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Participatory forest planning using AHP and TOPSIS

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Outline

- Objective and background
- Methods
  - AHP
  - TOPSIS
- Case study
- Conclusions

Photo: Julia Carlsson

Objective of the study

To test the combination of AHP and TOPSIS for evaluating a large number of alternative forest management plans in a situation with multiple objectives and several stakeholders.

The approach is applied in a case study of Vilhelmina municipality forest, northern Sweden.

Photo: Erik Wilhelmsson

Background

- Planning for sustainable forest management is complex
  - multiple objectives
  - stakeholders
- Decision support systems
  - long-term projections
  - scenario analysis

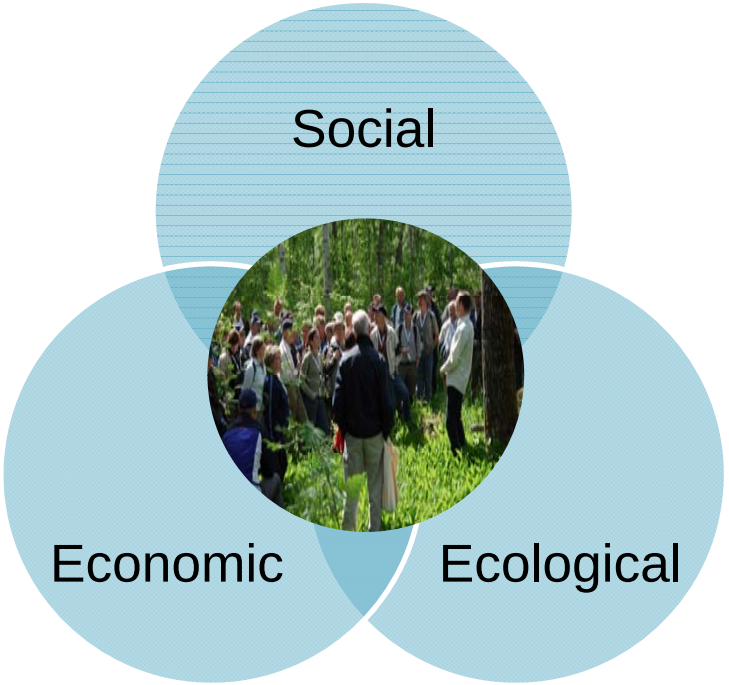
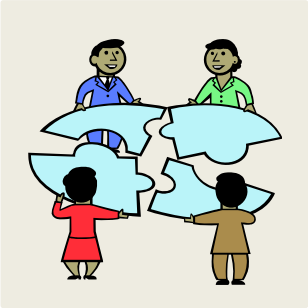


Photo: Leif Öster,
Sveaskogs bildbank

Multiple criteria decision analysis (MCDA)

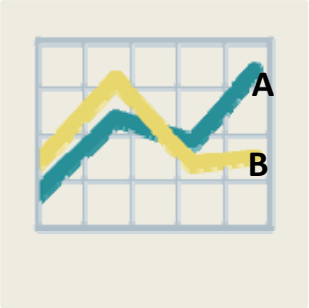
- Combines ”objective information” and ”subjective preferences”
- Structured decision making process



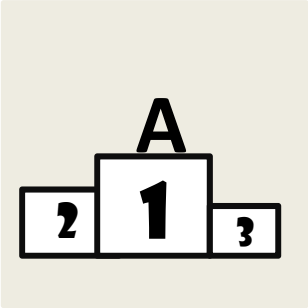
Frame the decision problem

Define alternatives

Weighting of objectives



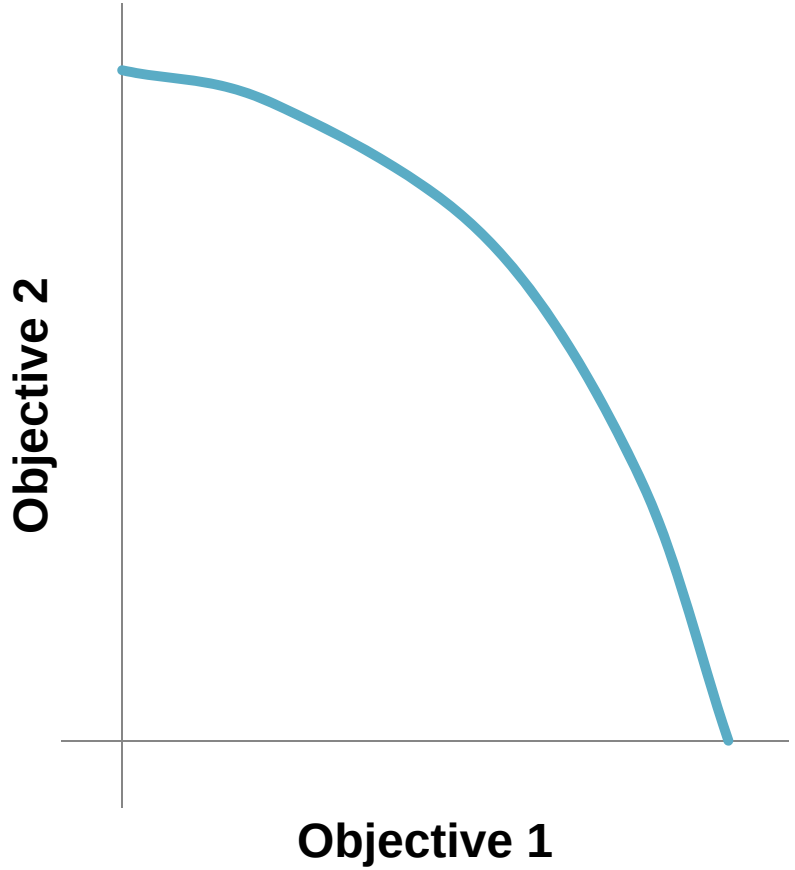
Evaluation of alternatives



Overall ranking of alternatives

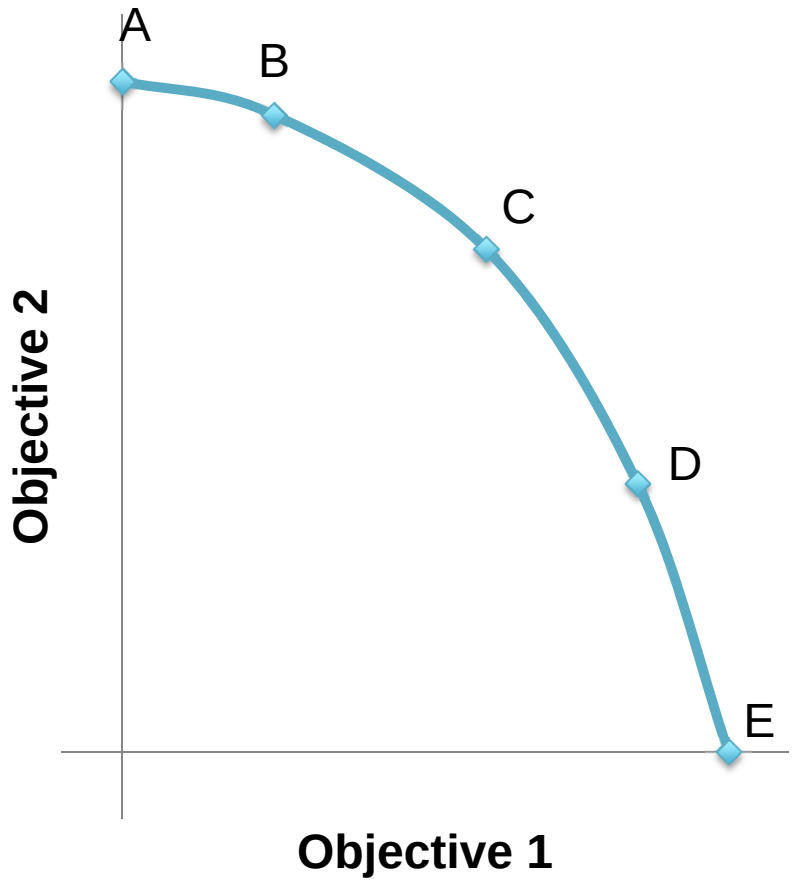
Forest planning problems

- **Continuous** character – many possible solutions



Forest planning problems

- **Continuous** character – many possible solutions
- Often only **a limited number** of alternative plans are considered

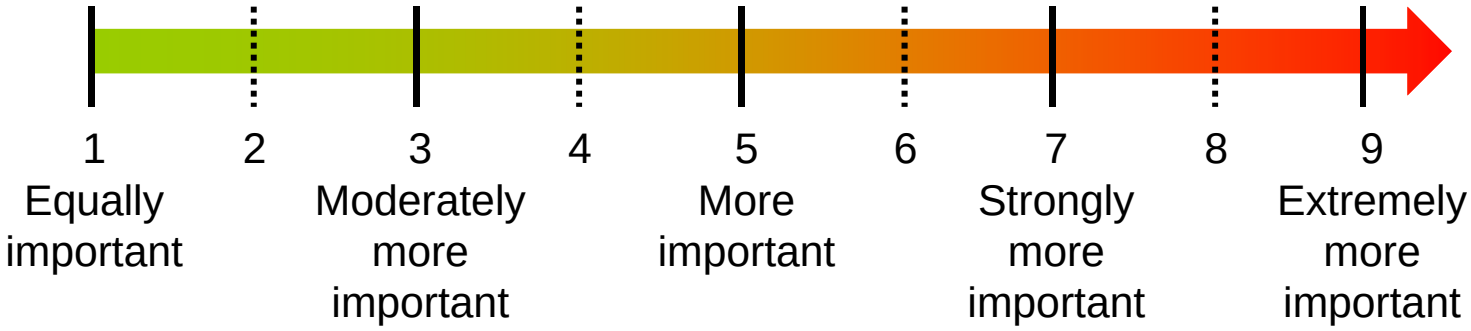


AHP

- Analytic Hierarchy Process (Saaty 1980)
  - Pairwise comparisons of objectives and alternatives
  - 9-grade scale

+ Established and relatively user-friendly method

- Many comparisons are demanding



TOPSIS

- Technique for Order Preference by Similarity to Ideal Solution (Hwang & Yoon 1981)
  - Ranking based on distance to the “best” and “worst” solutions

+ Automatizes evaluation of alternatives

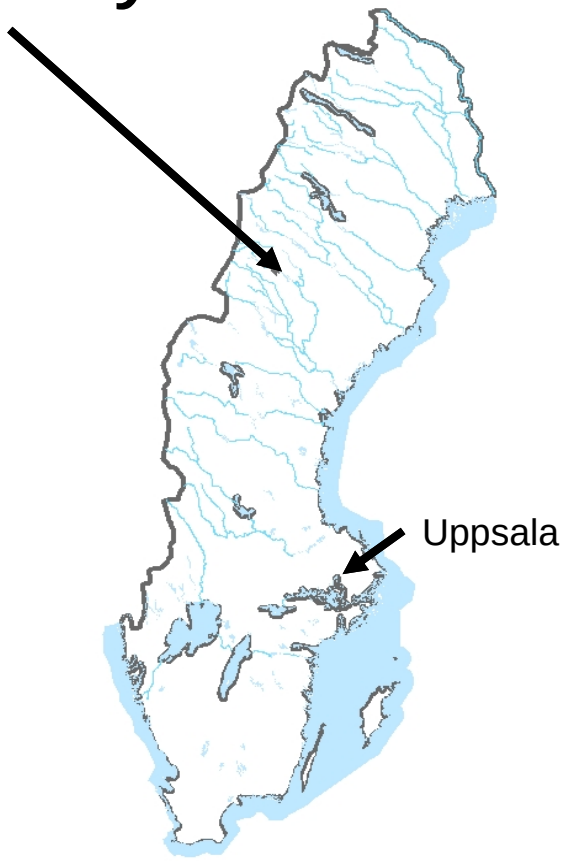
- Black box?

TOPSIS

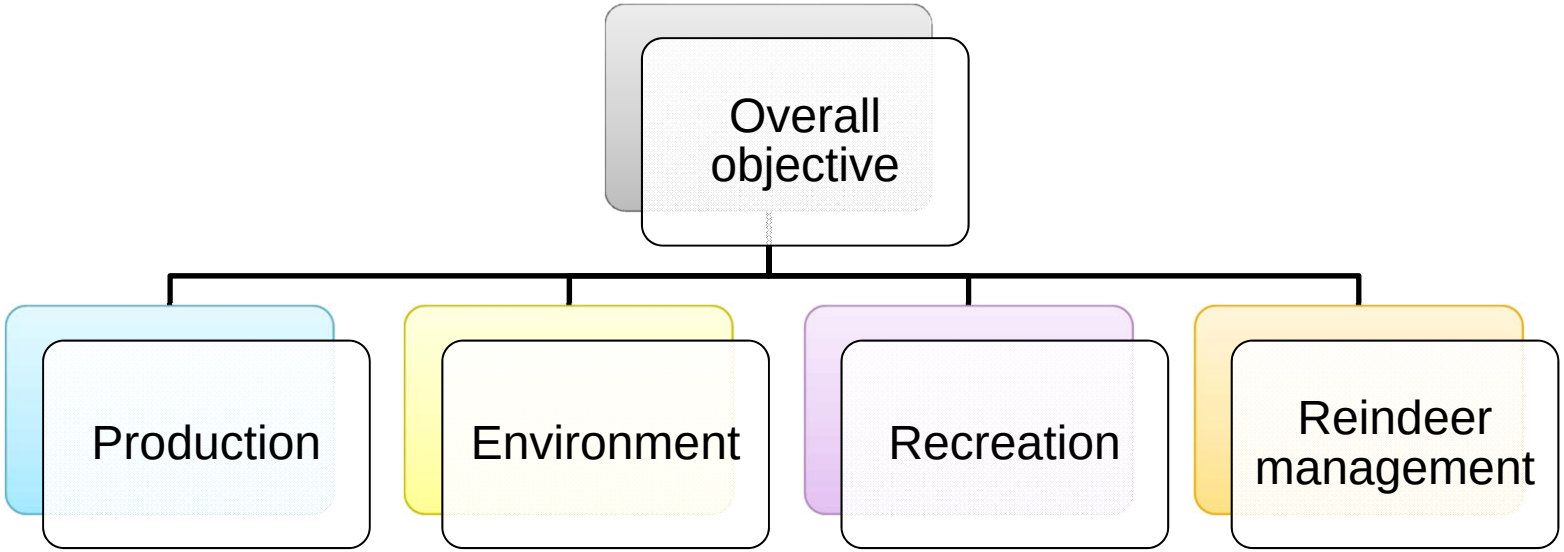
1. Creation of evaluation matrix and normalization
2. Calculation of weighted normalized ratings
3. Identification of best and worst solutions
4. Calculation of distance to best and worst solutions
5. Calculation of similarities to best solution
6. Ranking of preference order

The Vilhelmina case study

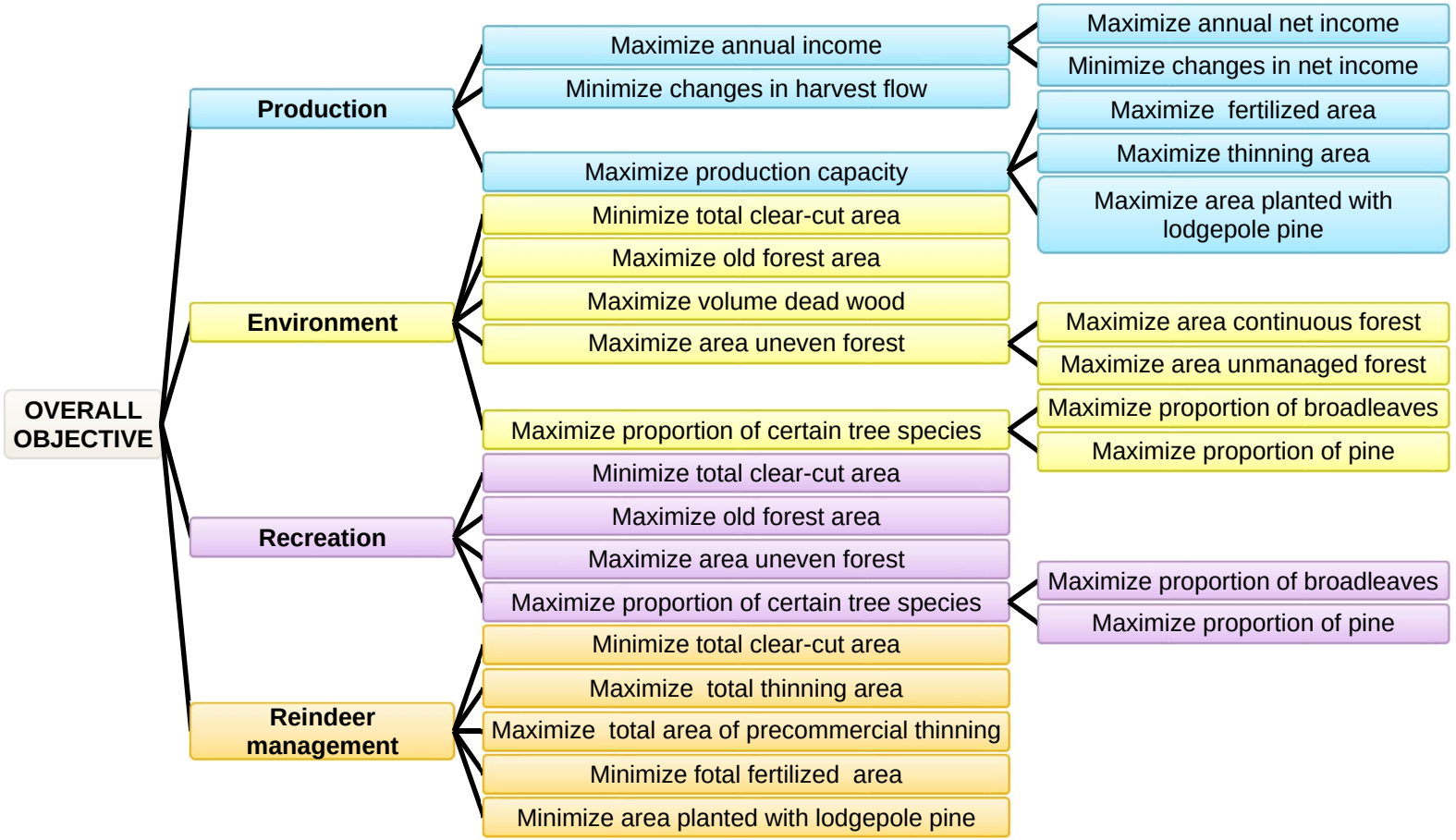
- Municipality forest
- 6 700 ha productive forest land
- Reindeer herding: forest grazing
- Vilhelmina Model Forest



Stakeholders and objectives

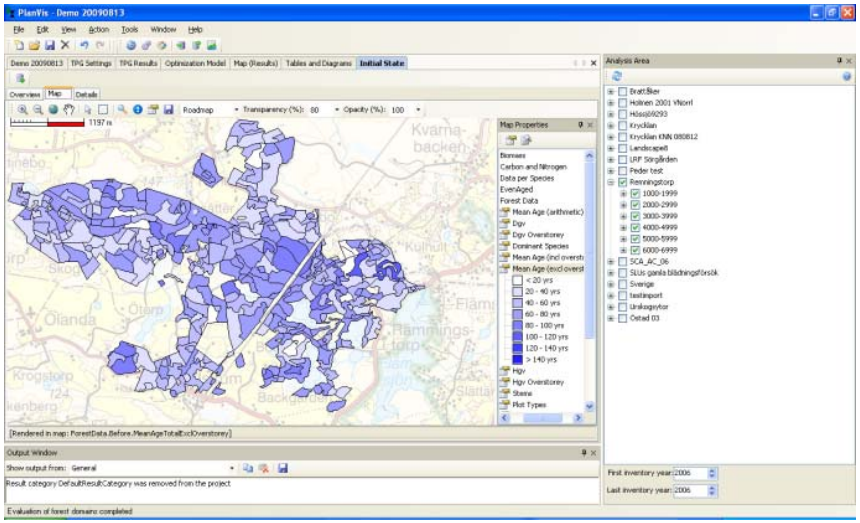


Objective hierarchy



Alternative forest plans

- 27 long-term plans
- Generated with Heureka PlanWise
- Based on combinations of:
  - 3 simulations of management
  - 4 objective functions
  - 10 constraints



Preferences and overall ranking

- Stakeholders weighted objectives using **AHP**
- **TOPSIS** produced overall rankings of the alternative plans
- Different weights of influence for the groups were tested
  - Equal weights
  - Production = 0.5
  - Environment = 0.5

Ranking of plans by groups

Rank	Production	Environment	Recreation	Reindeer management
1	27	24	20	21
2	14	26	21	25
3	2	22	24	18
4	15	23	26	8

Overall ranking of plans compared with group rankings

Equal weights for all groups

Rank	Plan	Production ranking	Environment ranking	Recreation ranking	Reindeer management ranking
1	**21**	7	22	2	1
2	**25**	13	13	17	2
3	**20**	6	20	1	6
4	**27**	1	11	15	9

Overall ranking of plans compared with group rankings

Equal weights for all groups

Rank	Plan	Production ranking	Environment ranking	Recreation ranking	Reindeer management ranking
1	**21**	7	22	2	1
2	**25**	13	13	17	2
3	**20**	6	20	1	6
4	**27**	1	11	15	9

Overall ranking of plans

With various weights for the groups

Rank	Equal weights	Production = 0.5	Environment = 0.5
1	21	21	26
2	25	20	27
3	20	27	25
4	27	25	15

Conclusions

The combination of AHP and TOPSIS:

- Uses the DSS potential to generate a diversity of plans
- Incorporates stakeholders' preferences for the objectives
- Automatizes the evaluation of alternatives
- May point to further alternatives

Photo: Julia Carlsson


Thank you!
Questions?
Photo: Erik Wilhelmsson

TOPSIS for group decision making

a. Each stakeholder assign weights to the criteria
b. Each stakeholder is assigned a degree of importance
c. Steps 2 to 5 of TOPSIS are carried out for each stakeholder, calculating the similarities to positive-ideal solution simultaneously for each group member. resulting in a relative-closeness matrix (for each alternative of each member)
d. The importance weights of the group members are introduced into the relative-closeness matrix. This is we step 3 in the original TOPSIS which is then followed to the final step, "*Step 6: Rank Preference Order".*