Integrated Economic and Social Approaches for the Evaluation of Forest Management Sustainability: the Case of Lithuania

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Abstract

According to the concept of sustainable forest management, forests should be managed to meet the social, economic, ecological, cultural and spiritual needs of present and future generations. There exist problems in deciding how evaluate best the conception of sustainable forest management and there are several methods for the assessment of forest management sustainability: multi-criteria analysis, economic evaluation of forest multifunctionality, and a social choice approach.

Research objectives are to develop an integrated method for evaluating forest management sustainability based on an economic evaluation of forest multifunctionality and on the opinions of the population regarding the relative importance of different types of forest resources.

Research methods are analysis of scientific and other sources related to the evaluation of forest management sustainability, methods for classifying forest functions, and evaluation of forest management sustainability through a sociological survey of the population.

In our study, the economic evaluation of multifunctionality of Lithuanian forests revealed the following proportions for the three types of resources in the forest structure: economic one constituted 41.1%, ecological one amounted 37.6% and social one was 21.3%. According to the results of the sociological survey, the importance of economic resources is 39%, followed by the ecological resources, 32% and the social resources, 29%. To evaluate the forest management sustainability level, we used a comparison method, in which the results of the economic evaluation of forest resources were compared with the results of the sociological survey that measured the respondents' preferences. The results of this comparison revealed that the level of forest management sustainability corresponds to 84.6% of the survey respondents' expectations.

Key words: forests, sustainability, economic evaluation, sociological survey

Introduction

The boundaries of forest economics have been extended, and market signals are no longer sufficient to assess forest management sustainability (Kant 2007). Many other types of signals, such as social, cultural, ecological and environmental, are relevant to this assessment. To solve the problem of how to assess forest management sustainability best, several approaches have been suggested: a multi-criteria analysis, an economic evaluation of forest multifunctionality, and a social choice approach.

The first method, a multi-criteria analysis, is based on the criteria and indicators of forest management sustainability. The Analytic Hierarchy Process (AHP) has been widely used to develop systems of criteria and indicators and to assess changes in forest management sustainability (Mendoza and Macoun 1999, Mendoza and Prabhu 2003). AHP includes the following: a hierarchical structure of principles, criteria and indicators; the determination of the relative importance of each criterion and indicator; and assessment procedures. The multi-criteria approach was used for the assessment of forest management sustainability of European forests according to European criteria and indicators (FE 2011). For each indicator, one "key parameter" that exemplified the main purpose of the indicators was chosen. The performance of countries on each key parameter was assessed on a scale from one to five.

The second approach for forest management sustainability assessment involves the economic evaluation of forest multifunctionality. The first version of this conception is that sustainable forest management is a balancing act that requires ecological values to

be carefully balanced against economic or social values. This balance aims to maximize the triple bottom line of forest values (economic, ecological and social). The second version is that economic activity must operate within the ecological constrains of the forest ecosystem (McDonald, Lane 2004). A wide array of economic valuation methods for the assessment of forest benefits has been developed. Research studies have performed economic evaluations of forest multifunctionality and determined the total economic values of forests (Adger et al. 1995, Brun 2002, Vyskot 2003, Merlo and Croitoru 2005, Mizaras 2006, Croitoru 2007, Tempesta and Marangon 2008, Pocavec 2008, EFI et al. 2008, Türker et al. 2010). Often the total economic value of forest is categorized on direct use values (timber, firewood, hunting, mushrooms, etc.), indirect use values (watershed management, soil conservation, etc.), option values (potentional source), and bequest values (resources effecting future generation). However, these estimates are rarely associated with an evaluation of forest management sustainability.

The third method is a social choice approach to sustainable forest management. It has been suggested (Kant and Lee 2004, Kangas et al. 2006) that the existing market-oriented valuation techniques for forest values, having public good features, are subject to some conceptual limitations. Multiple forest values are closed to the concept at "social states" other than market price or monetary value and the decisions of "social choice" that are not guided by conventional benefit-cost analysis, which is based on the monetization of all costs and benefits. The authors (Kangas et al. 2006) proposed a non-market-oriented stated preference technique to identify all possible forest values and elicit people's preferences regarding the importance of various forest values. The two main features of this technique are the following: 1) to provide an opportunity for respondents to include all relevant alternatives (all forest values) *and* 2) to provide an opportunity for respondents to express their ordinal preference map (ordinal ranking) over all forest values without any reference to monetary amount.

No known evaluation method of forest management sustainability emphasizes the relationship between forest function groups (economic, ecological, and social).

The research objectives of this study are to develop an integrated method for the evaluation of forest management sustainability based on an economic evaluation of forest multifunctionality and on the opinion of the population regarding the relative importance of the different types of forest resources.

Research tasks include the following: 1) to develop a method for the evaluation of forest management sustainability; and 2) to illustrate the use of the method for the assessment of Lithuanian forests (evaluation of multifunctionality of the forests, sociological survey of the Lithuanian population regarding forest management sustainability, and evaluation of the forest management sustainability level in Lithuania according to data from the economic evaluation of the forests and the results of the sociological survey).

Materials and Methods

In the section below, we present information on the multifunctionality of Lithuanian forests, on methods for the evaluation of annual forest benefits, on sociological survey.

Classification of forest resources

Forest functions have many potential effects that are connected to forest growth processes as follows: production of biomass, influence on the environment (water, soil, climate, biodiversity, and health) and effects on people's physical and psychological needs (Vyskot 2003). In performing its natural function, the forest creates resources directly or indirectly corresponding to the needs of society. Forest functions become the resources when they garner social value, i.e., when a society begins to consciously use the forest functions (Dieterich 1953, Deltuvas 2008). Forest functions become the resources when they are used for the public. Therefore, the concepts "forest functions" and "forest resources" can be applied to describe different aspects of the same phenomenon.

There are many classifications of forest functions and resources. These are mostly divided into two groups: products (wood and non-wood) and service (water, soil, health, biodiversity protection, climate regulation, recreation, cultural, etc.) (MEA 2005). To evaluate the multifunctionality of Lithuanian forests, we used a modified MEA classification: wood, mushrooms, berries, herbs, hunting, recreation, carbon sequestration, biodiversity, water protection (increase in river water flow, cleaning of polluted water, and maintaining ground water), soil protection (erosion control), and maintaining sanitary and hygienic state (dust retention by urban forests).

Multi-criteria analysis

During the Ministerial Conference of the Protection of Forests in Europe, which was held in Oslo at 14-17 June, 2011, 6 Pan-European criteria and 35 quantitative indicators were used for sustainable forest management evaluation of European regions and European countries (FE 2011). For each quantitative indicator (Table 1) one "key parameter" was chosen,

which focuses on the main purposes of the indicator. The key parameters for the quantitative indicators are assessed on a scale from one to five. The average rating of Lithuanian forests management sustainability was 3.34 scores. The highest 5 scores Lithuania were rated by following indicators: C/N index (the carbon to nitrogen ratio in the forest floor to the carbon to nitrogen ratio in the mineral soil) median value; percentage of FOWL (Forest and Other Wooded Land) under management plan; share of plantations in FOWL; share of introduced species in FOWL, volume of deadwood per hectare of FOWL; forest sector labour force as percent of population. The lowest 1-2 scores were rated by following indicators: percentage of natural ecosystem area at risk of eutrophication for an emission scenario based on current legislation; percent of forest area damaged by biotic, abiotic and human induced cases; and government expenditure for forest services per 1 ha of forest.

Evaluation of the multifunctionality of Lithuanian forests

The total forest area in Lithuania is 2,174 thousand ha and covers 33.0% of the country territory. Since 1991, this area has increased by 204.4 thousand ha, and forest coverage has increased by 3.1%. Lithuanian forests produce wood and non-wood products and perform recreational and other socio-ecological functions (CO_2 sequestration, protection of biodiversity, water, soil, etc.). The multifunctionality of Lithuanian forests was evaluated using methods described in the literature (Merlo and Croitoru 2005). The annual value of wood was evaluated according to the average annual income from wood sales. The annual income from non-wood forest products was estimated from data on annual harvesting and market prices. Forest recreational resources were evaluated by a contingent valuation method. To evaluate CO_2 sequestration, the prices of pollution permits were used. For

Table 1. The multicriteria evaluation of forest management sustainability in Lithuania, 1990-2010 (FE 2011)

Indicator	Key parameter	Unit	Thresholds	Score
1.1	Annual change in forest cover 1990-2010	%	0.18	4
1.2	Annual change in growing stock/ha, 1990-2010	m^3	0.45	3
1.3	Percent of even-aged forest in the age class of 0-40 years	%	31.9	3
1.4	Annual change in total living carbon stock on FOWL, 1990-2010	%	0.80	3
2.1	Percentage of natural ecosystem area at risk of eutrophication for an emission scenario based on current legislation	%	100	1
2.2	C/N index, median value for the country	Index	1.72	5
2.3	Percent of sample trees in defoliation classes 2+3+4	%	17.7	4
2.4	Percent of forest area damaged by biotic, abiotic and human-induced causes	%	4.8	2
3.1	Ratio fellings/Increament, 2005	%	83.2	4
3.2	Ratio value of marketed roundwood/ Growing stock, 2005	EUR/1000 m^3	439	3
3.3	Value per hectare of marketed non-wood goods	EUR/ha	7.4	3
3.4	Value of marketed services per hectare	EUR/ha	0.40	3
3.5	Percentage of FOWL under management plan or equivalent	%	100	5
4.1	Share of single species stands in FOWL, 2005	%	25.95	3
4.2	Share of natural regeneration in total regeneration, 2005	%	76	3
4.3	Share of plantations in FOWL	%	0	5
4.4	Share of introduced species in FOWL	%	0.18	5
4.5	Volume of deadwood per hectare of FOWL	m^3/ha	23.3	5
4.6	Share of forest land managed for conservation of genetic resources	%	0,172	3
4.7	Landscape pattern index	Index 1-5	2.5	3
4.8	Availability of data on threatened forest species	Scale 1 to 4	2	3
4.9	Area protected as percent of FOWL	%	17.3	3
5.1	Protective function index: soil and water	Scale 2-4	3	3
5.2	Protective function index: infrastructure etc.	Scale 2-4	3	3
6.1	Availability of information on ownership and private holdings	Scale 3-4	4	4
6.2	Share of GDP taken by forest sector, 2010	%	2.0	4
6.3	Net entrepreneurial revenue per hectare, average of years reported	EUR/ha	37.3	3
6.4	Government expenditure for forest services per ha of forest, average of years supplied	EUR/ha	0.29	2
6.5	Forest sector labour force as percent of population	%	1.4	5
6.6	Non-fatal accidents per 1000 workers, 2010	No.	n.a.	n.a.
6.7	Consumption of wood products (roundwood equivalent), per head, 2007-2009,	m^3	1.6	4
6.8	Net imports as percent of apparent consumption, 2007-9	%	7.6	3
6.9	Share of energy from wood in national energy production	%	20.7	4
6.10	Annual visits per hectare of FOWL	No.	61.5	3
6.11	Index of data availability on number of cultural and spiritual sites	Scale 3-4	3	3
Average				***3.34***

n.a. – no assessment

evaluation of biodiversity protection functions was accept assumption to used opportunity costs (losses in wood income). Opportunity costs are widely used for evaluation biodiversity conservation (Norton-Griffiths, Southey 1995, Kniivilä, Saastamoinen 2002, Kaphengst et al. 2001). The method of avoided cost was used to evaluate the water protection, protection against erosion, and sanitary and hygienic functions.

A number of assumptions and simplifications were used. The evaluation was performed on the basis of the current situation without the prognosis of future forest changes. The method used for the economic evaluation used both market prises and non-market-based evaluation techniques. An incomplete list of forest functions and resources was used. Due to the lack of statistical data on forest resources, various literature values and estimations were used.

Wood

Due to increases in both forest area and the average volume of stands, the growing stock in the forests is increasing. In 2009, the volume of Lithuanian stands was 453 million m³, and in 2013, it was 510 million m³. The growth in volume over 10 years was 13%. The average annual amount of wood cut in the last decade was 5.5-7.4 million m³. The annual benefit of wood is evaluated according to the average annual income from wood sales. The average income (from 2001-2011) was 115.6 million EUR in the state forest enterprises (ME, SFS 2011). The extrapolation of this income to all Lithuanian forests (state forest – 49.5 %, private forest – 38.9% and forest reserved for restitution – 11.6 %) results in 233.1 million EUR. The monetary amounts in national currency LTL have been converted into EUR at the rate of 1 EUR equal 3.45 LTL (as of 31.12.2014).

Non-wood products

The average annual harvest of non-wood products (mushrooms, berries, herbs and hunting) and their prices are presented in the Table 2. The annual value of mushrooms estimated 38.6 million EUR, berries – 8.4, herbs – 0.4, hunting –25.7 million EUR.

Recreation

Special recreational forests cover 65.6 thousand ha in Lithuania. These forests include: forest parks, resort forests, city forests, forests of recreational sites, and forests of recreational zones in national and regional parks. Most recreational activities take place in designated recreational forests; however, the recreational function is also partly served by forests with other purposes. According to the results of a contingent valuation survey (Mizaras et al. 2013) in 2012, the forests in Lithuania received approximately 33.4 million visits per year for recreational purposes. The forests are mostly visited for rest and relaxation (36 %) and for collecting mushrooms (26%) and berries (18%). The willingness to pay is estimated at 1.02 EUR/day. The annual value of recreational forest resources is 34.1 million EUR.

Table 2. Non-wood forest resources in Lithuania

Forest resources	Name of annual output	Quantity	Price (value) EUR (unit)
Mushrooms	Harvest, tons	8,500	4.55 (kg)
Berries	Harvest, tons	2,310	3.65 (kg)
Herbs	Harvest, tons	53.2	7.0 (kg)
Hunting	Moose	196	1,237
	Red deer	941	2,119
	Roe deer	15,908	513
	Wild boar	23,797	522
	Brown hare	6,249	10
	Fox	15,346	50
	Beaver	9,993	77
	Raccoon dog	5,767	60
	Marten	847	50
	Wolf	40	510
	Other	1,700	515

Sources: harvest of mushrooms (Kuliešis, Rutkauskas 2000), berries data 2001-2010 according (ME, SFS 2011) about sales of berries doubled for gathering without sales, herbs - data 2001-2010 according (ME, SFS 2011) about sales of herbs doubled for gathering without sales, hunted game 2001-2010 according (ME, SFS 2011), prices of mushrooms, berries according (ME, SFS 2011), prices of herbs according (Petrošiūtė 2010), prices of game according to the price list for foreign hunters (averages of the prices intervals).

Carbon sequestration

The evaluation criterion is the value of carbon sequestrated in the forest. It is found (Miškininkystė 1979) that the production of 1 g of dry material requires 0.5 g of carbon or 1.83 g of CO_2. The annual value of carbon sequestration is as follows:

$$V_{CO_2} = Z \times k_S \times 1.83 \times K_{CO_2}, \quad (1)$$

where V_{CO_2} is the annual value of carbon sequestration, EUR; Z is a volume of increment, m³; k_s is a coefficient of dry wood, ton/m³; K_{CO_2} is the price of CO_2, EUR/ton.

The average amount of carbon sequestration in Lithuanian forests is 12.7 million ton (Mizaras et al. 2013). The average price of pollution permissions (2012) is 7.1 EUR/ton. The annual value of CO_2 sequestration is 90.2 million EUR.

Biodiversity protection

Biodiversity in Lithuanian forests is protected in conservation areas (reserves, protective forests, for-

ests in "Natura 2000", key habitat territories, and biodiversity trees after clear cuttings). The area of strict nature reserve forests is 26.9 thousand ha, the area of ecosystem protection and recreational forests is 266.8 thousand ha, and the area of protective forests is 331.4 thousand ha. Since 2000 an integral European ecological network of special protected areas, was created, 453.2 thousand ha of total territory have been identified as "Natura 2000" in Lithuania. These territories include areas for the conservation of birds (334.5 thousand ha) and for habitat protection (118.7 thousand ha). Approximately 10 years ago, following the experience of foreign countries, the decision to leave biodiversity trees in Lithuanian forests after clear cuttings was made. The consequences of this decision involve leaving 7-10 trees/ha worth of stumps and hollows (trees that provide wildlife habitats). The loss of wood income is used to evaluate the cost of biodiversity. The annual cut losses are: strict reserves – 115.5 thousand m³, reserves – 822.8 thousand m³, protected forests – 85.0 thousand m³, "Natura 2000" forests – 117.8 thousand m³, key habitats – 193.3 thousand m³, and trees of biodiversity – 100.0 thousand m³, or total 1434.4 thousand m³. The common income losses associated with the protection of biodiversity include: strict reserves – 4.7 million EUR, reserves – 33.4 million EUR, protected forests – 4.4 million EUR, forests in "Natura 2000" – 4.1 million EUR, key habitats – 11.7 million EUR, and biodiversity trees – 2.8 million EUR. The total annual value is 61.1 million EUR (Mizaras et al. 2013).

Water protection

The most important water protective functions of forests are the following: increasing river water flow (185 m³/ha on average), cleaning polluted water (26 m³/ha on average) (Pauliukevičius 1974, 1975), and increasing ground water flow (545 m³/ha per year from forests with loamy and clay soils) (Karazija and Vaičiūnas 2000). A forest area of 2.1 million ha increases river water flow by 388.5 million m³ annually. The price of water according to the law of water resource taxes is 0,002 EUR/m³. The annual value of the increase in river water flow is 0.8 million EUR. Lithuanian forests cleaned 54.6 million m³ of polluted water (average annual). The price of biologically cleaned water is 1.02 EUR. The total value of this forest function is 55.7 million EUR. Loamy and clay soils occupy 24.4% of Lithuanian forests (Kenstavičius, Brukas 1984). According to the increase in ground water flow of 545 m³/ha and the price of underground water of 0.0175 EUR/m³, the value of the increase in ground water is 4.9 million EUR. The total annual value of forests water protection functions – 61.4 million EUR.

Erosion control

An area of 24.7 thousand ha of Lithuanian forests is designated for protection against erosion. In hilly lands, approximately 3.4 tons/ha of soil are washed out annually. This amount of soil contains the following amounts of chemicals: N – 8 kg, K – 36 kg, F – 11 kg, and Ca – 25 kg (Pauliukevičius 1974). Assuming that 24.7 thousand ha of soil is not washed out in erosion protection forests, the retention of soil nutrients would be as follows: N – 198, K – 889, P – 271, and Ca – 618 tons. The value of the retained fertilizers is 0.7 million EUR.

Sanitary and hygienic function

Dust retention is an important forest function in urban forests, which constitute 13.1 thousand ha in Lithuania. This annual average retention is approximately 44 tons of dust per ha (Miškininkystė 1978). It totals 576.4 thousand ton. Bearing in mind that artificial dust extraction by scrub gear costs 23.6 EUR/ton, the value of dust retention by city forests would be 13.6 million EUR.

Total

The total evaluation of Lithuanian forest multifunctionality results in an annual benefit of 567 million EUR (Figure 1).

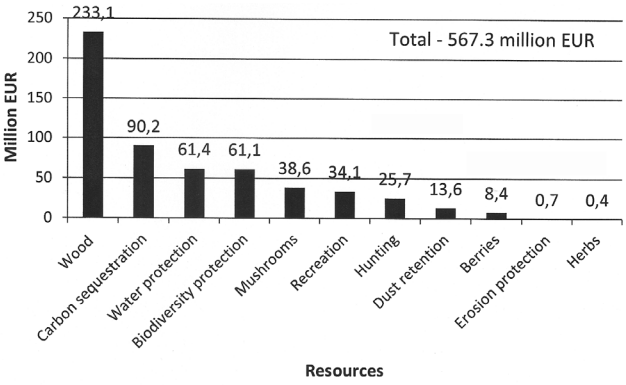

Figure 1. Annual value of Lithuanian forest resources

Sociological survey

The survey objective is to clarify the public opinion about forest management in Lithuania. The questionnaire consists of 18 questions which include different aspects of forest management (Table 3). A key question of the questionnaire is, how did you assign the importance of economic, ecological and social functions of Lithuanian forests today? Respondents were asked to use marginal features of 100 and 0% for indication of forest function. Economic function (wood): 100% comply with maximization of wood cutting in all

Table 3. Questionnaire on the state of Lithuanian forest and forestry

Question	Response options
1. Forest functions (economic ecological, social) importance	%
2. Forest ecological benefit assessment (on average per year 1 hectare)	Up to 10 LTL,* 101-500, 501-1000, 1001-2000.
3. Opinion on a voluntary waiver of forest cuttings for ecological function conservation	I do not agree, I would agree, I would agree if compensated losses.
4. Frequency of visits in forests in the last 12 months	Not visit, 1-2 times, 3-4 times, Once a week, More than once a week, Once a month, More than once a month.
5. Forest visiting goals	Recreation, Picking mushrooms, Berrying, Gathering herbs, Nutting, hunting, Lumbering fuel wood, Other.
6. Opinion on forest coverage	Enough, Too much, Too little, I don't know.
7. Opinion on the forest cover changes in Lithuania	Increases, Decreases, Unchanged, I don't know.
8. Forest functions (economic, ecological, social) importance	Very important, Important, Rather important, Rather not important, Not important, Completely not important, I don't know.
9. The importance of different forest functions (biodiversity conservation and other ecological, non-wood forest products, recreation, wood fuel, raw material for industry, creation of jobs, hunting)	Very important, Important, Rather important, Rather not important, Not important, Completely not important, I don't know.
10. What the state has to pay more attention (forest economic, ecological, social functions)	%.
11. Forest management evaluation (state and private)	Very good, Good, Neither good nor bad, Bad, Very bad, I don't know.
12. Statements on forest management (forests are harvested too much, forests harvested as necessary, forest are harvested too little, good forest reforestation, protected from insects, disease and fire, a well-developed recreational infrastructure)	Agree, Somewhat agree, Partly not agree, Not agree, I don't know.
13. Opinion on the state regulation (the some state and private forest, private forests must be less)	%.
14. Sufficiency of recreational infrastructure	Sufficient, Not enough, I don't know.
15. Sufficiency of protected areas in forests	Too much, Too little, Enough, I don't know.
16. Sufficiency of information sings in forests	Sufficient, Not enough, I don't know.
17. The most effective means of information on forest (television, internet, consultations, newspapers, radio, seminars and others)	%.
18. Sufficiency of information provided to the public about forests and forestry	Sufficient, Not enough, I don't know.

* The LTL was the currency of Lithuania until 31 December 2014. It was replaced by the EURO as the official currency of Lithuania on 1 January 2015 at the fixed exchange rate of 1 EUR = 3.4528 LTL.

forests according increment and work places in the forestry sector. 0% complies with reducing cuttings in all forests, minimization income from the forests and work places in the forestry sector. Ecological function (biodiversity conservation, water and soil protection, CO_2 sequestration): 100% comply with limitation of cuttings, reducing of income from the forest and number of work places in the forestry sector. 0% complies with maximization of wood cuttings in all forest according to increment and work places in the forestry sector. Social function (free non-wood forest products and ecosystem services): 100% comply with management of all forests according to priorities of social function, 0% comply with ignoring of social functions. The interview method was used for survey data collection. Respondents were representing all ten counties. For the interviews were selected 1003 respondents in the age from 18 to 75 years old. A multiple-stage, stratified stochastic sampling method was used for obtaining statistically significant data (statistical error of 1.4% on 95.0% reliability). According to the survey results, the importance of the economic function was 39%, the ecological function – 32% and the social function – 29%. Annual ecological benefit per hectare respondents valuated as follows: less 500 LTL valuated 20% of respondents; 501-1,000 LTL valuated 17% of respondents; 1,001-2,000 LTL valuated 16% of respondents; more than 2,000 LTL – 17%; 28%

of respondents did not indicated the value of annual ecological benefit.

The majority of respondents (74%) would agree voluntarily give up cuttings for conservation of forest ecological functions, but 62% of these respondents do it only in case of income losses compensation.

The data of frequency of forest visits were collected: 16% of respondents – visit forest once a month, 18% – several times a month, 6% – once a week, 28% – 3-4 times a year, 15% – 1-2 times a year, 17% – less frequent.

Respondents indicated the purposes of forest visits. Purposes of forest visits were as follows: recreation indicated 72% of respondents, collecting mushrooms – 66%, and collecting berries – 31%. Respondents' opinions about sufficiency of forest coverage in Lithuania were as follows: 57% of respondents indicated that forest coverage is sufficient, 36% – indicated that forest coverage is too low, 2% of respondents were sure that forest coverage in Lithuania is too high (5% did not express their opinion). The two thirds of respondents (67%) believe that forest coverage in Lithuania was decreased, 22% – unchanged, 4% – increased (7% did not express their opinion). Respondents indicated the importance of forest ecological benefit. Their opinions about forest ecological benefit were as follows: 56% of respondents believed that the ecological benefit of forests is very important for the country and its people, 33% of respondents believed that the ecological benefit of forests are important. The forest economic benefit is very important to 47% of respondents, important – to 36%.

Respondents expressed their opinion of and indicated the quality of forest management in state and private forests. The opinions of respondents were as follows: 52% of respondents believed that state forests are very good and good managed, 47% of respondents had the same opinion about forest management of private forests. However two thirds of respondents tended to the conclusion that forest cuttings level are too high. Respondents' opinions regarding forest regeneration and protection was as follows: 52% of respondents believed that the quality of forest regeneration was high and 49% of respondents indicated that forest protection against pests, diseases and fires was sufficient. Respondents' opinions regarding sufficiency in number of forest recreational facilities were as follows: 35% of respondents indicated that number of forest recreational facities was sufficient (cognitive, educational, recreational trails, viewpoint, camping sites, picnic places, rest points etc.), 40% of respondents indicated that the number of mentioned above recreational facilities was unsufficient. Respondents also indicated sufficiency of information about recreational facility. 48% of respondents expressed that information about recreational facilities in the forests was sufficient, 42% of respondents indicated that information about recreational facilities in forests was unsufficient. Respondents indicated the effectiveness of means for information dissemination about the forest and the forestry. The results of the evaluation of means were as follows: the most effective means for information dissemination about the forest and the forestry was television; among them 57% of respondents indicated this mean as the most important one. Other informational means were indicated as less important: 23% of respondents indicated internet as an important mean, 9% of respondents indicated consultations and seminars, newspapers – 6%, radio – 5%. 38% of respondents expressed opinion that the public has sufficient information about the forests and the forestry. However, 18% of respondents did not express their opinion regarding sufficiency of information about the forests and the forestry.

Results

The development of an integrated method for the evaluation of forest management sustainability based on an economic evaluation of multifunctional forests and on a sociological survey of the population regarding forest management sustainability is the main result of our study.

Conceptual model

The stages of the evaluation of forest management sustainability are as follows (Figure 2): 1) the economic evaluation of forest multifunctionality; 2) the estimation of the proportions of the total value (in %) represented by economic, ecological and social forest resources from the economic evaluation; 3) the sociological survey of the population regarding forest management sustainability; 4) the proportions of the total value (in %) represented by economic, ecological and social forest resources from the sociological survey, %; 5) the comparison of the estimation of the proportions of the total value (in %) represented by the three types of forest resources and proportions based on the sociological survey results and calculation of the sum of the absolute differences between the proportions derived from the economic evaluation and those derived from the sociological survey, and 6) calculation of forest management sustainability levels by deducting five points from the total 100% estimation.

The following calculation formula was used:

$$I = 100-[\ |A-a| + |B-b| + |C-c|\ ], \quad (2)$$

where A, B, C are the proportions of the total value (in %) represented by economic, ecological and social

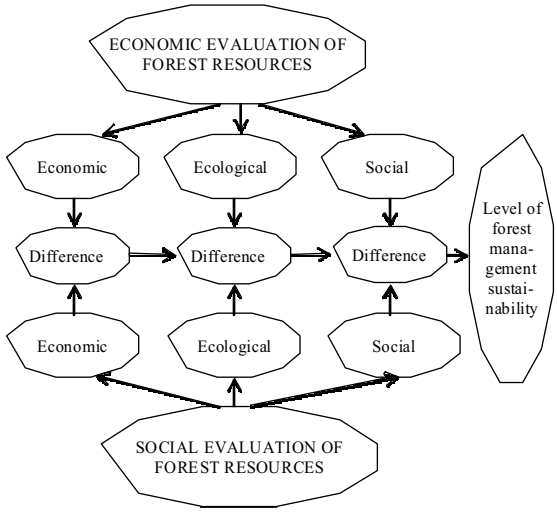

Figure 2. The conceptual model for the estimation of the forest management sustainability level

forest resources, respectively, derived from the economic evaluation; a, b, c are the proportions of the total value (in %) represented by economic, ecological and social forest resources, respectively, derived from the social evaluation.

This formula (2) means that the level of forest management sustainability according to the social evaluation equals 100%. All differences of the economical evaluation from the social one decreased the level of forest management sustainability.

The illustration of the mentioned methods

Table 4. Economic and social evaluation of resources of the Lithuanian forests

Forest resources	Economic evaluation		Social evaluation, %
	million EUR	%	
Economic (wood)	233.1	41.1	39
Ecological (carbon sequestration, biodiversity protection, water protection, soil protection)	213.4	37.6	32
Social (recreation, mushrooms, berries, herbs, hunting, dust retention)	120.8	21.3	29
Total	***567.3***	***100.0***	***100.0***

The data from the economic and social evaluations are presented in Table 4.

In this case, we grouped forest resources into economic, ecological and social categories: the economic category comprises wood, the ecological category comprises carbon sequestration, biodiversity protection, and water and soil protection, and the social category comprises recreational functions, dust retention, and Lithuanian forest products (mushrooms, berries, herbs and hunting) those are usable without payment. The proportions of the total value derived from the economic evaluation for the different categories are: economic resources – 41.1 %, ecological resources – 37.6%, and social resources – 21.3%. The proportions of the total value derived from the social evaluation for the different categories are: economic resources – 39%, ecological resources – 32%, and social resources – 29%.

Based on the data from Table 4, the forest management sustainability level is calculated according to (2):
$I = 100-[\ |41.1-39| + |37.6-32| + |21.3-29|\ ] = 84.6$.

The largest difference between the public's evaluation and the economic evaluation occurred with social forest resources (7.7%), followed by ecological resources (5.5%) and economic resources (2.1%).

Discussion and Conclusions

All methodologies of forest management sustainability assessment have their limitations and should be improved. Project "Implementing Criteria and Indicators for Sustainable Forest Management in Europe" (EFI 2013) concluded outlook for future research on multicriteria assessment of forest management sustainability: to improve the efficiency of data collection while reducing its burden, developing composite indicators, clear deliberation whether and how assessment procedure scan address policy needs, C&I (Criteria and Indicators) revision will require a thorough process based on the latest state-of-the art in C&I research.

Forests economic evaluation methods are also problematic. After their analysis of forest valuation and accounting systems, Hogg and Jöbst (2005) argued that globally a number of methods have been developed to capture forest values and their change in accounting, but both an accurate method and a feasible one remains to be elusive. Forest accounting opponents frequently make the following arguments: the estimated costs of an annual update are too high or a reduction in costs could only be attained by compromising the accuracy of the results beyond acceptable levels (Tzshupke 2009). With similar problems in forest evaluation the authors of this paper encountered too.

Due to methodical problems and lack of data it is required various assumptions, simplifications and expert estimations. One or the other assumptions may result in differences in estimates.

Comparing our results with the results of other authors, we note the similarity of wood and non-wood products, the evaluations of water protective functions and difference in assessments of the other forest func-

Table 5. Total economic value of forests – structure comparison, %

Countries	Wood	Grazing	Non wood products	Recreation	Hunting	Watershed protection	Carbon sequestration	Biodiversity conservation	Dust retention	*Total*
Lithuania	41.1	-	8.4	6.0	4.5	10.9	15.9	10.8	2.4	***100.0***
Average TEV of Northern Mediterranean countries* (Croitoru, Merlo 2005)	37.4	5.6	8.9	17.9	1.7	10.0	4.5	14.0	-	***100.0***

*Greece, Albania, Croatia, Slovenia, Italy, France, Spain, Portugal

tions, of course, caused by difference in nature conditions and used assessment methods.

The variety of methods of forest management sustainability assessment consists of the conditions to search for their combination for complexity of evaluation effect.

For development of methodologies and indicators for the Lithuanian forest economic evaluation, assessment specific legislation (standards, guidelines, etc.) are needed. Such attitudes were expressed by such authors like Bishop (1998), Turner et al. (2003). They proposed to adopt a decision at the political level, which clearly defines the value of the forest setting positions.

Conclusions and proposals: 1. Various methods are suggested for the evaluation of forest management sustainability: multi-criteria analysis, economic evaluation, and a social preferences approach. 2. None of the known methods for the evaluation of forest management sustainability emphasize relationships between forest function groups (economic, ecological and social). 3. An integrated method for evaluating forest management sustainability based on a multifunctional forest economic evaluation and on a sociological survey of the population regarding forest management sustainability is suggested. 4. The economic evaluation of multifunctionality of the Lithuanian forests revealed that three forest resource types are associated with the following proportions of the total value: economic – 41.1%, ecological – 37.6% and social – 21.3%. 5. According to the results of the sociological survey in Lithuania, the most important forest resources are economic resources at 39%, followed by ecological resources at 32% and social resources at 29%. 6. In this case, the level of forest management sustainability corresponds to 84.6% of survey respondents' expectations.

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