

# BETWEEN COMPROMISE AND CONSENSUS IN GROUP DECISIONS IN FOREST MANAGEMENT

## GRUPNO ODLUČIVANJE U UPRAVLJANJU ŠUMAMA: IZMEĐU KOMPROMISA I KONSENZUSA

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### Summary:

Forest management has become increasingly complex since economic profit became only one of several important management objectives. Considering a diverse set of goals requires the use of multi-criteria decision making. When the only goal was to maximize timber production, the planning process often involved only one decision maker: the forest owner. In the last 20 years, however, planning has changed to include the interests of multiple stakeholders, including local communities, public representatives, hunters, environmentalists, and recreationists, each of which has different knowledge, experiences, prospects, and interests. The formation of a group of stakeholders can be based on participatory planning. The main challenge in group decision making is to resolve the conflict of the group's objectives and preferences. Aggregating individual preferences is not only a mathematical problem but also a philosophical one. We present the analytic hierarchy process as suitable multi-criteria method, which has been already applied in areas such as forestry and harvest scheduling, biodiversity conservation, regional planning, and forest sustainability. A case study of the forest area at Pohorje, a mountainous area in northern Slovenia, was conducted in order to implement the described theoretical findings. The aim of the study was to select the optimal alternative for Pohorje development. We identified five possible alternatives based on indicators of sustainability. The alternatives were compared by several stakeholders according to the results of a SWOT analysis performed at a workshop of stakeholders, who discussed individual chapters of forest management scenarios. The results of the analysis show that the alternative benefits for people, which takes into account all of Pohorje's important aspects, is the most appropriate for Pohorje development.

**KEY WORDS:** forest management; multi-criteria decision making; analytic hierarchy process, group decision making, compromise, consensus, Pohorje, Slovenia

### Introduction

#### Uvod

Ever since economic profit ceased to be its only important objective, forest management has become more complex. Socio-cultural and ecological values of forests are now si-

gnificant goals of many forest landowners and stakeholders. Forests provide a wide range of benefits, including tourism, recreation, hunting, biodiversity, non-timber products, educational opportunities, regulation of climate conditions, and aesthetic value, in addition to timber production. The pre-

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sence of multiple objectives and subjective preferences often determine the solution of the problem to be better-or-worse and not true-or-false (Nordström 2010).

To develop better solutions in sustainable forest management, it is almost essential to include a group of decision makers rather than one decision maker. Stakeholders, rather than the general public, most often participate in the process, as interested organizations, groups, or individuals. Thus, they choose to be active partners in the decision making (Rowe and Frewer 2000).

The power that stakeholders possess in the participatory process can vary substantially and has been described using a ladder of participation (Arnstein 1969, Macpherson 2004). The extent of the power can vary from nonparticipation, where the agency or the owner decides alone, to a level at which people are informed of the decisions without an opportunity to comment. Next, partial involvement of participants is described as stakeholders being involved in appropriate aspects of the planning, implementation, and management of the process. The highest level of involvement is participants' control, where stakeholders are in full control of the decision process. The power can vary also between the stakeholders because of their varying levels of knowledge and experiences (Mianabadi et al. 2011).

When the only goal of forest management was to maximize timber production, the owner of the forest was often the only decision maker. In participatory planning, different interests are represented by different stakeholders such as forest owners, governmental institutions, non-governmental organizations, local communities, hunters, environmentalists, and recreationists.

The inclusion of stakeholders in the decision process offers many advantages, from increasing public awareness of forest management and building trust in institutions, the decision process, and its solutions, to avoiding and resolving conflicts between stakeholders, sharing information, and including local knowledge, various prospects, and preferences in the decision model (Hiltunen et al. 2009). At the same time, some disadvantages can emerge. In addition to incre-

ased time and costs, the main problem can be the disappointment of the manager or stakeholders, who do not see a "higher-quality" solution (Reed 2008).

Therefore, it is important to establish whether a group result is a consensus, about which the stakeholders are convinced regardless of their initially different beliefs (Hartmann et al. 2009), or only a compromise, which the decision makers agree to support in the spirit of cooperation, despite not believing it is necessarily the best option (Steele et al. 2007).

One of the necessary conditions for stakeholders to be satisfied with the solution of the decision process is that they are satisfied with the participatory process itself. The criteria for evaluation of the participatory process are normative (such as fairness and structured group interaction), substantive (quality and selection of information, opportunity to influence process design and outcome), and instrumental (clear goals, transparency, and acceptance of outcome) (Menzel et al. 2010).

The main contribution of the present paper is that it shows how to incorporate different goals and a group of stakeholders in multi-criteria model in order to select an optimal strategy for the development of highland Pohorje in Slovenia.

The paper is organized as follows. In the methods section, we review multi-criteria decision methods, with an emphasis on the analytic hierarchy process (AHP). We present the NATREG project that took place in Pohorje. We proposed an AHP model for selecting an optimal strategy for development of Pohorje. In the results and discussion section we provide the results of the model. The final section presents the main conclusions and suggestions for future work.

## Methods

### Metode rada

Group decision making can be divided into two branches: unstructured and structured. Participatory approaches include newsletters, websites, public meetings, telephone surveys, interviews, and internet-based decision support applications. A commonly used form of group meetings is workshops, in which stakeholders can share their opinions and seek common decisions. They can be based on brainstorming and discussion or connected with any of the social choice or multi-criteria decision methods (MCDMs). Social choice theory is based on voting systems (plurality voting, approval voting, Borda count, pairwise voting, multi-stage voting, utilitarian voting, proportional voting, fuzzy voting, or probability voting), the efficiency of which has been proved throughout the history of democracy. The voting schemes can be evaluated according to consistency, independency, Pareto-optimality, and other criteria. Their result is usually compromise since a kind of majority opi-

**Table 1:** The adaption of Arnstein's Ladder of participation for forestry (Macpherson 2004)

**Tablica 1:** Adaptacija Arnsteinove ljestvice sudjelovanja u šumarstvu (Macpherson 2004)

Participants Control	– Nadzor sudionika
Full Participants Involvement	– Puni angažman sudionika
Partial Participants Involvement	– Djelomični angažman sudionika
Consultation	– Konzultacije
Information	– Informacije
Persuasion	– Uvjeravanje
Agency Control	– Agencijski nadzor

nion prevails. MCDMs are useful in participatory planning since they encourage the participants to structure the decision making and discuss all important objects systematically. AHP is one of the most frequently used MCD techniques in forest planning (Ananda and Herath 2009, Brumec et al. 2013, Kangas and Kangas 2005, Pezdevšek Malovrh et al. 2012, Sheppard and Meitner 2005, Wolfslehner and Seidl 2010, Wolfslehner and Vacik 2008).

The structure of AHP consists of a hierarchy of the goal, criteria, subcriteria, and alternatives. The AHP method is based on pairwise comparisons. For paired comparisons, a fundamental scale of the AHP (Saaty 1980) from 1 to 9 is used. A reciprocal value is assigned to the inverse comparison. Comparisons between individual objectives are gathered in comparison matrix *A*.

**Table 2:** The fundamental scale of AHP

**Tablica 2:** Osnovna skala AHP-a

Value Vrijednost	Description Opis
1	Criteria <i>i</i> and <i>j</i> are equally important – Kriteriji <i>i</i> i <i>j</i> su jednako važni
3	Criterion <i>i</i> is slightly more important than criterion <i>j</i> – Kriterij <i>i</i> je važniji od kriterija <i>j</i>
5	Criterion <i>i</i> is more important than criterion <i>j</i> – Kriterij <i>i</i> je znatno važniji od kriterija <i>j</i>
7	Criterion <i>i</i> is proved to be more important than criterion <i>j</i> – Kriterij <i>i</i> je puno važniji od kriterija <i>j</i>
9	Criterion <i>i</i> is absolutely more important than criterion <i>j</i> – Kriterij <i>i</i> je iznimno važniji od kriterija <i>j</i>
2, 4, 6, 8	Middle values – Srednje vrijednosti

Saaty (1980) presented the eigenvector method for deriving priorities in which, according to the comparison matrix *A*, the priority vector is obtained by solving the equation  $Aw = \lambda_{max} w$ , where  $\lambda_{max}$  is the largest eigenvalue of matrix *A*:

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ \frac{1}{a_{12}} & 1 & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \dots & 1 \end{bmatrix}$$

In AHP, the group result (compromise or consensus) also depends on the initial degree of consensus among the stakeholders. In the case of independent stakeholders evaluating the defined set of alternatives, the result is usually a compromise. If stakeholders construct the common model and evaluate it individually, the main influence on the final consensus outcome presents the application of the mathematical aggregation model. The last possibility is a meeting of the group at which members generally have the same objectives. The group can then try to reach a consensus, first in terms of developing the hierarchy and then in generating

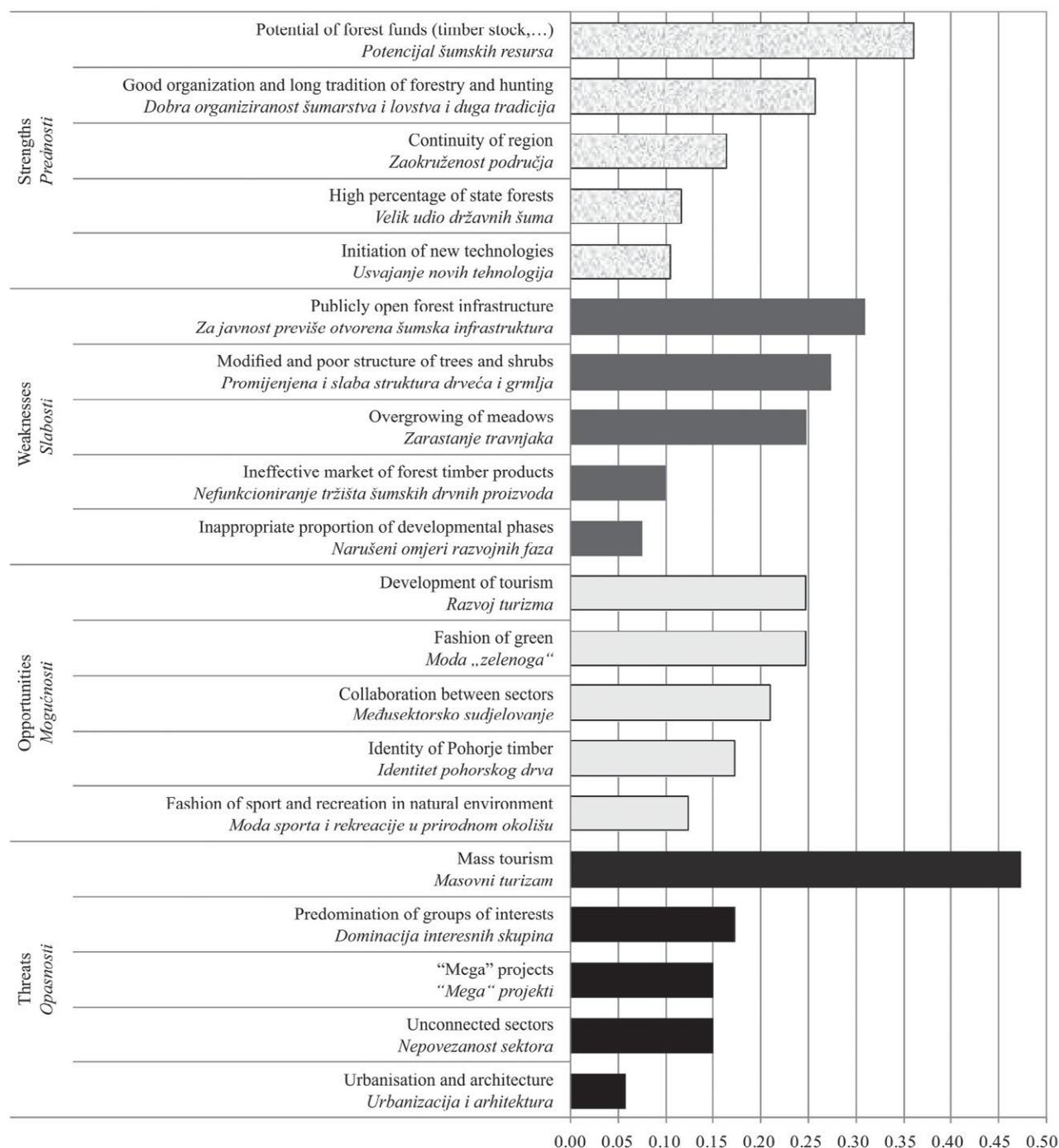
pairwise comparisons. If they cannot reach a consensus regarding a particular judgment, they can vote or try to achieve a compromise (Dyer and Forman 1992). There are two types of aggregation (Forman and Peniwati 1998): aggregation of individual judgments and aggregation of individual priorities. Both cases have many models for aggregation in literature; most are compromises, but some are claimed to be consensual models.

In order to implement the described theoretical findings, a forest management application was made in Pohorje, a highland region that covers 840 km<sup>2</sup> in northeastern Slovenia and is mostly covered with conifer forests. Due to impermeable ground, characteristic peaty bogs have formed. The forests provide habitats for numerous rare and endangered bird species. The main economic activities in Pohorje are forest exploitation, agriculture on the edge of the region, and tourism. Pohorje was declared a Natura 2000 site and an agreement for the development of the Pohorje regional park was signed.

The NATREG project – managing natural assets and protected areas as sustainable regional development opportunities (NATREG 2011) was conducted at Pohorje in 2009–2011. The project was managed by The Institute of the Republic of Slovenia for Nature Conservation with the objective of developing a management plan for Pohorje. Three workshops were organized to discuss forestry and hunting, agriculture, and tourism (Uratarič and Marega 2010); the case study presented here involves only forestry and hunting. Nineteen stakeholders responded to an invitation to the workshop: regional units of the Slovenia Forest Service, the Institute of the Republic of Slovenia for Nature Conservation, the Hunting Association of Slovenia, and the Chamber of Agriculture and Forestry. At the workshop, a SWOT (strengths, weaknesses, opportunities, and threats) analysis was conducted in the field of forestry and hunting in Pohorje (Lešnik Štuhec and Gulič 2010). The most important strengths are the potential of forest funds and the organization and long tradition of forestry and hunting. The greatest weakness is the publicly open forest infrastructure. The most significant opportunity and threat are both connected to tourism.

As part of the forestry and hunting workshop, participants also ranked the indicators of sustainability, ecological, economic, and socio-cultural objectives and evaluated them on a scale ranging from very irrelevant to very important (Nose Marolt and Lešnik Štuhec 2010). The mean values were calculated. The indicators with mean value greater or equal to 1 (important indicators) are presented in Figure 2.

The aim of our study was to select an optimal alternative for Pohorje's development. We set the SWOT groups as criteria and the SWOT factors as sub-criteria of our model. We grouped the indicators into five groups; some groups



**Figure 1:** The weights of the SWOT criteria

**Slika 1:** Težine SWOT kriterija

can overlap, although this is not indicated here. Based on the indicators, we identified five alternatives, which take all indicators into account but emphasize some more than others; these are: biodiversity, where the main importance is given to nature protection and protection of rare and endangered species; environmental advantages, which focuses on oxygen, carbon, water, climate, etc.; benefits for people, which emphasizes recreation, education, timber, water, air, and aesthetic value; the development of tourism; and economic issues, the most important of which is timber production.

The decision tree of goals, criteria, and alternatives is presented in Figure 3.

We selected five stakeholders, all of whom have been also involved in the NATREG project, to pairwise compare all alternatives according to all SWOT factors. We proposed that all stakeholders' opinions are equally important. We used geometric mean (Saaty and Peniwati 2008) to aggregate the individual pairwise comparisons into group comparisons, which were gathered in group comparison matrices.

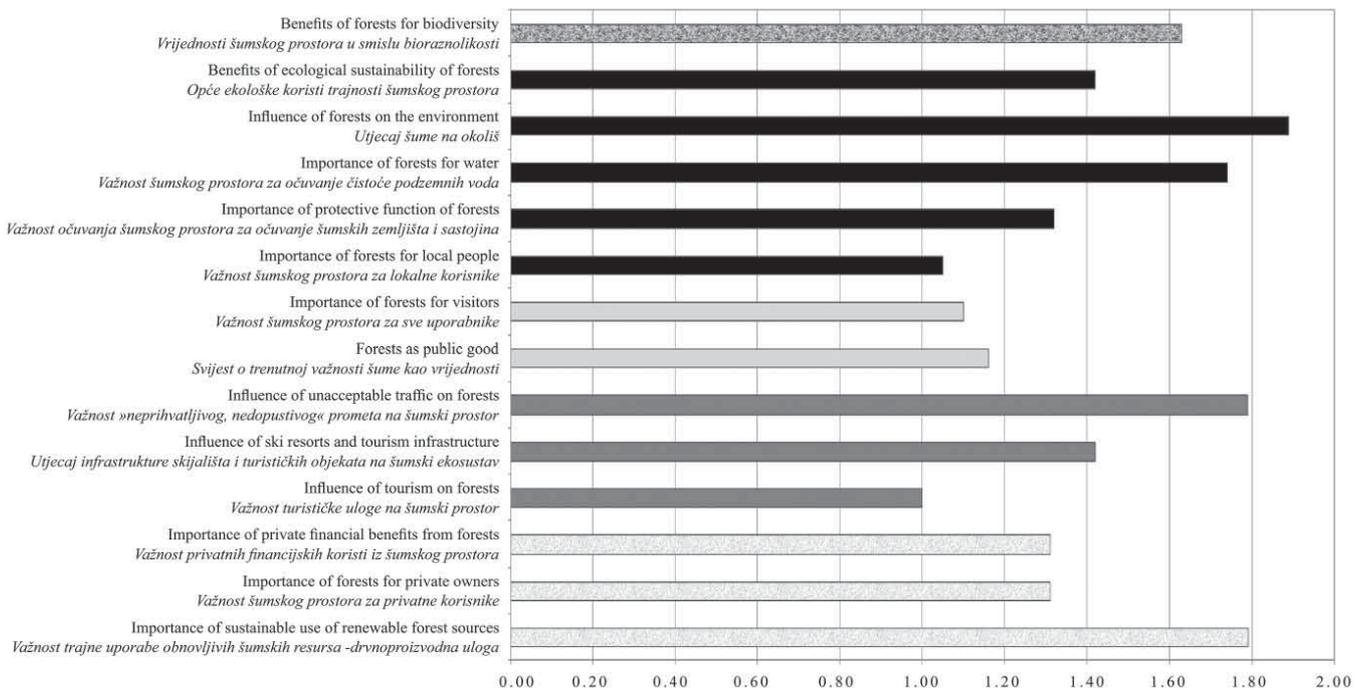


Figure 2: The weights of the indicators

Slika 2: Težine indikatora

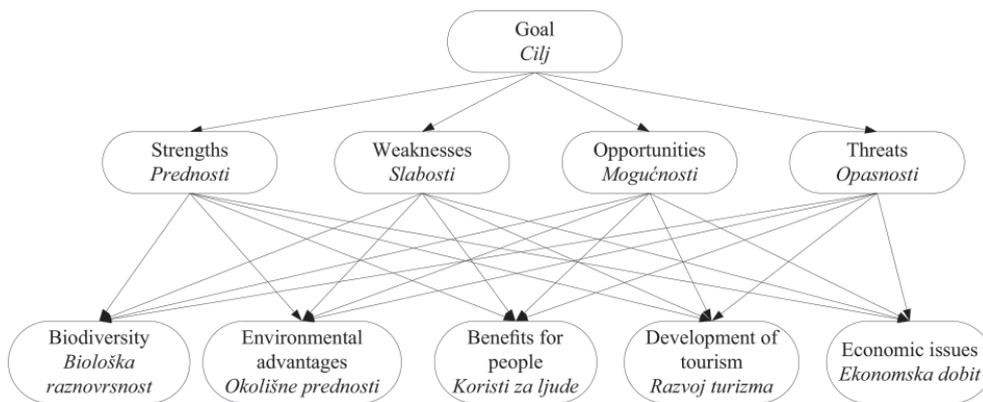


Figure 3: The AHP decision tree  
Slika 3: AHP stablo odlučivanja

## Results and discussion

### Rezultati istraživanja i rasprava

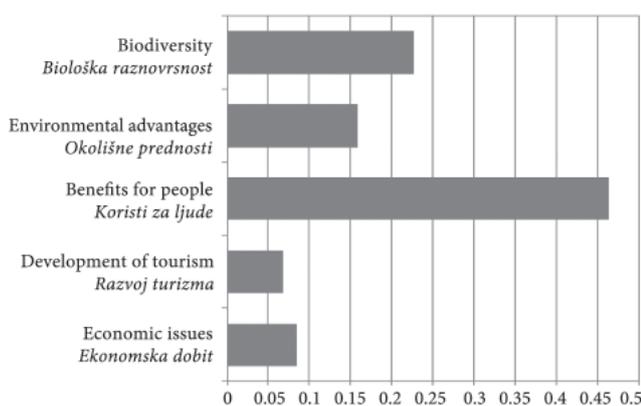
We derived group priority vectors using the eigenvector method from group comparison matrices. The group priorities of alternatives according to each SWOT factor were synthesized with the weights of the SWOT factors from Figure 1 to obtain the weights of alternatives according to each SWOT group; the results are shown in Table 3. Higher weights at strengths and opportunities and smaller weights at weaknesses and threats indicate better results. For final evaluation, we assumed that all SWOT factors are equally important. There are several ways to synthesize the results of alternatives according to SWOT factors. We used a multiplicative formula,  $P_i = \frac{S_i O_i}{W_i T_i}$  (Wijnmalen 2007), where the

weights of strengths and opportunities are multiplied and divided by weights of weaknesses and threats. The final results are presented in Figure 4.

The final results show that benefits for people is the most appropriate alternative for Pohorje development. It is somehow the most neutral alternative and takes into account all aspects from timber production to biodiversity conservation. It was ranked in either second or third place by all of the SWOT groups. Its weight (46.3 percent) is much higher than the weights of the next two alternatives; namely, biodiversity (22.6 percent) and environmental advantages (15.9 percent). The biodiversity alternative is good for reducing weaknesses and avoiding threats in Pohorje, but was ranked last in terms of strengths and opportunities. Environmental advantages did not stand out in any SWOT

**Table 3:** Weights and ranking of alternatives according to each of SWOT factors**Tablica 3:** Težine i rangiranje alternativa prema svakom SWOT faktore

Alternatives Alternativa	Strengths Prednosti		Weaknesses Slabosti		Opportunities Mogućnosti		Threats Opasnosti	
	Weights težine	Ranking rangiranje	Weights težine	Ranking rangiranje	Weights težine	Ranking rangiranje	Weights težine	Ranking rangiranje
Biodiversity Biološka raznovrsnost	0.1390	5	0.0756	1	0.1073	5	0.1238	1
Environmental advantages Okolišne prednosti	0.1428	4	0.1270	3	0.1302	4	0.1309	2
Benefits for people Koristi za ljude	0.1767	2	0.1133	2	0.2760	2	0.1319	3
Development of tourism Razvoj turizma	0.1644	3	0.3461	5	0.3342	1	0.3276	5
Economic issues Ekonomska dobit	0.3771	1	0.3380	4	0.1523	3	0.2858	4

**Figure 4:** The final weights of alternatives**Slika 4:** Konačne težine alternativa

group. Development of tourism (6.9 percent) and economic issues (8.4 percent) ranked last overall since they emphasize only the importance of one sector for Pohorje development.

## Conclusion

### Zaključak

Sustainable development of forestry has a significant influence on the preservation of Pohorje. The most important issues are conservation of biodiversity, unpolluted groundwater, and sustainable use of renewable forest sources. Timber production is not considered an economically efficient business opportunity. Insufficient attention is paid to education, experience of nature, or cultural heritage in forests (Nose Marolt and Lešnik Štuhec 2010).

The next step will involve inclusion of SWOT analysis of tourism and agriculture in the decision tree. Pairwise comparisons in AHP should be performed on all important groups of stakeholders at Pohorje. The results from the forestry side should then be combined with the results of agriculture and tourism to inform the comprehensive management plan.

The results of our study show how we can incorporate different objectives in the model that often appear in forestry planning. In our case study, timber production could not be considered as the only important opportunity because of other important issues in Pohorje; namely, tourism, agriculture, biodiversity, water, air, climate, recreation for people, and education. In such cases, group decision making is important in order to include different views, experiences and knowledge in the model. The main stakeholders should not be only from the field of forestry but also, in our case, from important fields, such as protection of nature, agriculture, tourism. It could also be worth including representatives of local groups.

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## Sažetak:

Upravljanje šumama evaluiralo je u složeniji zadatak, budući da je ekonomska dobit samo jedna od nekoliko važnih ciljeva upravljanja. Uvažavajući tako različit skup ciljeva upravljanja, zahtijeva korištenje višekriterijske metode odlučivanja. Kada je maksimalna proizvodnja drva bila jedini cilj, odluke o planiranju procesa u većini slučajeva donosio je vlasnik šume. Posljednjih dvadeset godina, proces planiranja se promijenio te uključuje interese više zainteresiranih strana kao npr. lokalne zajednice, javne predstavnike, lovce, ekološke, rekreativce i druge. Oni imaju različita znanja, iskustva, perspektive i interese. Formiranje grupe treba se temeljiti na participativnom planiranju. Glavni problem grupnog odlučivanja je rješavanje konflikta između različitih ciljeva i preferencija. Grupiranje pojedinačnih preferencija nije samo matematički već i filozofski problem. U radu smo predstavili analitički hijerarhijski proces kao prikladnu višekriterijsku metodu, koja se već primjenjuje u području šumarstva, planiranju žetve, očuvanju biološke raznolikosti, prostornom planiranju, održivosti šuma i drugdje. Studija o šumskom području Pohorja, planinskom lancu u sjevernoj Sloveniji, izvodi se prema opisanim teorijskim osnovama. Cilj našeg istraživanja bio je izbor optimalne alternative

za razvoj Pohorja. Identificirali smo pet mogućih alternativa na temelju pokazatelja održivosti. Alternative su uspoređivali nekolicina zainteresiranih sudionika, prema rezultatima SWOT analize, koja je izvedena na radionici, gdje su sudionici raspravljali o pojedinim poglavljima scenarija o upravljanju šumama. Rezultati pokazuju da je alternativa "Dobrobiti za ljude", koja uključuje sva važna gledišta za Pohorje, najprikladnija za razvoj istog.

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**KLJUČNE RIJEČI:** upravljanje šumama, višekriterijsko odlučivanje, analitički hijerarhijski proces, grupno odlučivanje, kompromis, konsenzus, Pohorje, Slovenija