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Joining or not joining non-industrial private forests into a single management unit: A case-study shaped as an Analytic Network Process

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ABSTRACT

The study aims to find out how the management of non-industrial private forests (NIPF) can be improved by a larger and more consistent participation of all important stakeholders involved in making one of the most important decisions the forest management planning system copes with: whether or not the forest planner shall create a separate forest management unit for NIPFs, considering a wider variety of interconnected benefits, costs risks and opportunities.

The decision making process was conceived as an Analytic Network Process (ANP) and all important aspects worth being taken into consideration were embodied in four conceptual subnets that gather benefits, opportunities costs and risks defined from three different perspectives: social, economic and ecological. The method was tested on an important decision which is made each ten years when the forest management plans shall be updated. The input data were collected from two small associations of landowners whose forests are managed by Solca forest district (FD), county of Suceava, Romania. The total forest area supposed to be included in the new management unit is about 360 ha and the natural type of forest is beech, mixed with silver fir. Two alternatives were taken into account: the business as usual scenario (the same rotation for all stands and the same silvicultural system, irrespective to the ownership type) and a new management unit, explicitly designed for NIPF, where coppice with standards will produce fuelwood and small size round wood for rural construction.

An extensive survey was carried out in order to find out the most important criteria worth being taken into account when such a decision shall be made, as well as the landowners' expectations, concerns and uncertainties with respect to the two options: business as usual scenario and a new FMU respectively. A second survey was distributed among the villagers of a neighboring commune in order to appraise the local demand for fuelwood. Based on the information collected at the first hand four subnets referring to benefits, costs, opportunities and risks have been produced and, within each subnet, three different clusters were defined in order to appraise the relative importance of economic, social, and ecologic aspects. Making pairwise comparisons between alternatives against criteria, clusters, and subnets, we have concluded that a new management unit for NIPFs is feasible and desirable. Even though ANP seems to be a very flexible tool for making complex decisions, any potential user shall be aware of some risks pertaining to ANP methodology, especially the tendency to make too complex networks, compelling to pairwise comparisons that make less sense. On the other hand, the case study presented in this article has demonstrated that pairwise comparisons may refer not only to the relative importance of whatever two criteria or alternatives, but also to the likelihood or desirability of some certain processes that might occur in case of pursuing one of the two alternatives taken into consideration. The procedure we have proposed for making or not making a new FMU can be developed or adapted to other situations where a consistent dialogue between the decision makers and the stakeholders is a more than necessary.

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1. Introduction

The forest management has to cope with numerous challenges raised by a large variety of stakeholders and most of these stakeholders refer to two main issues of public concern: on the one hand, how the forest management could be sustainable on long term and on the other hand how to uphold the ecosystem resilience, taking into account the economic and social objectives pursued by forest owners or forest managers (Blanco et al., 2005; Rist and Moen, 2013).

Hence the forest resilience turns to be an important issue whenever the management is being changed or new biotic or climatic pressures occur. Valente et al. (2015) have identified three pillars of forest sustainability: 1) mitigation of forest threats; 2) forest full-value improvement and 3) stakeholder involvement in forest policy. Inevitably, forest resilience depends not only on abiotic and biotic factors, but also on the socio-economic factors embodied into the management plan and forest policy. When it comes to private forests the relationship between forest management and property rights turns to be more complex. On the one

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Table 1
Management units for Romanian beech forests.

Type of MU	Main ecosystem services and their importance	Horizontal structure and rotation	Recommended minimal area (ha)	Silvicultural system
A	Soil protection, low	Even age/120	600	Uniform
B	Water regulation, soil protection, moderate	Even age/140	600	Group
G	Water regulation, soil protection, biodiversity conservation, high	Uneven age, 50 cm limit dbh (1 or 2 trees per hectare reach the limit dbh).	100–200	Selection
P	Biodiversity conservation, low	Two-story structure, 20–30 yrs. rotation for beech firewood and 80–100 years for sawn-wood (beech and white fir)	100–200 ha	Coppice with standards

hand the forest owner wants profit, on the other hand the professional forester has to obey the forest policy; therefore, new communication means and decision support systems are essential in solving potential conflicts between these two groups of prevailing stakeholders (Mungai et al., 2004; Perçin, 2010).

The forest management planning system, meant to keep up the forest resilience, plays different roles in different countries, according to a series of measures and regulations supporting the implementation of the forest policy. For instance, Brukas and Sallnäs (2012) carried out a comparative study between Sweden and Lithuania and concluded that the management plan is still used as a governing tool in the ex-communist country, while in Sweden its role is rather informative, but not normative. In a way the potential threats coming from the society are handled either by stiffer norms – more familiar for the ex-communist countries – or more awareness, which is acknowledgeable in a well-established democratic system.

Nevertheless, one of the core means of implementing the forest policy is the forest management unit (FMU), which is an effective arena where different stakeholders and institutions may interact with each other and come up with different perspectives over the domestic forest policy (Sahide et al., 2016a); moreover, through the FMU different authorities may exert their power at national, regional and local level and central government may regain its bureaucratic power as Sahide et al. (2016b) have demonstrated. When it comes to international commitments on reducing deforestation, FMU may also play important roles in improving the consistency of local governance and reducing forest degradation, as a case study has recently demonstrated in Indonesia (Kim et al., 2016).

Along with conflict resolution, cooperation is equally important and Kittredge (2005), based on an extensive literature review, has concluded that incentives for getting people associated shall be provided by a sound forest governance. Nonetheless, innovative processes have barely penetrated the forest management planning and Jarský (2015) concluded that, in the Czech Republic at least, innovation has failed to address the latent conflicts between stakeholders, like professional foresters and landowners.

Multiple use forest management depends on a great extent on effective coordination between institution and stakeholders, as Baskent et al. (2009) demonstrated in a case study deployed in Turkey. When desertification and soil erosion became a real threat, as it happened in southern Romania, the landowners may voluntary join into an association (Stringer et al., 2009), which could be regarded as a social reaction to a critical level of ecosystem resilience.

1.1. Socio-economic context and goal of the study

The Romanian forest planning system is based on the sustained yield principle which implies not only quite long rotations (over 100 years) but also strict regulations on silvicultural systems, timber cruising and harvesting operations (Anonymous, 2008; Abrudan, 2012).

In order to provide ecosystem services *and* wood in different ratios all feasible options referring to rotations and silvicultural systems are clustered into few types of FMUs. For instance, the current technical standards recommend, for beech forests, rotation over 100 years and three different silvicultural system, according to how important the ecosystem services are, as Table 1 shows. In addition to these three options we have considered realistic and feasible another FMU type, not yet officially acknowledged but agreed by professional foresters as a solution for NIPF; this new type, labeled with "P" (from *private*), is described in the last row of Table 1.

In our case-study a separate "P" FMU for NIPF has been conceived as a means to make the forest management more flexible, which is an important issue for small forest ownerships (Scherr, 2004). Worth noting in this context, a great deal of literature is focused on forest owners' typology (Bieling, 2004; Mizaraite and Mizaras, 2005; Serbruyns and Luyssaert, 2006) assuming that fewer types of forest policies better match fewer profiles of forest owners. Joint ownership is quite common in Romania (Mantescu and Vasile, 2009) and the existing associations could undertake more responsibilities regarding the forest sustainability in order to come to terms with the forest managers, who have to apply some time consuming silvicultural practices, most of them related to harvesting works.

According to the latest amendments to the Forest Act (Anonymous, 2015) each private forest owner shall agree a managerial contract with a FD in order to have the forest watched against illegal logging and the timber cruising carried out by professional foresters. How this process goes on and to which extent the forest owner may decide when and how much wood can be harvested depend on the forest management plan, which is compulsory for NIPF larger than ten hectares[1] (Anonymous, 2015). If the forest owner does not want a management plan, then she or he may harvest up to 3 m^3/year/ha provided a 10-year contract for forest watching and timber cruising services has been agreed with the FD. If the forest owners do not want to manage their NIPF into a separate FMU, their forests will be managed according to the rules – established for that public forest, all stand being included in one of the three FMUs (A, B, or G) described in the first three rows of Table 1.

A separate forest management plan shall be produced on decennial basis for each FD provided the forest is public and for each property, for individual or joint ownership; a FD may include one or more FMUs, each one having its own cutting budget, annual allowable cut, and harvesting plans, according to the Forest Act (Anonymous, 2008). The forest area (compartments and sub-compartments) allocated to an already existing FMU or, on the contrary, to a new one shall be decided prior to a new forest management plan. The formal document supporting such a decision is the *terms of reference*, which shall be agreed and approved by the FD staff, a representative of the public authority, and, the last but not the least, by the landowner before getting started the field works for the new management plan. The terms of reference for Solca FD new management plan are to be written down in 2016 and the field works planned for 2017.

Considering all these details a new FMU for NIPFs could be seen as an informal institution (Nichiforel, 2010), for the reasons already explained. From a silvicultural point of view, if a new MU is created, the FD staff must cooperate more with the forest owners because the coppice with standards requires more professionalism and discernment in selecting the sprouts to be harvested as fuelwood.

[1] For smaller NIPF forest management planning is not compulsory but the amount of timber harvested annually cannot exceed 3 m^3/ha.

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Coppice with standards typically produces a two-story canopy forest: a beech and hornbeam coppice layer with a short rotation (20–30 yrs.), and an upper mixed layer with Norway spruce silver fir and beech, with more than 80 year rotation. Before the Austrian governance that came in the region by 1775, Solca region had been typified by old-growth beech and silver fir mixed forests. Norway spruce was introduced later and nowadays beech and deciduous species are coming back in their natural area.

The goal of this study is to produce a procedure to support the decision of making or not making a separate FMU for NIPFs, having in mind that either option comes with a series of opportunities and threats, in addition to the benefits and costs most of the foresters are aware of. Such a procedure was not tested on small communities of forest owners in Romania, and it may allow, not only a consistent communication between foresters and landowner, but also a better understanding of the decision making process too. Therefore, shedding light on the advantages and disadvantage of each option, on short, medium and long term, from social, economic and environmental perspective is a secondary goal of the study.

1.2. State-of-the-art with the Analytic Network Processes

We have conceived this decision-making procedure as an Analytic Network Process (ANP) in order to better tell and contemplate the benefits, costs, opportunities and risks (BOCR), as Thomas Saaty (1996, 2005) has recommended. Compared with other multicriteria decision-making methods, ANP and Analytic Hierarchy Process (AHP) have been used in a much wider series of applications and Sipahi and Timor (2010) summarized as many as 232 studies based on AHP/ANP in health care, transportation, environmental management and many others, just in 4 years, between 2005 and 2009. Between 1986 and 2003 Vaidya and Kumar (2006) summed up other 150 articles on AHP, of which 70 were published in USA, followed by Finland (9 studies), and United Kingdom (8 articles).

Jaafari et al. (2015) used the same methodological framework (BOCR by ANP) to select the best harvesting technology in a case study located in Iran, while Horodnic (2015) applied AHP to produce a multicriteria risk index for environmental-friendly logging systems. Wolfslehner et al. (2005) carried out a comparative analysis of AHP and ANP to assess the sustainability of four forest management strategies, according to a set of six criteria and 43 indicators of forest sustainability. The problem was resumed later in a new methodological envelope adapted to the forest management level (Vacik et al., 2007; Wolfslehner and Vacik, 2008) and Yüksel and Dağdeviren (2007) concluded that SWOT analyses, where a certain degree of dependency between factors is sizable, shall be better approached as ANP than AHP.

Wijnmalen (2007) noticed that different BOCR indices proposed in literature (Saaty, 1996; Saaty, 2005; Saaty and Vargas, 2006) may produce different priorities on the same set of alternatives. Based on a hypothetical set of numerical data processed in different ways the author concluded that *reciprocal values of costs and risks* should not be taken into account for BOCR index. Another worthwhile theoretical contribution to ANP came from Ergu et al. (2014) who demonstrated that setting a threshold value for the largest eigenvalue produced by pairwise evaluation, differentiated on how many entities are compared helps the decider to make consistent evaluations, without computing the consistency ratio (CR) as Thomas Saaty (1980) recommended.

Bottero et al. (2011) used AHP and ANP to choose the most suitable wastewater treatment system while Chen et al. (2005) developed an integrated model based on fuzzy ANP to evaluate various technologies through the lens of benefits, opportunities, costs and risks; the same method was used by Tseng and Lin (2008) who examined the quality of the management using the following criteria: effective leadership, people management, customer focus, strategic plan and process management and concluded that competitive advantages are cost, quality, delivery and flexibility. Meade and Presley (2002) also concluded that ANP may provide reliable solution if the decision maker is placed on a strategic level, able to look after all important aspects on long term.

2. Material and method

According to ANP terminology, each node represents a benefit, an opportunity, a cost, or a threat (risk); all logically related nodes have been gathered into clusters, and the clusters into the four subnets recorded in the first column of Tables 3 and 4. The two alternatives were separately compared against each pair of subnets and, within each subnet against clusters, and within clusters against nodes. The nodes can also be compared against each other, in the same cluster or in different clusters, according to the logical dependencies identified with the forest owners and the FD staff. All priorities are finally recoded in the final super matrix.

The pairwise evaluations between nodes within to same cluster (symbolized in Fig. 1 by arrowed loops), or between nodes from different clusters were performed according to ANP procedure, using scores from 1 to 9. Each score renders the degrees to which one of the two nodes/clusters/sub-nets *contributes to*, *is likely to occur* or *is desired* for achieving the goal. The ANP goal, in our case, is to decide whether or not a P type FMU will be created. The meanings of the odd scores from 1 to 9 are the following: 1 – equal importance, 3 – moderate importance, 5 – strong importance, 7 – very strong importance, and 9 – extreme importance. Intermediate scores (2, 4, 6, 8) may also be used if needed (e.g. 2 – weak importance, 4 – moderate plus, 6 – strong plus, 8 very, very strong).

The main property of the ANP/AHP evaluation scheme is the reciprocity: if *a* is *x* times more important/likely/desirable than *b* with respect to a given criterion or alternative, the reciprocal value (1/x) is assigned to the less important element. Another advantage of the AHP/ANP procedures is the possibility to estimate a sort of logical consistency within any evaluation matrix. The consistency ratio (CR) is given by the consistency index (CI) divided to the inconsistency index (RI), which depends on the number of items (n) compared within a matrix. Whatever paired items (nodes, clusters or sub-nets) are consistently evaluated within a matrix if CR calculated for that matrix is smaller or equal to 10%.

The field data were provided by the private forest owners whose forests are managed by the Solca FD, Suceava County. Part of these owners are gathered into two joint ownership associations, "Obstea Humoreni" (157.8 ha) and "Obstea Solonetul Nou, Cacica" (159.5 ha), while 156 individual forest owners who have been restituted with small patches (up to one hectare) are not yet associated. The socio-economic profiles of the two forest owners' associations are summarized in Table 2.

Because the decision of making a new FMU shall be made prior to a new forest management plan we have agreed with the FD staff to

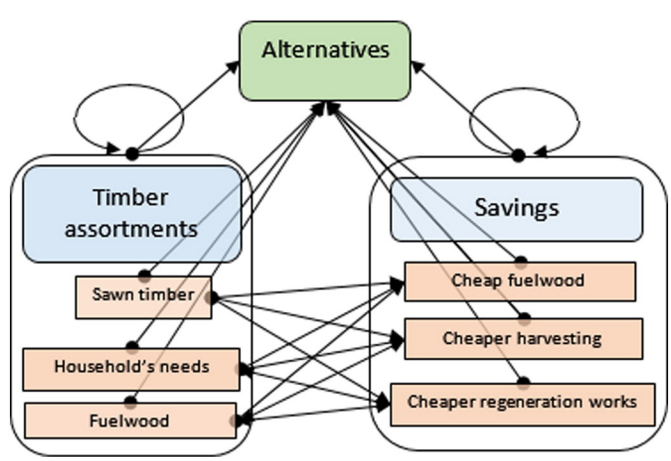

Fig. 1. Structure of the economic benefits subnet.

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Table 2
Socio-economic profile of the two main associations in Solca FD.

Association	Average age (years)	Average revenue per annum and family (equivalent in €)	Main revenues (multiple incomes have been reported)	Main problems spotted by steering committees or FD staff
Obstea Humoreni	60 ± 13	1200–16,000	Pensions (35%), agriculture & husbandry (70%), salaries (5%)	Membership fees are not paid in due time, many absentees at the general assembly
Obstea Solonetul Nou, Cacica	53 ± 17	4500–13,500	Pensions (20%), agriculture & husbandry (80%), salaries (10%)	Some members of the association have not transferred properties to their successors before their deaths

prepare the terms of reference of the new management plan, taking into consideration not only the forest owners expectations but also the risks and opportunities opened by a new FMU.

Two questionnaires were distributed among the forest owners in Solca and its neighborhoods in order to evaluate 1) people's expectations with respect to the forest management, and their knowledge about forestry, and 2) the fuelwood demand at local scale.

The first questionnaire (responded by 80 persons) was designed to evaluate how sustainable the fuelwood supply might be on long run, assuming that a new FMU was created. In addition to the technical question referring to wood supply for household's needs ('how happy are you with the wood supplied by your own forests?', 'how much fuelwood do you need each year?') three other questions were addressed in order to evaluate 1) the degree to which the forest itself is an additional burden to the forest owner, 2) her or his willingness to get rid of the forest, if a buyer would show up, and 3) her or his willingness to accept higher fees for the timber cruising, if the coppice with standards were adopted.

Other two open questions were addressed in order to evaluate the landowners' knowledge about silvicultural systems (group system versus coppice with standards) and their expectations and concerns regarding the forestry, in general: illegal logging, overgrazing, natural regeneration, and game management.

All 63 respondents committed to be active forest owners went through the second section of the survey where they have been asked to find out a series of benefits, costs and opportunities opened by the two options. This list was finalized by the FD staff and openly discussed with the forest owners at FD headquarter. The forestry staff has thoroughly explained to the forest owners the legal and technical constraints related the new silvicultural system and other important practicalities (for instance, the importance of using high quality tools for coppicing), in order to help them make or agree with the evaluations made by the forestry staff, on issues where the forest owners experience is irrelevant. Finally, a list of *benefits*, *opportunities*, *costs* and *risks* has been written down, either for keeping the status quo ("A" type MU) or for making a "P" type FMU as shown in Table 3 and Table 4. The pairwise evaluations were made at FD headquarter together with some owners' representatives and the forestry staff.

The second survey was answered by 40 respondents sampled along the commune of Todiresti, whose inhabitants are buying fuelwood from the local forest owners, Solca FD and wood processing companies located in the area.

Table 3
Benefits and opportunities of choosing between BAU and a new MU.

Subnet	2nd subnet	Cluster	Nodes included	Appraised as…
1. Benefits	1.1. Economic	1.1.1. Timber assortments	1.1.1.1. Sawn wood	Importance
			1.1.1.2. Timber for household needs	Importance
			1.1.1.3. Fuelwood	Importance
		1.1.2. Savings	1.1.2.1. Cheap fuelwood	Importance
			1.1.2.2. Cheaper harvesting operations	Importance
			1.1.2.3. Cheaper regeneration works	Importance
	1.2. Social		1.2.1. Responsiveness in making decisions	Likelihood
			1.2.2. Payments in due time	Likelihood
			1.2.3. Better involvement in forest watch	Likelihood
	1.3 Silvicultural	1.2.2. Regeneration works	1.2.2.1. Shorter regeneration period	Likelihood
			1.2.2.2. Better coordination of field works	Likelihood
				Likelihood
		1.3.1 Tending works	1.3.1.1. Thinning and cleaning at due time	Likelihood
			1.3.1.2. Less harvesting damages	Likelihood
			1.3.1.3. Maintain valuable species	Likelihood
2. Opportunities	2.1 Economic	2.1.1. Sell valuable timber grades	2.1.1.1. Logs sold at the roadside	Preference
			2.2.1.2. Wood on stump	Preference
			2.2.1.3. Auctions with NFA	Preferable
		2.1.2. Fuelwood procurement	2.1.2.1. From their own NIPFs	Likelihood
			2.1.2.2. From harvesting companies	Likelihood
			2.1.2.3. From forest district	Likelihood
	2.2 Social	2.2.1. Among forest owners	2.2.1.1. Internal cohesion of owners' association	Preference
			2.2.1.2. Allowable cut equally shared by the association members	Preference
			2.2.1.3. Develop an action plan for forest owners' association	Preference
		2.2.2. Among forest owners and forest staff	2.2.2.1. Payments in due time for forest services provided by the forest district	Importance
			2.2.2.2. Lesser pleadings to the forest authority	Importance
			2.2.2.3. Less illegal cuttings	Importance
	2.3 Silvicultural	2.3.1. Regarding forest regeneration	2.3.1.1. Natural type of forest	Importance
			2.3.1.2. Diversified vertical structure	Importance
			2.3.1.3. Shorter rotation	Importance
			2.3.1.4. Two-story stands	Likelihood
		2.3.2. Regarding tending works	2.3.2.1. Larger area for thinnings and clearings	Likelihood
			2.3.2.2. Intense thinnings approaching the maturity age	Likelihood

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Table 4
Costs and risks of choosing between the status quo and a new MU.

Subnet	Clusters	Nodes	Evaluation based on
Costs	3.1. Ecological	3.1.1. Biodiversity loss	Importance
		3.1.2. Soil shallow erosion	Importance
		3.1.3. Injuries produced to remnant trees	Importance
	3.2. Social	3.2.1. Lack of interest in forest management	Importance
		3.2.2. Less accessible fuelwood	Importance
		3.2.3. Lack of confidence in the forest staff	Importance
	3.3. Economic	3.3.1. Regeneration works (including annual assessment)	Likelihood
		3.3.2. Forest watching	Likelihood
		3.3.3. Pest control	Likelihood
Risks	4.1. Ecological	4.1.1. Overgrazing	Likelihood
		4.1.2. Game harnessing	Likelihood
		4.1.3. Poaching	Likelihood
		4.1.4. Valuable forest species disappear	Likelihood
	4.2. Social	4.2.1. Conflicts with logging companies	Importance
		4.2.2. Conflicts among forest owners	Importance
		4.2.3. Conflicts with forest staff	Importance
	4.3. Economic	4.3.1. Less revenue from timber	Likelihood
		4.3.2. Not enough money for regeneration fund	Likelihood
		4.3.3. Too much fuelwood	Likelihood

The total private forest amounts to 360.3 ha and all NIPFs, gathered into a single FMU could be managed to produce fuelwood and small amounts of round wood for household needs. This survey was shorter than the first one and it aimed at assessing whether or not more fuelwood can be sold on the local market, having in mind that a cash default could be a threat if the forest owners had no timber to sell to the industry.

Unlike the AHP where only top-down dependencies are accepted, the ANP allows bidirectional influences, meaning that nodes or clusters can be connected in feed-back loops. In Fig. 1 the two alternatives (not explicitly referred to in the topmost box) depend on what the forest owners want to harvest (fuelwood or sawn wood) but the two timber grades also depend on the savings made with firewood procurement and regeneration works (the cluster included into the sub-net of the economic benefits, see Table 3).

For instance, cheaper harvesting operations (node 1.1.2.2. Table 3) depend on how large the felled trees will be, while the desired grade (sawn wood or fuelwood) is affecting the harvesting costs through the size of the same trees; all these reciprocal dependencies are captured into two matrices further embodied in the final supermatrix.

The interdependency between timber grade and regeneration cost is even stronger, in that the coppice with standards provides more fuelwood and more logs for households needs, while the regeneration cost is negligible. As shown in Table 3 and Table 4 the relative evaluation does not always refer to how 'important' is something compared with something else but also to the relative preference, or the occurrence likelihood of one node compared with another one, given each alternative.

This flexibility in defining the problem helps us explain to the stakeholders (forest owners and forestry staff) the interdependencies between nodes and facilitate the dialogue among them, having the outcomes of the first survey.

With all comparisons done we have produced the unweighted supermatrix, which includes all reciprocal evaluations between nodes. The next step consists of weighting the nodes' priorities with the priority of the cluster they belong to in order to get the weighted supermatrix. Finally, the *limit matrix* is the weighted supermatrix raised to powers until its elements are stabilized.

In so doing all indirect influences from one node to another one or towards more distant nodes are captured, as Saaty and Vargas (2006) demonstrated. The values along the main diagonal of the limit matrix are the partial priorities calculated for each node, their sum being one.

The input data for ANP have been collected from the forest owners and the forestry staff during a preparatory discussion about the expectations and constraints regarding the term of reference for the next forest management plan. The paired evaluations were made by the author along with the FD staff taking into consideration the opinions collected from the forest owners through the first surveys. The data were processed by the Superdecision software (Anonymous, 2015), using the BOCR template.

Initially it was quite difficult to tell the benefits from the opportunities and costs because, in many cases, a benefit is just a lower cost and what initially had been supposed to be a benefit turned to be an opportunity; one should be aware that the same conceptual difference is between costs and risks. Eventually all nodes (benefits, opportunities, costs and risks) that make the difference between the two options have been grouped into three subnets: economic, social and silvicultural/ecological (Tables 3 and 4). Each subnet has more or less clusters but one cluster is common for all: it is the goal, i.e. the two alternatives compared against nodes (basic criteria) and clusters.

The benefits and opportunities were grouped into two subnets, (except for the social benefits, grouped into a single cluster) while the costs and risks were gathered into only one subnet for each. The social benefits were gathered into a single cluster and consists of: higher responsibility in making decisions, payment in due time for forest-related services (an important problem the FD staff was complaining about) and thorough commitment in preventing illegal cuttings.

3. Results

The information collected through the first survey was used to evaluate the degree to which the forest owners are aware of the multiple implications a new FMU might have, on short and long run. According to the second survey designed to gauge the local demand for firewood it was estimated that 80% of the firewood consumed by Todiresti inhabitants comes primarily from the forest, which is a good signal for getting organized the NIPFs into a new FMU.

The unweighted supermatrix corresponding to the first subnet (i.e. economic benefits) is shown in Table 5. Local priorities of the nodes included into the two clusters (timbre grades and savings) were bound

Table 5
Unweighted supermatrix of economic benefits subnet.

Cluster	Nodes included in cluster	1.1.1. Timber grades			1.1.2. Savings			Alternatives	
		1.1.1.1.	1.1.1.2.	1.1.1.3.	1.1.2.1.	1.1.2.2.	1.1.2.3.	With MU	Without MU
1.1.1. Timber grades	1.1.1.1. Sawn wood	0.000	0.167	0.143	0.000	0.000	0.000	0.105	0.731
	1.1.1.2. Timber forhouseholdneeds	0.333	0.000	0.857	0.000	0.000	0.000	0.258	0.081
	1.1.1.3. Fuelwood	0.667	0.833	0.000	0.000	0.000	0.000	0.637	0.188
1.1.2. Savings	1.1.2.1. Cheap fuelwood	0.163	0.232	0.760	0.000	0.750	0.250	0.833	0.000
	1.1.2.2. Cheaper harvesting operations	0.297	0.184	0.144	0.833	0.000	0.750	0.167	0.750
	1.1.2.3. Cheaper regeneration works	0.540	0.584	0.096	0.167	0.250	0.000	0.000	0.250
Alternatives	With MU	0.143	0.800	0.875	0.889	0.250	0.167	0.000	0.000
	Without MU	0.857	0.200	0.125	0.111	0.750	0.833	0.000	0.000

Local priorities for the nodes included into two clusters are enclosed in boldfaced boxes.

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Table 6
Weighted supermatrix of economic benefits.

Cluster	Nodes included in cluster	1.1.1. Timber grades			1.1.2. Savings			Alternatives	
		1.1.1.1.	1.1.1.2.	1.1.1.3.	1.1.2.1.	1.1.2.2.	1.1.2.3.	with MU	without MU
1.1.1. Timber assortments	1.1.1.1. Sawnwood	0.000	0.056	0.048	0.000	0.000	0.000	0.052	0.365
	1.1.1.2. Timber for hosehold needs	0.111	0.000	0.286	0.000	0.000	0.000	0.129	0.040
	1.1.1.3. Fuelwood	0.222	0.278	0.000	0.000	0.000	0.000	0.318	0.094
1.1.2. Savings	1.1.2.1. Cheap fuelwood	0.054	0.077	0.253	0.000	0.600	0.200	0.417	0.000
	1.1.2.2. Cheaper harvesting operations	0.099	0.061	0.048	0.667	0.000	0.600	0.083	0.375
	1.1.2.3. Cheaper regeneration works	0.180	0.195	0.032	0.133	0.200	0.000	0.000	0.125
Alternatives	with MU	0.048	0.267	0.292	0.178	0.050	0.033	0.000	0.000
	without MU	0.286	0.067	0.042	0.022	0.150	0.167	0.000	0.000

Local priorities for the nodes included into two clusters are enclosed in boldfaced boxes.

within thick lines. These priorities were produced by paired comparisons. Below the local priorities of the timber grades there is another set of local priorities which render the relative importance of savings against timber grades (0.163; 0,232; 0,760;…;0.096).

So far the values within this supermatrix do not take into account the local priorities of the three clusters (timber assortments, savings and alternatives). The next supermatrix (Table 6) contains the weighted local priorities, smaller than the previous ones because the unweighted values have been multiplied by the overall priority of the cluster. Within each cluster the local priorities are stochastic normal, i.e. their sum is one.

Finally, the combined local priorities of each node, taking into account all direct and indirect influences are presented in the limit supermatrix; Table 7 exhibits the limit supermatrix just for economic benefits sub-net.

Table 8 shows the data needed to calculate the two BOCR indices, one for BAU, and one for a new FMU. The weights of the four major subnets noted in the first column are slightly equal and the asterisks added to the last two columns indicate the highest final priorities for each subnet. The two BOCR indices on the bottom line show that making a new FMU for NIPFs really makes sense, even though all three risk indices of promoting coppice with standards outweighs the risk of BAU scenario.

All activities carried out in Solca FD now can be standardized into a procedure summarized as follows: 1) define the two alternatives (BAU and whatever other MFU); 2) enumerate the benefits, opportunities, cost and risks as nodes, and make a subnet for each category; 3) within each subnet previously created, group the nodes into other three subnets: economic, ecological and social; 4) make pairwise evaluations among subnets, clusters and nodes against the two stated alternatives or between them, if feed-back loops are needed; 5) compute the final priorities for each alternative, multiplying the local priorities of the first-level subnets, with the local priorities of the second level subnets, and the corresponding local priority of each alternative.

4. Discussion

Screening the local priorities listed into the two columns on the right side of Table 8 one would be concerned about some large differences between the desirability of the two options. Somehow surprisingly, the three types of risks are higher with a new FMU, and the social and economic costs are also higher. All three social risks envisaged by the interviewed stakeholders are more likely to occur if the forest owner really takes advantage of more opportunities. As a matter of fact, the risks are closely associated with the opportunities because any lost opportunity, not exploited after a period of time, eventually turns into a risk of non-confidence in what initially had been considered reliable and feasible. And this kind of judgment holds for both forest owners and the employees of the forest district.

On the one hand the foresters will have to face new technical challenges (opportunities) but if they fail to make the difference between a beech sprout and a seedling, or if they cut off too many silver fir trees, the whole endeavor will turn into a bad example for all professionals. On the other hand, the forest owners might have unrealistic expectations from the new technical arrangement and eventually they might be disappointed because some simple restrictions or additional costs were inevitable, like fencing the regeneration patches in harvested areas in order to protect them from grazing.

The economic opportunities of BAU scenario seem to be more substantial because logs for lumber is a sought after merchandise; had the forest owners enough confidence in the forestry staff and had they mature trees to harvest, they would take advantage of higher prices and afford to buy fuelwood from the logging companies or even from the FD. On the contrary, a coppice with standards FMU tailored to produce more fuelwood and some less valuable logs for households' needs will somehow disconnect the forest owners from the local market: they won't have to buy fuelwood, probably they would sell, but without other sources of income, they cannot pay for the forest-related services, which probably will be more expensive with a new FMU.

For example, timber cruising in a coppice with standards requires more effort because more trees shall be harvested (the intrinsic value of timber doesn't matter in this case, according to Romanian standards), tending works require even more skill and attention (for reasons already explained) while the protection measures for already regenerated patches might be expensive too (even though the regeneration itself costs less). Because such a decision is completely novel and may produce a snow-ball effect if it succeeds, it is very important to evaluate all effects of changing the official recommendations provided by the forest planners.

Table 7
Limit supermatrix of economic benefits.

Cluster	Nodes included in cluster	1.1.1. Timber grades			1.1.2. Savings			Alternatives	
		1.1.1.1.	1.1.1.2.	1.1.1.3.	1.1.2.1.	1.1.2.2.	1.1.2.3.	With MU	Without MU
1.1.1. Timber assortments	1.1.1.1. Sawn wood	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
	1.1.1.2. Timber for household needs	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037
	1.1.1.3. Fuelwood	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1.1.2. Savings	1.1.2.1. Cheap fuelwood	0.262	0.262	0.262	0.262	0.262	0.262	0.262	0.262
	1.1.2.2. Cheaper harvesting operations	0.298	0.298	0.298	0.298	0.298	0.298	0.298	0.298
	1.1.2.3. Cheaper regeneration works	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122
Alternatives	With MU	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094
	Without MU	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088

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Table 8
Input data for computing the BOCR indices of the two alternatives.

1st subnet and their priorities	2nd level subnets	Local priorities	Final priorities (raw values)	
			With MU	BAU scenario
Benefits	Economic	0.4530	0.0942	0.0876
0.2491	Silvicultural	0.3993	*0.2874	0.1112
	Social	0.1477	*0.2395	0.0939
Opportunities	Economic	0.4632	0.1385	*0.1933
0.2326	Silvicultural	0.1684	*0.1267	0.0770
	Social	0.3684	*0.4460	0.0155
Costs	Economic	0.2551	*0.2008	0.1325
0.2245	Silvicultural	0.4082	*0.2503	0.0830
	Social	0.3367	0.1201	*0.3799
Risks	Economic	0.3571	*0.2177	0.1156
0.2938	Ecological	0.2143	*0.2741	0.0592
	Social	0.4285	*0.2416	0.0917
BOCR indices			0.6191	0.3809

Nodes whose priorities are higher for a new MU than BAU scenario.

Such a study facilitates a thorough analysis of the social and economic ties between the forest owners and the forestry staff. As shown in Table 2, lacking the cash flow to pay forestry services is a serious issue popped up by the first survey. Considering that most of the forest owners are quite old and their revenues are pretty low (see the 3rd column of the aforementioned table), a new FMU would be a better option than BAU scenario, which do not provide fuelwood but, instead, it is urging the forest owners to sell small amount of sawn wood on a competitive market that makes them even weaker due to high transaction costs. If they sell wood on the stump, they cannot get good prices for small quantities; selling logs at the roadside, they have to pay the harvesting operations and the risk of cash default is even higher, compared with the new situation, when they would sell just fuelwood.

In Solca FD the forest planners will create a new FMU and if the outcomes will be positive it means that forest owners' commitments are reliable and similar decisions could be made in other places with quite similar conditions. Conversely, if the coppice with standards will bring about more damages than benefits, after ten years the FD staff may come back to the BAU scenario, simply because such a decision is not irreversible.

The main disadvantage of using ANP is the tendency to make things even more complicated than they are, just for being consistent with the ANP paradigm which claims that each cluster must have at least two nodes within. For example, if a new node (criterion) pops up when the problem is presented to the decision makers (as actually has happened in our case study) the first impulse is to make a separate cluster instead of plugging that new node into an already created cluster. However, if that new criterion does not fit into any old cluster, the modeler has to come up with another node, just to justify the new cluster; and this is an important trap any decision maker shall be aware of. The opposite tendency is to deter from incorporating different indirect outcomes just for avoiding complicated networks.

5. Conclusions

In spite of many controversial issues like those already mentioned in the literature review, the ANP is a good facilitator between different stakeholders who may agree or disagree on the outcomes of any decision they have to make. This flexibility is attractive for many practical applications where people have to get along in making decisions based on qualitative or sketchy information, or their own personal experience.

One important merit of ANP/BOCR is its ability to help stakeholders analyze a great deal of information and hypothesize a series of cause-effects links and side-effects. In contrast with a simple multicriteria analysis which binds the vision of the decision makers to a given set of independent criteria, ANP helps decision makers formalize the process in a consistent way, even though the outcome is somehow predictable. In fact, ANP fills the gaps between complex mathematical planning models, difficult to feed with data, and social enquiry, which is barely supported by mathematical models focused on easing any decision making process.

Another advantage of ANP/BOCR is to address the same issue, for example more harvesting operations carried out in a given time horizon, from a variety of standing points: the forest owners seize the opportunity to harvest fuelwood paying less (which is a benefit), while the forestry staff perceives it as an economic cost (more effort to evaluate how the regeneration goes on, more timber watching because more harvesting operations are being carried out) and the environmentalists (role played by the FD staff and the forest planers) see only the risks of having detrimental effects on biodiversity and ecosystem services.

In a broader context of rapid policy changes (shorten rotation and adoption of silvicultural system which are not quite environmentally-friendly, like coppice with standards) it is important to make appropriate ex-ante inquires and evaluations of all possible outcomes. Nevertheless, if the forest owners' expectations are not fulfilled for whatever reason, and they will be asking for more wood, the professional foresters must be aware of additional costs and risks, like fines applied by the forest authority for disobeying one or more legal provisions. Any policy change brings forth new loopholes which might be predicted in advance if the problem is modelled as an ANP, and this is a real opportunity the policy makers shall take into consideration.

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