



APPLICATION OF ANALYTIC
HIERARCHY PROCESS AND BORDA
COUNT
IN MANAGEMENT OF PROTECTED
AREAS

Milena Lakicevic

Faculty of Agriculture
University of Novi Sad
Serbia

e-mail: mlenal@poli.uns.ac.rs

INTRODUCTION

- In the past, decision-making in management of protected areas was “top-down” oriented.
- Nowadays, making responsible decisions involves the inclusion of the various stakeholders’ groups.
- Question that arises is: in what way to examine the public and experts’ opinion.



INTRODUCTION

- This paper offers a proposal how to address these concerns.
- Proposed framework combines application of multi-criteria analysis and social choice theory, by linking Analytic Hierarchy Process (AHP) and Borda count.
- The application of proposed approach is shown on a case example of the National Park 'Fruska gora', Serbia.



INTRODUCTION

- The problem is stated as: selecting the best management plan for the National Park 'Fruska gora'.
- Decision makers: experts and public.
- Experts: local authorities and academic experts.
- Public: representatives of local communities and tourists.
- Experts (AHP) \longrightarrow Public (Borda count) \longrightarrow Aggregation (CCM).



METHODS OF RESEARCH – AHP

- Analytic Hierarchy Process (AHP) is one of the most commonly applied decision-support tools.
- AHP requires well-structured problem represented as a hierarchy.

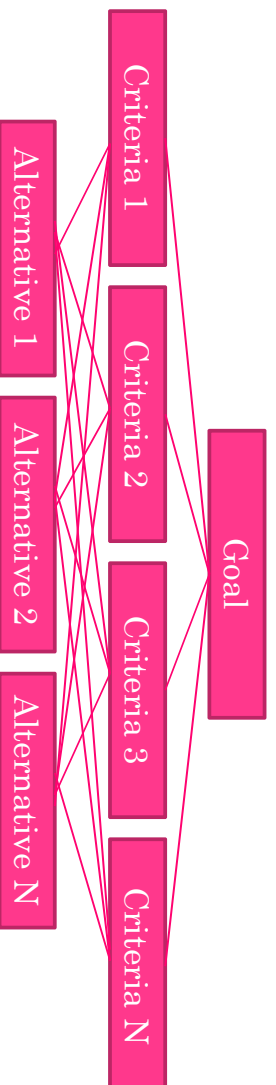


Figure 1. An example of hierarchy in AHP

METHODS OF RESEARCH – AHP

- Comparison of elements
- Eigenvector method
- Overall priorities of alternatives with respect to the goal

Table 1. Saaty's Importance Scale

Definition	Assigned value
Equally important	1
Weak importance	3
Strong importance	5
Demonstrated importance	7
Absolute importance	9
Intermediate values	2,4,6,8

Table 2. Matrix of comparison

1	a ₁₂	a ₁₃	a ₁₄	a ₁₅
1/a ₁₂	1	a ₂₃	a ₂₄	a ₂₅
1/a ₁₃	1/a ₂₃	1	a ₃₄	a ₃₅
1/a ₁₄	1/a ₂₄	1/a ₃₄	1	a ₄₅
1/a ₁₅	1/a ₂₅	1/a ₃₅	1/a ₄₅	1

METHODS OF RESEARCH – BORDA COUNT

- Borda count is an elective method suitable for field of forestry.
- If n is number of alternatives, the highest ranked alternative scores n points, the second ranked obtains $n-1$ points, and so on. The lowest ranked alternative gets 1 point.
- The winner is the alternative getting the most votes.

METHODS OF RESEARCH – CONSENSUS CONVERGENCE MODEL

- For certain alternative individual weights provided by n decision makers are marked as: $p_1^0, p_2^0, \dots, p_n^0$.

- A metric that calculates weights of respect between decision makers is:

$$w_j = \frac{1 - |p_i^0 - p_j^0|}{\sum_{j=1}^n 1 - |p_i^0 - p_j^0|},$$

i individual assigning the weights, j individual being assigned, n number of group members

METHODS OF RESEARCH – CONSENSUS CONVERGENCE MODEL

- The weights of respect are used to create $n \times n$ size matrix:

$$W = \begin{bmatrix} W_{11} & W_{12} & \dots & W_{1n} \\ W_{21} & W_{22} & \dots & W_{2n} \\ \dots & \dots & \dots & \dots \\ W_{n1} & W_{n2} & \dots & W_{nn} \end{bmatrix}$$

- If P is a vector of initial alternative's weights, consensual vector of weights is obtained by iterative equation:

$$P_c = WP_{c-1}$$


CASE STUDY EXAMPLE

- Fruska gora is proclaimed a national park in 1960.
- The area of active protection is 25.525 ha.


- Fruska gora is called the 'mirror of geological past' thanks to unique and very rich deposits of fossil fauna and flora.

- In this area, there are 16 orthodox monasteries famous for their specific architecture, treasures, libraries, frescoes and numerous archeological sites.

CASE STUDY EXAMPLE

- Criteria:
 - (C₁) Preservation of species and genetic diversity
 - (C₂) Maintenance of environmental services
 - (C₃) Tourism and recreation
 - (C₄) Scientific research
 - (C₅) Wilderness protection
 - (C₆) Protection of specific natural/cultural features
 - (C₇) Education
 - (C₈) Sustainable use of resources
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- 

CASE STUDY EXAMPLE

- Alternatives (management plans):
 - (A₁) The current plan
 - (A₂) Tourism
 - (A₃) Environmental protection
 - (A₄) Sustainable use of natural resources
-
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PRELIMINARY RESULTS

- So far, 25 decision makers were interviewed.
- It is supposed to be included approximately 100 decision makers.
- Preliminary results give an advantage to plan 1.

PRELIMINARY RESULTS – EXPERTS

- AHP – Geometric Mean Method (GMM)
- Local authorities – two representatives
- Academic experts – three representatives

Plan	Local authorities	Academic experts
Plan 1	0.382	0.277
Plan 2	0.185	0.114
Plan 3	0.308	0.371
Plan 4	0.125	0.238

PRELIMINARY RESULTS – PUBLIC

- Borda count – Additive normalization
- Local communities – five representatives
- Tourists – 15 representatives

Plans	Local communities		Tourists	
	Votes	Weights	Votes	Weights
Plan 1	15	0.300	43	0.287
Plan 2	9	0.180	60	0.400
Plan 3	8	0.160	26	0.173
Plan 4	18	0.360	21	0.140

PRELIMINARY RESULTS – DECISION

- Consensus convergence model

Plans	Weights	Rank
Plan 1	0,315	1
Plan 2	0,218	3
Plan 3	0,254	2
Plan 4	0,213	4

CONSLUSIONS

- This paper can be useful in the theory and practice of forest science.
- Contemporary techniques, such as AHP, facilitate and shorten the decision-making process.
- Linking AHP with social choice theory has a great potential and flexibility.
- The paper offers a new framework in management of national parks, which is based on linking AHP and the method of social choice theory – Borda count.



CONSLUSIONS

- The approach provides successful implementation of the concept of participatory decision-making.
- The main goal of this research is to define a new methodology in the management of national parks and other protected areas, which provides the involvement of different stakeholders, according to the level of their competences.



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THANK YOU

