of interest for many different organisations, which often have a wide variety of differing and even contradictory sets of viewpoints and private interests.
The demands of forestry have been increasing and the number of roles which forests are required to perform has also been constantly growing. The position of forest management is therefore a complex one which is closely linked with other disciplines. The result of this complexity is that changes in forestry are introduced at a far slower pace than in other industrial sectors.
In the Czech Republic the necessity to bring in a number of innovations to the way that forest management is practiced has become urgent. Nevertheless, the progress of innovation has been affected by the traditional views of the modern forest and its functions as well as by the legislative environment. Both the widely held perceptions of forestry, and more importantly, legislation have a direct impact on the possibility of implementing the necessary changes to Czech Forestry.
This is the case with new methods of using public resources to fund forest management; commercial development, especially the collection of forest products (other than wood) for retail and the maintenance and the economic use of fallow land lying in prohibited safety areas adjacent to electrical cables. The development of forest tourism can also be observed in the Czech Republic (including hiking, cycling and horse riding) but it is problematic to include it under Forest Management and it should instead be viewed as part of the wider framework of rural, agricultural and regional tourism.
Modernisation of forestry production has been gradually taking place, either through consolidation of existing operations and technologies in timber production or through the introduction of new ones. Such developments however, are still at odds with traditional practices, which have used roughly the same amount of labour and technology regardless of the resulting efficiency; this accounts for the distrust of the changes and consequently for their slow introduction.

Keywords: Forestry changes, innovations, socio-economic problems, Czech Republic

Introduction

Forests are generally accepted as a natural resource with many functions, having both commercial and non-profitable uses for society, it is part of the planet's natural wealth but simultaneously it can provide significant commercial opportunities. Its economic, ecological and social importance lies in its wide range of commercial and non-commercial roles.
Forestry is considered a multi-faceted discipline and in the strictest sense a social discipline which has economic, ecological and social implications. As a primary industry it provides a raw material which is vital for humanity and though the environment is substantially influenced by the collection of this material it is considerably more environmentally friendly in the production, processing, use

and disposal of its products than other primary industries. At the same time Forest Management has a bearing on the ecosystem.
In purely financial terms forestry is not central to society, but it is of considerable importance in a wider economic, social and environmental context. This is evident in the activities of a variety of special interest groups and in regional, national and supra-national policies. Forestry and forests are influenced not only by woodland policies but also by policies related to the environment, rural development and industry. This influence varies according to location and is also shaped significantly by EU and International environmental rules.
As the possible uses for woods and forests have become the focus for a number of organisations with a variety of diverse and even contradictory ideas and aims, the range of interests that forestry as a field of study concerns itself with has increased to meet these new requirements and challenges. Therefore modern forestry is a complex subject which covers a broad range of disciplines; this has the effect of delaying the introduction of new innovations and developments and reducing their effect when they are finally put into practice.

1 The multiple functions of forests and forestry – the basis for innovations

Forests represent important areas of public interest as they provide the public with many other benefits besides that of timber. The principal benefits include: water control; soil protection; climate regulation; recreation; landscape formation, the preservation of habitats which can sustain a great diversity of wildlife and last but not least forests provide inhabitants with non-timber raw materials to use or trade.
Forests which are designated to primarily fulfil uses other than those related to the timber industry such as those with:

- protective aims (soil, water, environmental, ecological and settlements protection),
- conservation purposes (nature reserves, parks, sites of biological significance, monuments and cultural heritage sites),
- special uses (recreation, education and research etc),

represent around a quarter of the total area of forest in the Czech Republic, nevertheless all forest, including commercial ones, have several functions. In the Czech Republic, timber production is significantly restricted on more than half of the total area of forest due to non-industrial forest uses.
The extraction of goods other than timber and services from forests form an important part of the relationship between man and the environment as well as performing a socio-economic role. The ways in which forest goods and services are used, differ in theory and practice according to the needs of different countries and societies. Although they are rarely large-scale commercial operations, they do nevertheless have both a measurable economic role alongside their social functions.
It is not possible for the way in which systems for using and exploiting these forest goods and services operate to be identical or even similar, because each system is created with different objectives and in different times and places under widely varying social conditions. The varying ways of exploiting the natural resources of forests reflect the different needs and demands of their societies, nations and states. They are dynamic, constantly developing and adapted to their location. This means that in different countries, non-industrial forest goods and services are handled in a number of ways and promoted through a wide range of mechanisms.
Essentially we can speak about two different types of services provided by forests. The first is that of environmental protection, consisting of hydrology services, soil protection and air quality which have an indirect economic impact on society. The second type of services is of a social nature, such as health and recreation.
The hydrologic roles of forests comprise of protecting the landscape from fluctuating water levels, protecting the quality of water in streams and reservoirs, and maintaining ample sources of unpolluted water. Soil protection involves defending soil from water or wind erosion, landslides and

avalanches. Air protection covers the impact of the forest on the air quality and pollution by solid and gaseous matters (e.g. CO_2, Nitrogen Oxide, etc.) which play an important role in climate change.

Infrastructure in the landscape has been built to exploit the natural functions of forests, whether wider society is aware of this or not. They influence market processes, so potentially they can be seen as economic assets. If these natural functions did not exist, then societies would need to compensate for this by artificial measures which would represent extra costs and have a negative influence on the local or even the national economic market. The relationship between these environmental functions of forests and the economic consequences they have shows the true value and significance forests have for society.

Making decisions on the extent to which we need to balance the commercial exploitation of forests with minimising the environmental effects of human activities has been one of the major issues of the modern era. The production of timber in the Czech Republic has been by far the most important commercial application of forests from the perspective of landowners, but it also important from an economic and social perspective. Its impact in these areas is most conspicuous in rural regions and directly connected with the timber processing industry, which is also situated in rural locations, but it is of substantial importance even for those industries indirectly connected with timber production and processing, such as those who supply them or purchase their goods.

Reduction in timber production as a result of the growth of alternative uses of forests and therefore as a consequence of their increased social and economic significance can, on the other hand, result in a decline in the significance of the timber industry not only from the landowner's perspective but also from the wider social and economic viewpoint. This need not be a matter of merely a loss in productivity but it can also cause environmental damage, when the use of timber, a renewable and relatively ecological resource is replaced with additional production and consumption of non-ecological and renewable materials or causes an increase in timber production at other locations where it is not sustainable.

As for the economic impact it should be kept in mind that the timber industry in the Czech Republic operates entirely within the private sector. Within this environment it must serve the commercial market as long as it wishes to remain free of state interference. The fall in the use of forests as a source of timber and the resulting extra costs and reduced profit often means that for the land owner's perspective the land becomes more of a potential liability than a profitable asset.

The ability of the timber industry to produce an ecological and renewable material within the framework of the free market is therefore substantially reduced compared to producing materials which are neither ecological nor renewable. Because a reduction in timber production causes forests to have a reduced economic significance for landowners and tenants this financial loss should be reimbursed.

Measures promoting the restrained use of forest resources differ in the methods they use and their significance. There are ethical, normative, economic, and institutional tools (including both incentives and deterrents) used in the field of forest resource management. It is often the case that different programmes are not well integrated with each other. As an example, we can speak about the following mechanisms:

- Normative, administrative instruments (acts, regulations: limits, standards, permissions, licences)
- Economic (a large set of financial and other economic measures)
- Information (education, information campaigns)
- Voluntary approaches (unilateral engagements, obligations, public voluntary systems, negotiated agreements, contracts)
- Management and planning (environmental management systems, zoning of protected areas which have a significant effect on the wider environment, landscape use and planning)
- Institutional (establishment of state, regional, district or local organisations and bodies engaged in protection and promotion of environmental forest services).

All of these can be found in Czech forestry practice. The types of tools mentioned are not detached from one another but are linked and interdependent. The greatest attention is focused on economic and financial incentives (grants or subsidies, compensation, purchase of environmental services, tax concessions, low interest loans, the purchase of areas of forests, fees for deforestation, eco-labelling and financial penalties).
Some of these incentives are obligatory whilst others are optional.

2 Problems of introducing innovations in Czech forestry

The need for a variety of innovations in the Czech Republic is urgent. In principle these can be developed in several ways.

a) By establishing a new system to fund forestry which would integrate domestic and foreign public sources.
b) By seeking additional sources of income from new products and services via the market.
c) By making the production processes more efficient either through consolidation of the existing operations and technologies, or by the introduction of new processes and technologies in forestry, particularly those related to timber production.

In spite of these changes having the apparent support and interest of stakeholders the introduction of refinements to forestry have been delayed partly because of the traditional views on modern technology and the functions of forests, as well as by legislation. Both these reasons adversely affect the possibility of making forests more economically efficient from the owner's perspective. It should be noted that the traditional perception of forestry is not only one held by those living or working in forests but of the wider social environment which forestry is a part of.

2.1 The establishment of a system for system for funding forest management from public sources

Currently, the way forestry funding is managed by public sources has been inadequately organised, as funds from regional and national government and from the European Union have not been integrated with each other. Furthermore there is no clear distinction between subsidies, reimbursements and payments for the benefits that forests provide. If a large part of the financial revenue is understood to be ´subsidies´, that is to say ´gifts provided by the public (via state funds)´ which can be granted under certain conditions or depending on the economic situation but which need not be granted at all or whose rate of provision can vary, then such a system becomes problematic.
It is desirable that reimbursements of loss or payments for environmental services are clearly separated from the subsidies and accounted for separately. This would contribute to a substantially higher standard of decision-making on resource allocation and to a greater transparency of forestry funding, not only within the Czech Republic but across the European Union (Sisak, 2005). Financial proceeds should be accounted for separately by their different social and economic purpose, as:

- Subsidies proper, incentives as opposed to compensation for loss of profit.
- Compensation for profit losses due to a reduction in timber production as a result of social and environmental demands.
- Payment for the non-commercial uses of forests which benefit society, such as the recreational uses of woods and forests.

The effectiveness and efficiency of public funds should be calculated by a single formula for both regional and national purposes. In the Czech Republic and in its regions the following should be monitored:

- the funds directly spent in separate programmes and sub-programmes,

- the costs of accomplishing any given programmes or sub-programmes (total administrative costs including monitoring these activities),
- the rate of financial co-operation with landowners, tenants and forest managers (as a relative or absolute figure of the amount which is spent on production of goods or services)
- the results achieved compared to expenditure
- The amount produced as a value of all the uses of the forests which have been utilised in an area.

Not all the necessary information and relevant data is surveyed and recorded. Furthermore, the methods of funding should be simplified and standardised. To achieve this it is necessary:

- to establish a single system of funding which links all the different sources of these funds in the Czech Republic together,
- to simplify the administrative arrangements for applying for funding for small scale forest landowners and minor industrial enterprises
- to increase the accessibility to landowners and other relevant parties of the administrative bodies responsible for distributing funds
- To increase the knowledge and skills of administrative officers responsible for funding forestry to ensure that they would have a greater understanding of the issues involved in it.

Despite this there remains a clash of ideology with those who hold traditional views of forestry as well as with existing administrative procedures.

2.2 New sources of market income

a) Non-wood forest products

Theoretically it is possible to cultivate forest goods (aside from wood) specifically for a viable retail profit if the forest is adapted to a certain extent. Picking fruits in the forest by visitors has been very popular in the Czech Republic. The value of the main kinds of forest goods (apart from wood) was highest in 2001 at CZK 3,636 million, while the lowest was in 1996 at CZK 1,995 million and the annual average for the period from 1994-2005 was CZK 2,974 million. This amounts to 39.6 million kilograms of the main edible products of the forest (mushrooms, blueberries, raspberries, blackberries, cowberries and elderberries). The data has been adjusted for both the price changes of individual commodities and by the general level of inflation. Besides these products, certain other plants are collected in smaller amounts, namely medicinal plants, whose production is not usually included in the statistics (Sisak, 2006, Ministry of Agriculture, 2006).

Forest fruits and medicinal plants appear to be a good prospect for deliberate large scale cultivation. In the past, berries were commercially cultivated by landowners and managers and sold for profit. However, due to the current social conventions and laws concerning the forest and forestry, this kind of commercialisation cannot be reintroduced at present.

The Forest Law (289/1995 Coll.) stipulates that anyone has the right to enter the forest at their own risk and pick the forest fruits for their personal consumption and to collect dry brushwood lying on the ground. In return they are obligated not to damage the forest and to observe and obey the instructions of the landowner, tenant or their employees. That means that any visitor in a forest, regardless of the owner or the type of forest, can pick berries as long as they do so within these guidelines. There is no mention of any exceptions or ban on the right to pick fruit, even in the case of an owner who is deliberately cultivating the forest fruit for commercial profit and has spent time and money in order to pursue this goal. The governmental institutions responsible for forests can only regulate or prohibit access to a forest for a maximum of 3 months. This stipulation does not recognize the landowner's or manager's exclusive right to harvest fruits and other products that they have artificially grown.

<u>Payments for other commodities</u>

It is well known that in some countries, payments are collected for water which comes from forests and is used for human consumption. Such an approach is not possible in the Czech Republic under existing legislation and with the current modes of thinking amongst the public.

b) Use of fallow land in prohibited safety areas (e.g.) under electrical cables

In the Czech Republic there are several thousand hectares of forest land in restricted areas under electrical wires where legal regulations prohibit any plants above 3m in height (Forest Law alone (289/1995 Coll.). Such areas are excluded from any market production. Moreover their maintenance is very costly and creates a deficit. Nevertheless, it would be possible to use such land under the following conditions:

- If these areas can be transformed into coppice by planting bushes whose natural height is between 1-1.5 m. For this purpose plants can be used to strengthen the ecological uses of the countryside, such as pollen bearing plants which will attract bees and plants that can be used to create anti-erosion defences.
- In cooperation with land owners and other organisations, plots for wildlife could be established thereby compensating for the damage caused on adjacent forest land including hunting, this is particularly feasible in mountain regions where even the airborne plants could be used for grazing. Maintenance costs of such plots are small and the costs can be eliminated by making contracts with wild-life organisations and putting the plots into their administration.
- A further possibility is to use such areas, in cooperation with land owners and special-interest organisations, to allow certain kinds of cows and sheep to graze.
- A profit-making option, again in cooperation with the land owners, is the use of such land for special crop management or for other management with the aim of making profit or reducing the amount of money that would be lost from having to maintain these plots. A potential profit for a landowner can come from taking advantages of the subsidies available for this or from deliberate cultivation of special crops, such as energy crops and thicket, Christmas trees, willow coppice, forest fruit and medicinal plants. etc.

The possibility of bringing about most of these measures is mainly affected by the traditional uses of such areas and by legislation as well. Most of the measures described cannot be used on land administered by the State Forests of Czech Republic (some 50% of the total forest land area in the country). Such land cannot even be leased for such activities (Energy Act No. 458/2000, Coll.)

c) Forest-tourism development

This has a relatively large potential in the Czech Republic particularly if foreign visitors can be attracted to Czech forests alongside domestic visitors. Forest tourism must be considered as a part of the wider context of regional tourism in this country.

Attendance in forests which are accessible to public, including recreational, spa and suburban forests is fairly high in the Czech Republic. The long-term average number of visits for a Czech Resident has been 21 per year which corresponds to an annual average of 87 visits per hectare of forest land, with the minimum number of visits coming in 2004 (68/ha) at 16 and the maximum in 1994 (106/ha) at 24. Relaxation is the most frequent reason for going to a forest followed by fruit picking.

Forest attendance varies substantially with whether the location is in easy travelling distance from urban areas, with the recreational appeal and facilities of the forest, and also with the amount of forest fruit in the area. The rate of attendance in Central Bohemian forests is much higher compared with other regions, which indicates that the inhabitants of Prague are frequent visitors to forests (Sisak, 2006).

The quality of tourist routes has been gradually increasing as a result of the combined effort of organisations that are directly affected by tourism including the Association of Czech Tourists, large private and municipal landowners and the Forests of the Czech Republic State Enterprise. Czech forests are interlaced with a network of tourist routes not only for pedestrians, as was once the case, but also for cyclists and horse riders.

The number of places in rural areas that tourists can be accommodated in has been steadily growing and the quality of services available for tourists in rural locations has also been improving. Despite this it will not realistically be possible in the foreseeable future for forest tourism in the Czech

Republic to catch up with the levels of other forms of agricultural and rural tourism or for it to achieve the levels of development which are common in some EU member states.

d) Innovation of timber production processes

Production processes can be altered either by improving the existing facilities and methods for timber production or by introducing new ones. The improvement of existing methods and technologies can focus on providing the optimum natural growth conditions for the type of forest being exploited. Ultimately most of the timber industries operations could take place in areas of forests where the conditions for growth and cultivation of trees that produce timber are good.

This means, with respect to the economy and ecology, that it is important to work less extensively in forest areas which have poor timber production conditions where it would be more efficient to reduce the expenditure of manpower and money. On the other hand, where there are better conditions for production, there should be a requirement for more intensive work in the forest i.e. more labour and financial input in order to achieve greater results. This applies in the first place to cultivation starting with the natural regeneration of forests and ends with the provision of training for those working in timber production.

Introduction of new practices and technologies, still conflicts with traditional experience which is used to providing the same amount of labour and technology regardless of the resulting efficiency, this causes the new methods to be misunderstood and a reluctance to introduce such measures. Over reliance on previous methods and experience is not the only reason; once again the legislative environment is equally responsible.

The introduction of new techniques and technologies, such as those related to harvesting, has been equally conservative. The fairly widespread distrust of such technologies, especially with regards to their ecological impact on foliage and soil, has only recently been gradually overcome. It should be noted that the slow introduction of modern technologies has also been due to the extremely low cost of labour in forestry. Given the current cost of labour it is more efficient economically to employ larger numbers of people with less advanced technical equipment rather than to use more expensive modern technologies with a higher productivity per worker.

3 Conclusions

Forests should be regarded as assets that can be utilised in many different ways and forestry as a field which covers matters and concerns that are beyond those of simple economic management and in fact cover social and environmental issues as well, as it deals with both commercial and non-commercial consequences. This is why forest management is a topic of interest for a very broad spectrum of organisations and individuals, whose views and interests are often at odds with one another. The pressures and demands on forestry have been increasing and therefore so have the number of roles it is required to perform. Forestry is now a very complicated subject that overlaps with many other disciplines. This demonstrates the problems in the processes of introducing innovations into forest management and explains why they are slower in being introduced than in other industrial sectors.

The need to establish a number of changes in the way that forestry is practiced in the Czech Republic is critical. In principle there are several different ways of achieving this:

- By establishing a new system of forestry support.
- By finding new sources of income from non-lumber products and services via the business sector.
- By improving production processes both through more a diligent and efficient use of existing processes and technologies, and by the introduction of new ones.

Attempts at reforming the way forestry operates has been hampered by traditional views of the forest and modern forestry and by a legislative environment which restricts the scope for novel

solutions to problems facing forestry in the Czech Republic. Both these factors are a hindrance to an effective response to the needs of forestry.
As far as developments in funding from the state, it should be stated that currently the level of organisation and co-operation between the various regional, national and European sources of financing has been inadequate. Furthermore the distinction between subsidies, reimbursement and the payments for services is vague, a clearer separation of these would contribute to a considerably higher level of decision making with regards to the distribution of resources as well as helping to make funding more transparent not only in the Czech Republic but across the EU.
Theoretically it would be possible to produce ´non/wood forest products´ for the market deliberately in a forest environment, which requires to some extent, adapting the forest. Such forest products used to be ´harvested´ commercially by landowners. However, with respect to the existing public opinion on such maters and to the current legal situation such an approach is practically impossible. Also payment for fruit picking rights, as exists in some EU nations, is not realistic in practice.
Even fallow land lying near to vast areas around high voltage electric cables, cannot be utilised for market purposes properly due to existing legislation. The development of forest tourism can be observed in this country (walking, cycling and horse riding) but including it under forestry is troublesome and it should perhaps be viewed more in the wider framework of tourism in the countryside. The reason for this is not only that tourism, recreation and relaxation are perceived to be different but also in the different social and economic issues that tourism involves.
Innovation of production processes in forestry has been taking place gradually, these changes occur either through the completion and consolidation of the existing procedures and technologies or through the introduction and implementation of new, more advanced ones. These transformations are incompatible with the traditional experience and practice of forestry which involved the same levels of labour and technology regardless of efficiency or results; these alterations to forestry practice are therefore hindered by misunderstanding and their slow implementation. Reluctance to abandon old practices is not the only reason once again the legislative environment has been partly responsible together with the economic conditions especially with regards to the low cost of labour.

Acknowledgments

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2. *Analysis of business success of Croatian wood industry companies*

Ksenija Šegotić[1], Darko Motik[1], Maja Moro[1], Renata Ojurović[2], Andreja Pirc[1]
[1]Faculty of Forestry Unyversity of Zagreb, Svetošimunska 25, HR-1000 Zagreb, Croatia
[2]Government of the Republic of Croatia, Ministry of Regional Development, Forestry and Water Management, Ulica grada Vukovara, HR-1000 Zagreb, Croatia
segotic@sumfak.*hr*

Abstract:
Nowadays forests have significant economic, ecological and social function. Wood and wood-based products are still very important, although they are not the only benefit of forest. This paper assesses the success of Croatian wood processing industry companies according to number of employees, their educational structure, total revenues of the company and percentage of export to total revenue. The analysis includes companies that, according to the National Classification of Activities – NKD 2002., belong to the area of manufacture of wood and products of wood and cork, and the area of Manufacture of furniture and other processing industries. We have used data from ex Mynistry of Agriculture, Forestry and Water Management of Wood Industry and multicriterial analysis – analytical hierarchy process.

Key words: wood products, business success, multicriterial analysis

1. Introduction

The industry, including industrial wood processing, represents one of the most important economic priorities of the Republic of Croatia, due to the significant impact on the overall development of the Croatian society, and especially on the employment, foreign trade balance and national gross domestic product (GDP). The number of companies and the relevant employment confirms how important the industrial wood processing is for Croatian economy. According to the last official data of the Central Bureau for Statistics, the total number of companies in 2006 was 1381, out of which there were 634 companies in the Manufacture of furniture and other manufacture (DN 36), and 747 companies in the Manufacture of wood and of products of wood and cork (DD 20). The competitiveness between companies in wood sector of European and non-European companies and European Union companies, as well, is constantly growing (Lähtinen, 2007).

The leading force of the European economy are small and medium-sized businesses and the European Union encourages and creates better possibilities of their development, because small and medium-sized businesses are the key source of employment and business ideas. Croatian industrial wood processing can considerably contribute to the European efforts to put small and medium-sized businesses on the top of its development plan, according to its growing presence of 1318 registered small-sized companies and 56 registered medium-sized companies.

In the previous researches it has been established that the size of a company does not influence the success of the company's export. By comparison of the small, medium and big-sized companies it has also been established that the medium-sized companies will be more successful in exporting their products and services when compared to the small and big-sized companies (Eastin, Cunningham and Roos, 2004). Majocchi, Bacchiocchi i Mayrhofer have the same conclusion in their research in which they observed the impact of the company's size on the success of the export in the small and medium-sized businesses (Majocchi, Bacchiocchi, Mayrhofer, 2005). The company's size has impact on the company's business success. Small-sized companies are usually more successful in their business activities when compared to the big-sized companies (Pfeifer, 2001).

By development of the new technologies and globalization of the economy of the developed countries they are becoming economies based on knowledge. The level of knowledge and expertise of the work force has the significant influence on the competitiveness of the national economy (Bejaković, 2006). Companies managed by the university educated people are more successful in their business activities than the companies managed by the high school educated people (Pfeifer, 2001).

2. Material and methods

Determination of success has become very important in various aspects of human activities. In order to stay and grow in today's highly competitive business environment, companies have to aspire to success. The parameters of success are manifold since doing business is a complex process. Conventional economic methods for determination of success, such as cost-benefit analyses, internal return rate and other, are not always satisfactory.

The objective of this paper is to analyse business success of companies in Croatian wood sector. The same are defined according to the following categories: (1) Pursuant to economic activity, in accordance with the National classification of economic activities – NKD (NACE) 2002 (Official Gazette, 52/2003), with DD 20 – Manufacture of wood and of products of wood and cork and DN 36 – Manufacture of furniture and other manufacture; (2) according to its size, pursuant to the Small Business Development Promotion Act (Official Gazette, 29/2002) and Act on Amendments to the Small Business Development Promotion Act (Official Gazette, 63/2007), to small, medium and big; and (3) according to the legal form of the company registration, to joint stock companies, limited liability companies and craft.

Classification of companies included in this analysis is shown in Table 1.

Table 1 Classification of companies according to categories

	Craft (Trade)	*Limited liability company (Distribution company)*			*Join stock company (Company with share capital)*		**Σ**
		Small	*Medium*	*Big*	*Medium*	*Big*	
DD 20	15	33	7	0	2	1	**58**
DN 36	9	15	3	3	0	2	**32**
Σ	**24**	**48**	**10**	**3**	**2**	**3**	**90**

The three criteria for evaluation of success have been chosen: income per employee, percentage of export and percentage of university educated employees, with unequal importance of the said criteria. The data on all three criteria were gathered from development projects of companies within the framework of first granting of non-repayable aid for improvement and enhancement of industrial wood processing in 2007 by the former Ministry of Agriculture, Forestry and Water Management.

By inspecting all 90 companies according to the three criteria of success, the most successful ones have been chosen, singularly for each criterion, and the first 10 companies have been ranked separately for sectors DD 20 and DN 36. The data are shown in tables 2 and 3.

Table 2 Data for successful assessment of companies' success for the sector DD-20

Company	Income per employee (HRK)	Share of export in total income (%)	Share of university educated employees (%)
2	234,268.46	98	12.5
3	188,500.84	97	5.3
4	322,932.64	95	0.8
5	903,950.86	95	15.0
6	352,439.09	95	7.0
8	646,593.13	90	0.0
9	256,284.00	90	14.3
10	317,805.74	86	3.3
11	398,796.17	85	0.0
13	541,741.99	79	4.3

Table 3 Data for successful assessment of success of companies for the sector DN-36

Company	Income per employee (HRK)	Share of export in total income (%)	Share of university educated employees (%)
16	160,554.06	72	4.0
18	202,405.10	69	4.3
19	139,066.10	61	3.0
22	9,839.00	60	20.0
27	416,565.65	50	5.6
31	125,637.81	40	0.4
36	27,736.16	32	2.4
39	205,275.00	23	33.3
40	119,949.16	22	2.0
43	606,950.83	15	33.3

Ranking companies pursuant to their overall success assessed according to the three unequally important criteria is the problem of the multicriteria analysis and contains all the steps of the multicriteria decision-making. (Winston, 1994) AHP method was used. (Saaty, 1980)

The Analytical Hierarchy Process (AHP) is a decision making tool for multi-criteria decision analysis. The AHP mathematical theory was developed by T. Saaty in the 1970s. The AHP is a method of breaking down a complex, unstructured situation into its component parts; arranging these parts, or variables, into hierarchic order; assigning numerical values to subjective judgements on the relative importance of each variable; and synthesising the judgements to determine which variables have the highest priority and should be acted upon to influence the outcome of a situation.

AHP model for determination of the company's success in wood sector has the following criteria on the first level: (1) income per employee; (2) percentage of export; and (3) percentage of presence of university educated employees, and alternatives are companies that we want to rank (Figure 1)

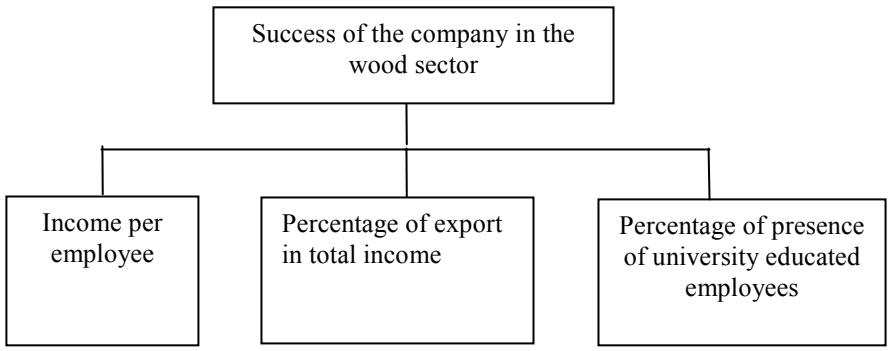

Figure 1 AHP hierarchy for evaluation of success of the companies in wood sector

3. Results and discussion

After the hierarchy was constructed, pairwise comparisons for the first level were made with the help of experts in wood technology using a 9-point scale. These evaluations resulted in matrix and by the eigenvector method we got the priorities of the criteria: income per employee 0.733, percentage of export in total income 0.199, percentage of presence of university educated employees 0.068.

So, the most important is first criterion. The priorites of the criteria are the same in both cases, DD20 and DN36. Then we have data from the tables 2 and 3 and the final result can be seen in Figure 2 and Figure 3.

Figure 2. Priorities of the companies in wood sector DD20

According to the results reached by the AHP assessment in the DD20 sector, company 5 has taken the first place for success. This company belongs to the group of small businesses, it employs 20 people (out of which 15% university educated), and the company exports 95% of its products. Then follows company 2, which belongs to the group of craft businesses, employs 8 people, out of which 12,5% are university educated. It makes profit of 234.152,23 HRK per capita (per employee), and exports 98% of its products. The results are as expected i.e. small companies achieve better results.

In the sector DN 36, the most successful company is company 43, which belongs to the group of small businesses, employs 6 people, out of which 33,3% are university educated and its export rate is 15%. The second most successful company is company 27, which belongs to the group of large businesses – joint stock company. Next is company 16, also belonging to the group of big businesses, with 1257 employees (out of which 50 people or 4% are university educated). This

company exports 72% of its products. In this case, the results of the assessment are not in concordance with prior researches because big companies also proved to be successful.

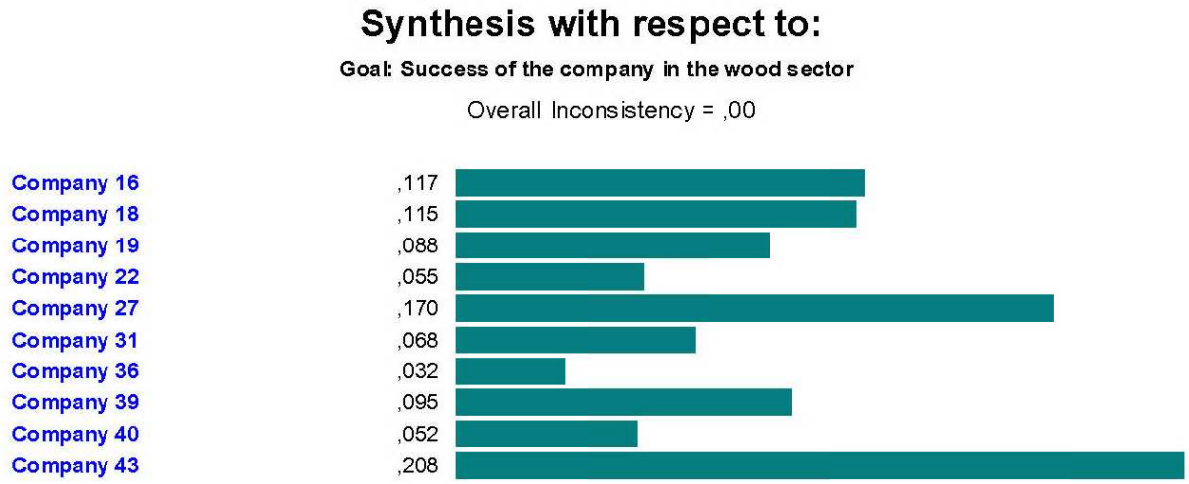

Figure 3. Priorities of the companies in wood sector DN36

4. Conclusion

To determine which company is the best has always been very interesting, but has also been a very complex problem. The ranking lists are most frequently based on only one quantitative indicator. The aim of this work was to provide a possibility of a different approach to this problem, that is, to consider the problem of company ranking as the problem of multicriterial decision making.

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3. *Evaluation of gravimetric and photometrIC methods fOR determination OF wood dust mass concentration*

Ankica Čavlović, Ružica Beljo Lučić, Matija Jug, Petar Skačej
Faculty of Forestry, University of Zagreb, Svetošimunska 25, 10002 Zagreb, Croatia
Fax: ++385-1-235-2532, Tel.: ++385-1-235-2433, e-mail: kos@hrast.sumfak.hr

Abstract
The aim of the research presented in this paper was to evaluate benefits and disadvantages of gravimetric and photometric methods for determination of dust mass concentration.
The samples of oak-wood dust were collected in a sawmill environment. The samples for gravimetric determination of respirable and total wood dust mass concentration were collected by stationary (N=24) and personal sampling method (N=26). The samples for photometric determination of inhalable wood dust mass concentration were only collected by the stationary method (N=38). Mass concentrations of respirable and total wood dust determined by gravimetrical method were significantly different for stationary and personal sampling methods (p_{resp} = 0.0004; p_{tot} = 0.0034). The results obtained by photometric method are only applicable when using a previously determined correction factor (k_f = 3.34).
Only the results of 8-hour measurements of mass concentration by gravimetric methods can be compared with limit values of aerosol mass concentration. However, the determination of mass concentration of wood dust by photometric method may be applied not only for short-term exposure measurements but also for additional measurements within the analysis of exposure time profile at workplaces during the working day.

Keywords: photometry, gravimetric methods, personal samplers, stationary methods, oak-wood dust.

Introduction

The problem of wood dust or airborne wood particles, as cause of contamination of work environment and living environment, are present in most wood-technological processes (mechanical processing of wood, drying, transport, wood combustion). Therefore, methods are developed for determining workers' exposure to airborne particles from the work environment. Within the research of personal exposure to particles from the work environment, apart from the application of gravimetric method, as the most reliable one, in determining mass concentration of wood dust, the possibility of application of photometric method is being increasingly investigated (Thomas et al., 1994; Koch et al., 2002; Lanki et al., 2002). The reason lies in the fact that, when using a gravimetric method, measurements that take place during a whole 8-hour shift are time consuming. Consequently, the need arose for instantaneous and yet continuous determination of mass concentration of wood dust in the workplace. It should be taken into consideration that the Council Directive 2004/37/EC prescribes the limit value of mass concentration of inhalable fraction of hardwood species, provided that the sample is collected for 8 hours (mass concentration of particles determined gravimetrically). The problem of airborne particles is very significant for the wood sector in Croatia, because beech and oak are the two most largely represented species with a share 73 % in wood processing, and a long-term exposure to these two species of wood causes the risk of developing adenocancer of nose cavity (Hausen, 1981; Kubel et al., 1988; Kohler et al., 1995; Bleich et al., 1998; Klein et al., 2001). Apart from the above wood species, emphasis should be specially placed on harmful effects of exposure to dust of some exotic species (abahi, kambala, macore, mahagony, meranty) as well as non-exotic species (pine, fir, juniper, birch, lime), which cause skin allergies and mucous membrane allergies of workers (Hinnen et al., 1995; Rosenberg et

al., 2002). Asthma is caused by wood dust of oak, beech, chestnut, pine, spruce, locust, palisander, kambala, abahi and others (Malo et al., 1995; Salvolinen, 1997).
In 1999 the European Community classified wood dust as carcinogenic based on *IARC* classification (International Agency for Cancer Research) (Klein et al., 2001). The Council Directive 2004/37/EC of 1999 prescribes the limit value of inhalable fraction of hardwood species of 5 mg/m^3. The same regulation applies to the mixture of particles containing not only particles of hardwood species but also particles of other wood species. According to the Croatian Regulation on Maximum Permissible Concentrations of harmful substances in premises and working environment of 1993, limit values were prescribed for mass concentration of respirable particles and total dust. Maximum permissible mass concentration of wood dust of hardwood species (beech, oak and exotic species) in the working environment is 1 mg/m^3 for respirable particles, and 3 mg/m^3 for total dust.
Data obtained by gravimetric method, as the most reliable one, were not only used for comparison with the prescribed limit values, but also as referential values for the assessment of results obtained by photometry. Photometric method is considered a promising method applicable for the determination of short personal exposures in the working environment (Lanki et al., 2002). Photometric method is more easily applicable than gravimetric method for making exposure time profile at workplace. The application of the method of continuous determination of mass concentration by photometry was researched by numerous authors in estimating personal exposure to wood particles at workplaces in woodworking industry (Koch et al., 1999; Koch et al., 2002; Tatum, 2002; Rando et al., 2005a; Rando et al., 2005b). The said authors presented the development and application of the optical unit RespiCon with selective fraction collector - inhalable, tracheal and respirable fraction of airborne particles. They determined the correction factor for individual fractions comparing the measuring results of mass concentration with the application of the optical unit RespiCon and the results of determination of mass concentration by gravimetric method of samples collected by referential IOM (*Institute of Occupational Medicine*) collector of inhalable fraction. This research showed the impact of particle size and individual particle fractions, respectively, on the efficiency of used samplers. Other authors investigated the influence of other physical characteristics of particles – particle form and reflection coefficient (O'Shaughnessy et al., 2002) and impact of relative ambient air humidity on results of photometry (Thomas et al., 1994; Lanki et al., 2002).
The objective of this paper is the comparison between gravimetric and photometric method of determination of wood dust mass concentration in establishing worker's exposure to wood dust in sawmills. This paper also presents the comparison between results obtained in determining mass concentration of samples collected by stationary method and personal sampling method.

Material and methods

Samples of wet oak were collected in a sawmill during cutting of oak logs by vertical bandsaw, and during machining on transversal and longitudinal circular saws.

Gravimetric method of determination of wood particles mass concentration

By personal sampling method, 13 pairs of samples of respirable particles and total oak wood dust were collected in the surrounding air of different wood processing machines (Figure 1). By the stationary method, 12 pairs of samples were collected for the determination of mass concentration of respirable particles and total oak wood dust.
The following data were recorded: air temperature at workplace, relative air humidity and air flow speed. Air flow in the workshop around the workplace was measured by thermo-anemometer Testo 425. The ambient temperature during personal sampling ranged between 11 and 19 °C, and during the use of the stationary method between 18 and 23°C. Relative air humidity during personal sampling ranged between 50 and 72 %, and during the use of the stationary method between 36 and 56 %. The average value of the measured air flow speed was up to 2.2 m/s.

Figure 1 - Personal sampling method

Mass concentration of respirable particles and total dust was determined by gravimetric method according to norm ZH 1/120.41. Weighing was performed by microscale METTLER-TOLEDO MX-5 (Greifensee, Switzerland, 2000). Quartz filters (Whatman QM-A), 25 mm in diameter, were used as the media for collecting samples of wood dust. Samples were collected with samplers produced by Casella (Bedford, UK, 2001). The suction flow rate was set at 2 L/min in wood particle sampling (CEN/TR 15230:2005).

Photometric method

At the same time, 19 pairs of samples were collected for gravimetric analysis with the aim of comparing the values of mass concentrations of inhalable particles of wet oak wood dust obtained gravimetrically and by photometric method (Figure 2). Photometric unit was used for reading mean values of mass concentration of oak wood inhalable particles. The unit for continuous measurement of mass concentration of airborne particles, model Split II manufactured by SKC (*Dorset*, UK, 2006) consists of the unit for processing and presentation of data, inlet part of photometric lens holder (optical part of the unit) and outlet part of IOM (*Institute of Occupational Medicine*) filter holder for gravimetric analysis. The optical part of the unit uses the source of infrared light located at the angle of 90° with respect to the photometer. When the particle passes between lenses, the intensity of light weakens and the recorded outlet signal is proportional to the value of mass concentration of airborne particles from the working environment. The housing is connected to the suction pipe manufactured by Casella (*Bedford*, UK, 2001) with air flow adjusted to 2 l/min (CEN/TR 15230:2005). After entering the housing, the air sample passes through the optical detector, and then through the filter. IOM filter holder is shaped in accordance with the standard for sampling the inhalable fraction (0.1 – 100 μm). According to the standard HRN EN 481:2007, the inhalable fraction is the mass fraction of total airborne particles inhaled through the nose and mouth.

The instructions of the NMAM Method 0600 (*NIOSH Manual of Analytical Methods*, *National Institute for Occupational Safety and Health*) were used for working with the unit for photometry of airborne particles.

In accordance with the recommendations of the unit manufacturer, an individual correction factor should be determined for each type of particles (metal, stone, wood dust) because, even at the same mass concentration, different types of particles do not have the same characteristic of light dispersion. The correction factor of the unit for continuous determination of mass concentration is established by comparison between values of mass concentration obtained gravimetrically and by photometric method. The correction factor is determined by dividing two values of mass concentration as follows (equation 1):

$$k = c_g / c_f \quad (1)$$

Where: k – correction factor for continuous determination of mass concentration,
c_g – mass concentration determined by gravimetric method, mg/m^3,
c_f – mean value of mass concentration determined by photometry, mg/m^3.

Figure 2 – Photometry unit stationary located near the workplace

The correction factor should be calculated from the mean value obtained on the basis of at least 10 repetitions. The unit for continuous determination of mass concentration should be reset to zero before each sampling. The highest mass concentration that can be determined by this unit is 200 mg/m^3. The average time required for stationary collection of sample pairs for the determination of mass concentration of inhalable particles by gravimetric or photometric method was 95 minutes.
The unit was adjusted so as to continuously record the mass concentration every 10 seconds. At the end of the measurement, the following data are available: all recorded values of mass concentrations (graphically and numerically), total number of data and measurements, minimum and maximum mass concentration, mean value of all data and short-term 15-minute exposure (STEL - *Short Term Exposure Limit*). Implementation of a continuous measurement of not less than 30 minutes is the condition for the determination of short-term exposure. An adequate programme is used for drawing the diagram which presents all values during the period of continuous determination of mass concentration by photometric method (Figure 3).

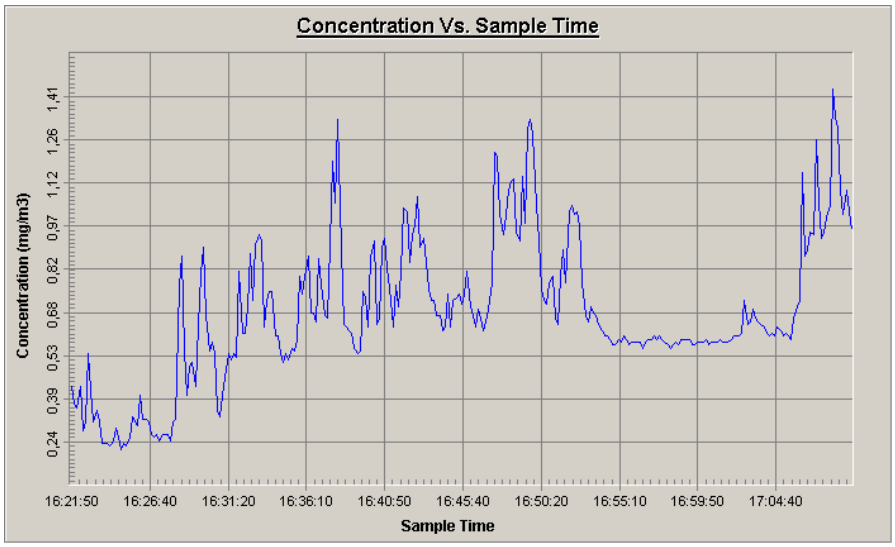

Figure 3 - Diagram of continuous determination of mass concentration by photometry

Wood dust is produced by chipping porous and hygroscopic wood material so that impact may be expected of relative ambient air humidity on the results of continuous determination of mass concentration of airborne wood particles by photometry. Technological procedures in woodworking industry differentiate the processing material according to basic classes of moister content in wood. For this research, procedures were selected of processing wet oak wood in a sawmill, where airborne particles with higher moister content are produced. Moister content of timber processed in a sawmill may even exceed 100 %, depending on wood species. In sampling by photometric method, the ambient air temperature ranged between 13 and 23°C and relative air humidity ranged between 38 and 72 %.

Descriptive statistics (mean, standard deviation) was made for all analysed variables, and the error of type I (α) of 5 % was considered statistically significant. The differences between results obtained by stationary and personal sampling method were tested by Student's t-test, under assumption that the condition of homogeneity of variance was met (McClive et al., 1988). If the homogeneity of variance were not met, nonparametric comparison of two independent groups would be made by Mann-Whitney u-test. All statistical analyses have been made by use of the statistics software - STATISTICA 6.0.

Results and discussion

Results of determination of mass concentration by gravimetric method

Table 1 presents the results obtained by determination of mass concentration of respirable particles (c_r) and total dust (c_{uk}) of oak wood by gravimetric method based on 8-hour samples collected by personal and stationary samplers.

Table 1: Results of determination of mass concentrations by gravimetric method

Gravimetric method for mass concentration determination of respirable particles (c_r) and total dust (c_{tot})												
Total	*Personal samplers*						*Stationary samplers*					
	n	c_{tot}	SDV*	n	c_r	SDV	n	c_{tot}	SDV	n	c_r	SDV
		mg/m^3			mg/m^3			mg/m^3			Mg/m^3	
	13	1.44	0.57	13	0.48	0.17	12	0.78	0.44	12	0.09	0.07

*SDV is the standard deviation of mean values.

None of the measured values exceeds maximum permissible mass concentrations referred to the Croatian Regulation on Maximum Permissible Mass Concentrations for total and respirable dust of hardwood species. Mass concentrations of respirable and total wood dust determined by gravimetrical method were significantly different for stationary and personal sampling methods ($p_{resp} = 0.0004$; $p_{tot} = 0.0034$).

German researchers (Henkel et al., 2001) compared the results of measurement carried out by personal and stationary samplers. After comparing a large number of data obtained by measurement with both methods, higher dustiness of ambient air was also recorded by personal samplers than by stationary samplers. Regardless of the fact that the comparison of these two methods showed that there was no correlation between the measured pairs of mass concentrations, there is no doubt when it comes to measuring the worker's daily exposure (Detering et al., 2000). In that case, personal samplers are used. The German regulation of 1990 ZH1-Vorschrift 120.41 allowed equal use of both methods.

The present European standard that has the status of the Croatian standard HRN CEN/TR 15230:2007 states that personal samplers may be used for stationary sampling, and however personal samplers cannot be valid stationary samplers. Similarly, stationary samplers are not suitable for personal sampling due to their weight. Additional common criteria for the stationary method and personal sampling method are specified in the standard HRN EN 13205:2007.

Results of determination of mass concentration by photometric method

Table 2 presents mean values of correction factors calculated from the ratio of mean value of mass concentration of inhalable particles determined by photometry (c_f) and mass concentration determined gravimetrically (c_g). Mean values are also presented of short-term 15-minute exposure STEL.

Table 2: Results of the determination of mass concentrations by photometric method

Photometric determination of mass concentration of inhalable particles												
	Gravimetric analysis			*Photometric analysis*								
	n	c_g	SDV*	n	c_f	SDV	n	k_f	SDV	n	STEL	SDV
		mg/m^3			mg/m^3			mg/m^3			mg/m^3	
Total	19	1.03	0.52	19	0.32	0.14	19	3.34	1.28	19	0.52	0.28

*SDV is the standard deviation of the measured values.

The results show that a short-term 15-minute exposure (STEL) is higher that the average exposure also measured by photometry. The actual exposure obtained by gravimetric method is considerably higher than the short-term exposure (STEL) measured by photometry.

According to the obtained results shown in Table 3, in determining mass concentration of oak wood with the unit for continuous photometry of wet oak wood dust, the correction factor of 3.34 should be applied.

Although this research shows no particle size distribution within the inhalable fraction, which is completely sampled by IOM samplers, the correction factor is considerably affected by different shares of fractions with sample particles nearly equal or smaller than 10 μm.

The results of similar researches of other authors (Koch et al., 1999; Koch et al., 2002; Tatum et al., 2002; Rando et al., 2005a; Rando et al., 2005b), who compared these two methods, showed that the efficiency of photometry (of wood particles) was nearly the same as the efficiency of the referential IOM sampler (correction factor is approximately 1) for particles up to 10 μm, and that the correction factor for the particles of extratoracic fraction (from 10 to 30 μm) would range between 1.5 and 2. The efficiency of samplers with photometry decreases with the increase of aerodynamic diameter of the observed particle, which results in higher correction factor. Another author, Baron (1995), also researched the capabilities of optical recognition of spherical particles and showed that the best photometer „sensitivity“ was for the particles of 0.6 μm at continuous mass concentration. Generally, lower exposure to airborne particles from the same sample is determined by continuous photometry unit, e.g. RespiCon, than by gravimetric method with IOM sampler of inhalable particle fraction (Koch et al., 2002; Rando et al., 2005a).

Past research of the share of respirable fraction in total airborne particles of wood dust collected by personal samplers at different workplaces in woodworking plants show that the mass share of the respirable fraction in total dust decreases considerably with the increase of mass concentration of total dust. In other words, the increase of mass concentration of total particles does not cause proportional increase of mass concentration of respirable particles (Kos, 2002)

Workers' exposure to wood dust at workplaces in woodworking plants varies considerably so that further research should investigate the impact of mass concentration and type of working operation on the size of correction factor. Determination of mass concentration of e.g. respirable and total dust (or some other fractions of inhalable particles) by personal sampling and gravimetric method gives useful data in describing the impact of mass share of smaller fractions in a mixed-particle sample on photometry efficiency. Further research of the correction factor for continuous determination of wood dust mass concentration should also contain the data on relative ambient air humidity (Thomas et al., 1994).

Conclusion

The determination of mass concentrations of airborne particles aimed at determining worker's exposure at workplace should be carried out by gravimetric method based on samples collected by personal sampling method. Compared to the stationary sampling method, the personal sampling method is more reliable and comparable to prescribed limit values.
Photometric method is not a replacement for gravimetric method in determining mass concentration of airborne particles. Similarly, the results of photometry cannot be compared to the prescribed limit values of workers' exposure to wood dust. These values may only be compared to the results of gravimetrically determined mass concentration based on samples of airborne particles collected for 8-hours. Such unit may be used due to its advantages with respect to the gravimetric method, which are related to the possibility of recording the time profile of workers' exposure, measurement of short-term exposure and possibility of getting a timely signal (setting off the alarm) at the moment when the prescribed (daily) limit values of mass concentrations of inhalable, thoracic or respirable fraction of airborne particles are exceeded. Light dispersion caused by particles is defined by their shape and size, and by reflection coefficient, this being the reason why the determination of the correction factor for the application of photometric method is so complex. According to the results of this research, the application of photometric method for the determination of mass concentration of wet oak wood particles is possible with the correction factor of 3.34.

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Author index

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University of Ljubljana
Biotechnical Faculty
Department of Forestry and Renewable Natural Resources
Večna pot 83, 1000 Ljubljana, Slovenia
Tel: +386 1 423 11 61, Fax: +386 1 257 11 69
E-mail: info.gozdarstvo@bf.uni-lj.si; web page: http:/www. bf.uni-lj.si