



Multi-criteria analysis applied to environmental impacts of hydropower and water resource regulation projects

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Scope

- Investigate different decision-settings in watershed management in Norway, related to hydropower generation:
 - Project level assessment
 - First time evaluation of water regulation concessions
 - Revisions of water regulation concessions
 - Strategic screening of hydropower concessions
 - Watershed management - composition of programs of measures under the Water Framework Directive (WFD).
- Investigate the potential of MCDA to improve existing practice
 - When the increased effort of using MCDA would be justified
 - Review of applications and case studies in Norway, Finland and The Alps

Multi Criteria Decision Analysis

- A structuring framework for the whole decision making process
 - identification and structuring stakeholders' objectives
 - development of (new) alternatives
- A formal way to incorporate decision makers', stakeholders' values and experts' knowledge in decision making
 - facilitates interaction and learning between experts, authorities and stakeholders
 - contributes shared understanding and commitment among stakeholders
 - model how stakeholders' values can affect the final decision
 - find widely acceptable (consensus/compromise) solutions
- Preference (value) modeling

Motivation

- Elements of MCDA already exist in:
 - Environmental Impact Assessment (EIA)
 - Social Economic Analysis (samfunnsøkonomisk analyse).

Guidance document on social economic analysis

Veiledning i samfunnsøkonomiske analyser - Finansdepartementet (2005)

Guidance on the 'concept screening of projects'

Kvalitetssikring av konseptvalg, samt styringsunderlag og kostnadsoverslag for valgt prosjekteralternativ. Veileder no.9 Utarbeidelse av KVV/KL - Finansdepartementet (2010).

The Norwegian Public Roads Administration 's guidance on Impact Evaluation

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Motivation

- Elements of MCDA already exist in:
 - Environmental Impact Assessment (EIA)
 - Social Economic Analysis (samfunnsøkonomisk analyse).

but...

MCDA techniques are not formally used to document and structure value elicitation.

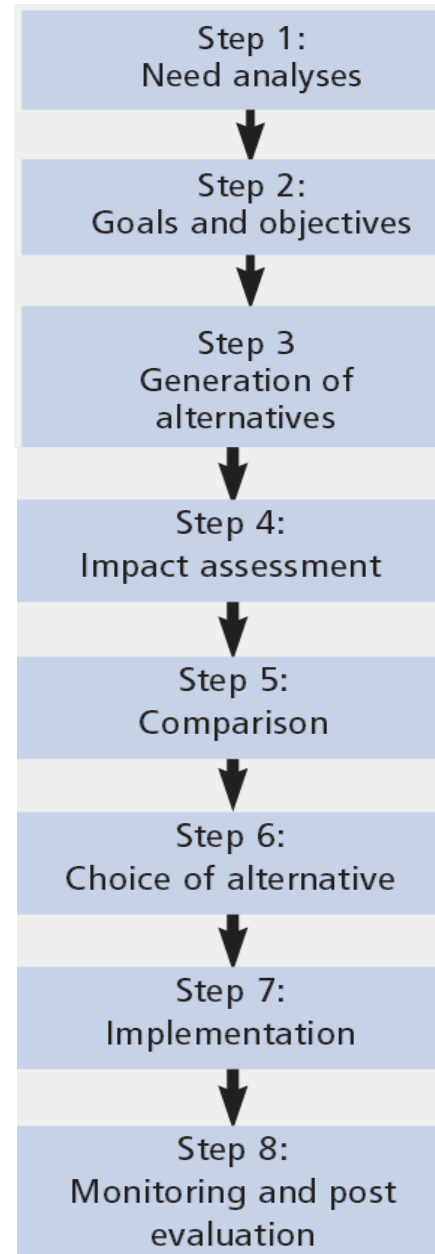
- Simple MCDA value scaling and weighting have mainly been used to integrate unpriced impacts into quantitative comparisons with power loss

Multiple stakeholder interests are acknowledged as important, but this intention is not formalized in value scaling

- Not clear how subjective value judgments of stakeholders in the Public Hearing process of projects are reflected in the subjective value judgments carried out by technical experts conducting EIA

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The planning process & MCDA



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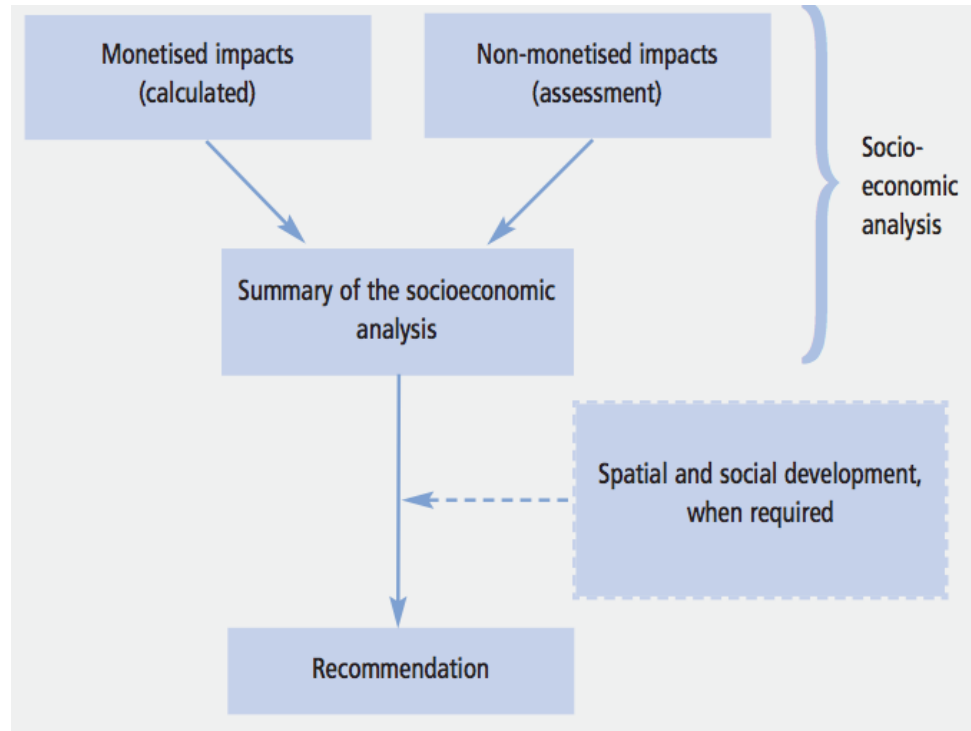
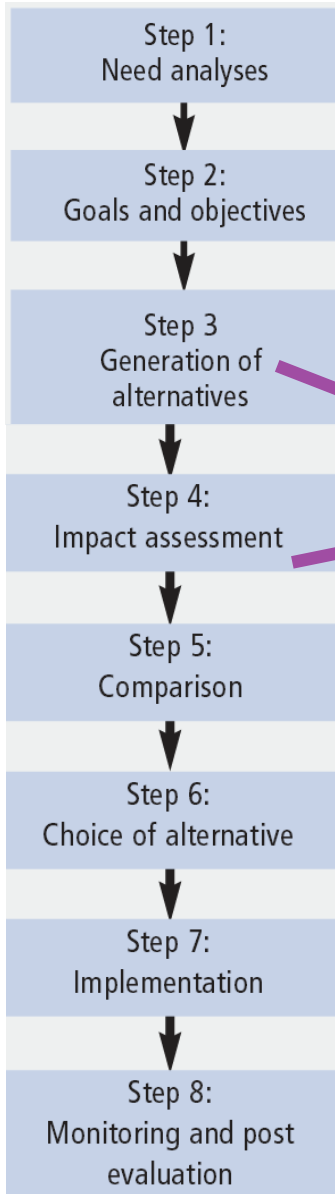
Involve policy makers, affected authorities, stakeholders and experts to say something about:

- Goals and objectives
- Alternatives to evaluate
- Impacts – and how to measure them
- Impacts – compare the alternatives
 - values and weights
 - Preference modeling
- Impacts & alternatives – validate the final choice (alternative to be implemented)



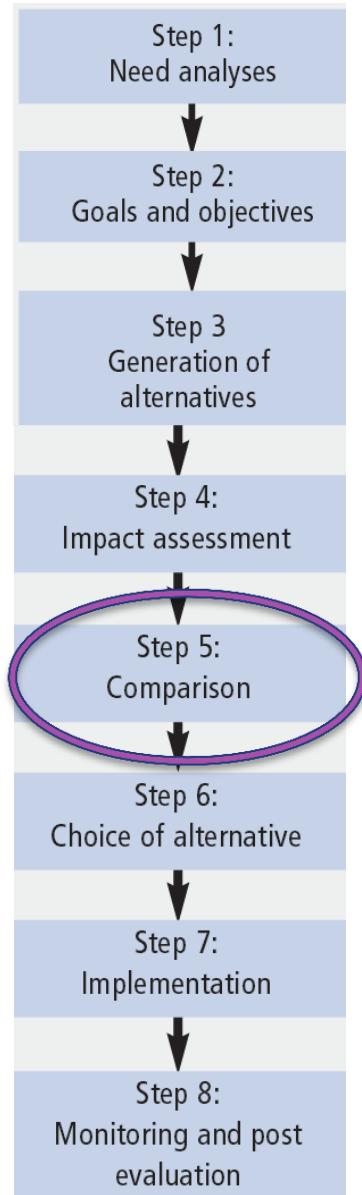
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Impact assessment: all impacts predicted to occur if a road transport project is implemented



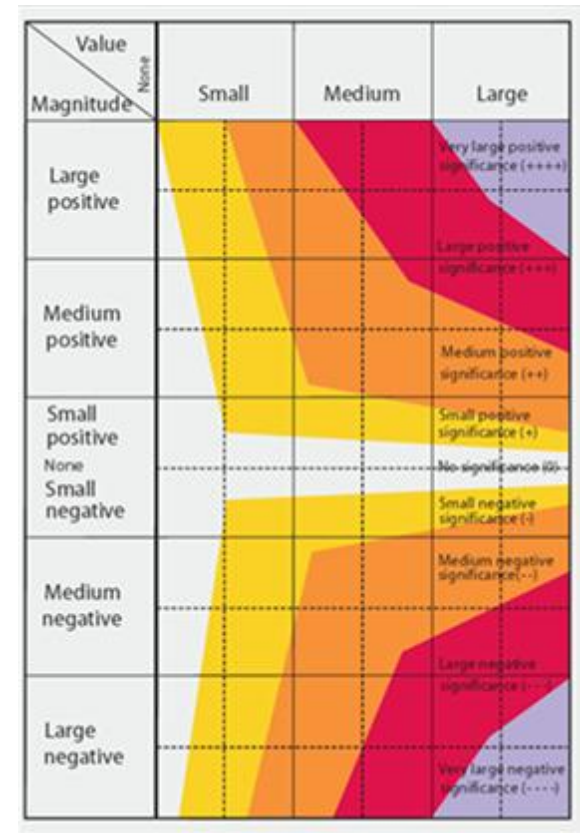
Impacts are estimated relative to a reference scenario/alternative 0

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Monetized aspects - costs & benefits for main groups of stakeholders

Non monetized aspects
Impact significance matrix



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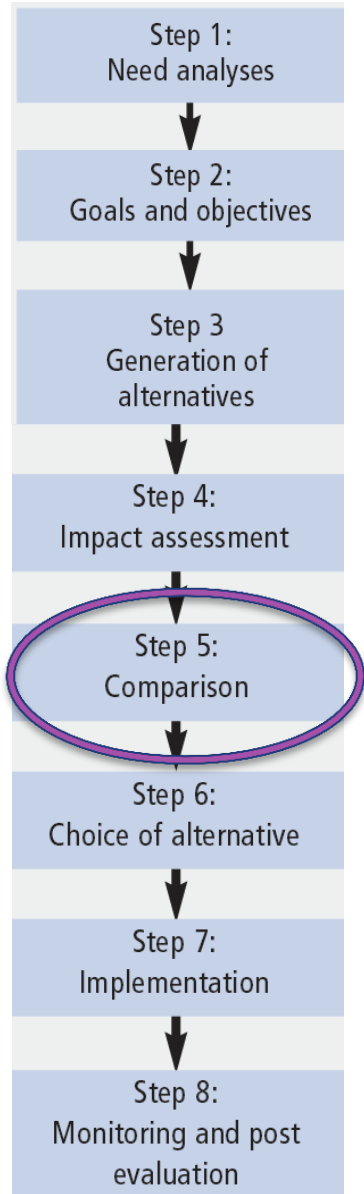
Non monetized aspects

Value

Magnitude: the future changes in an area and how much of this is caused by the project

Significance: an evaluation of advantages and disadvantages of a project compared to Alternative 0.

A combination of value and magnitude



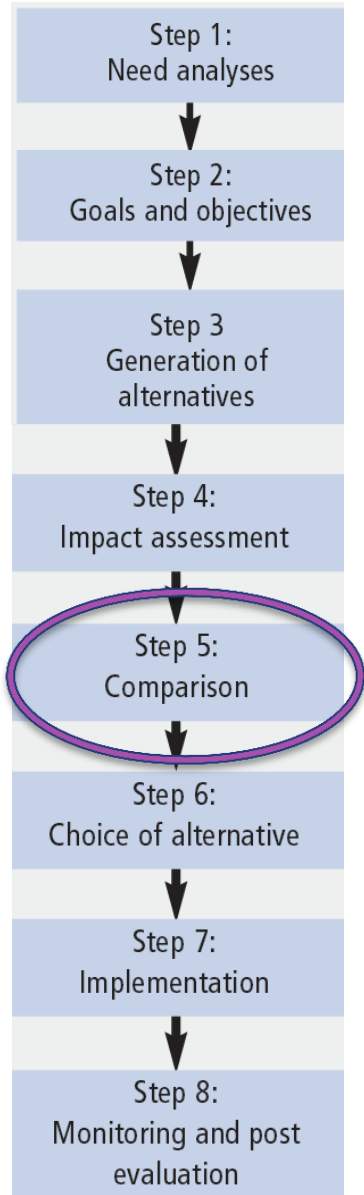
Value Magnitude	None		
	Small	Medium	Large
Large positive			Very large positive significance (++++)
Medium positive			Large positive significance (+++)
Small positive None Small negative			Medium positive significance (++) Small positive significance (+) No significance (0) Small negative significance (-)
Medium negative			Medium negative significance (-)
Large negative			Large negative significance (---) Very large negative significance (----)

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Non monetized aspects

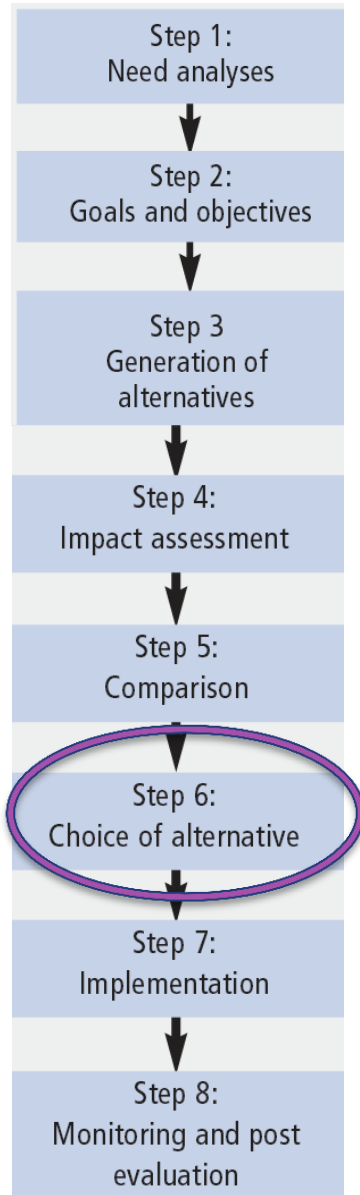
Significance

Value Magnitude	None	Small	Medium	Large
	Large positive			
Medium positive				Large positive significance (++++)
Small positive				Medium positive significance (++)
None				Small positive significance (+)
Small negative				No significance (0)
Medium negative				Small negative significance (-)
Large negative				Medium negative significance (--)
				Large negative significance (- - -)
				Very large negative significance (----)



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Value aggregation and ranking of alternatives



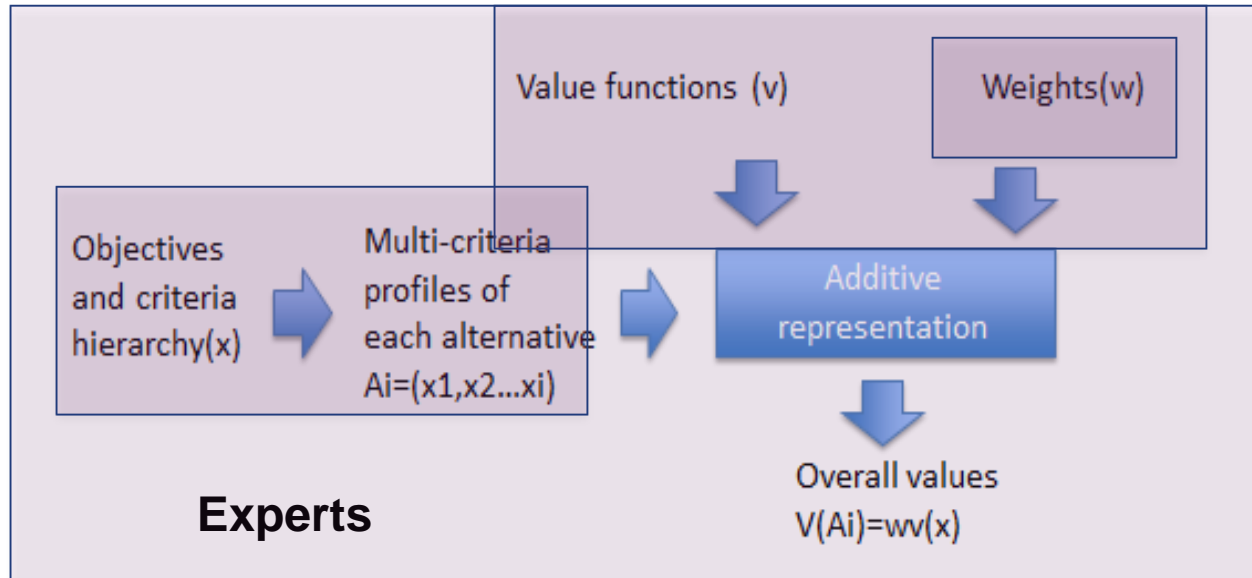
Theme	Alt. 0	Alt. A	Alt. B
Landscape/ cityscape		--	--
Community life and outdoor recreation		0	++
Natural environment		-	-
Cultural heritage		--	--
Natural resources		0	-
Total evaluation		Negative	Negative
Ranking	1	3	2

Impact \ Alternative	Alt. 0	Alt. A	Alt. B
Monetised: Net present value	0	90	-100
Non-monetised: Comparison summary and ranking	None 1	Negative 3	Negative 2
Socioeconomic evaluation	0	Uncertain ⇒ Positive	Negative
Ranking	2	1	3

MCDCA model

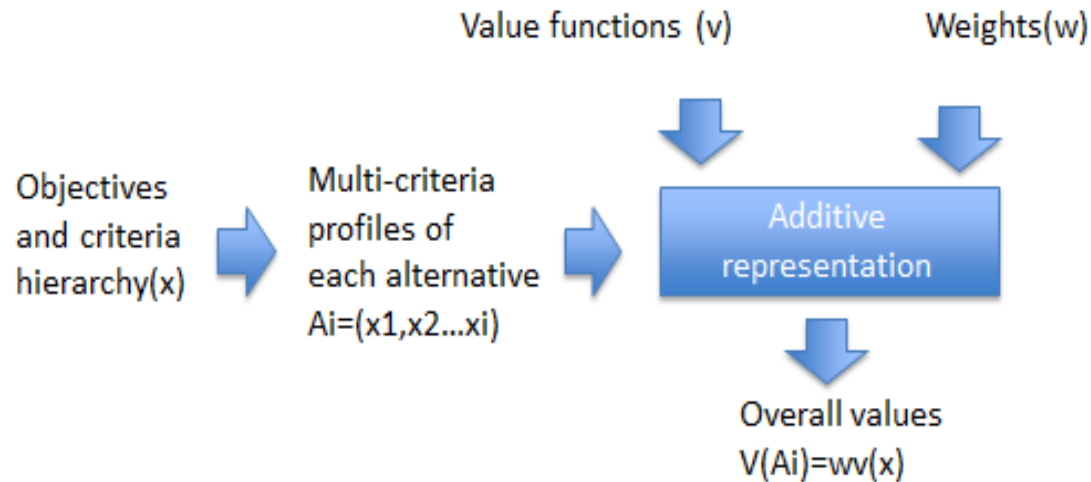
Decision makers

Stakeholders



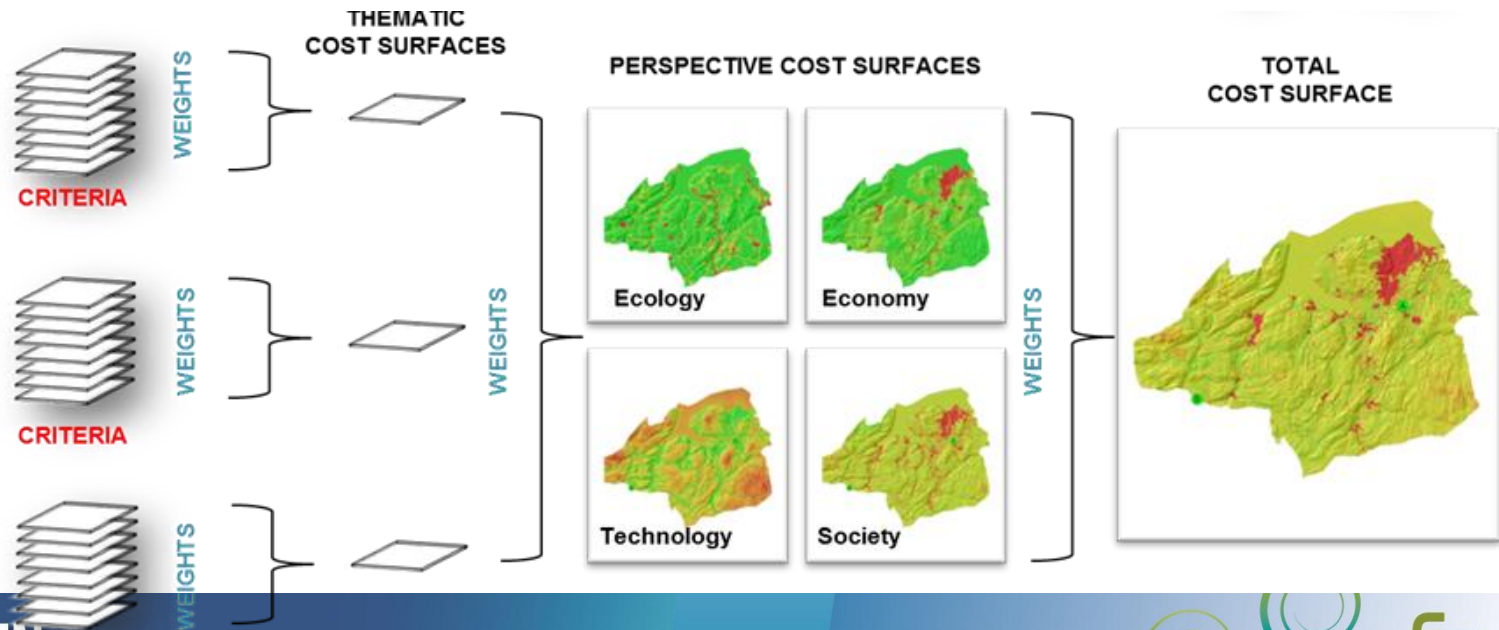
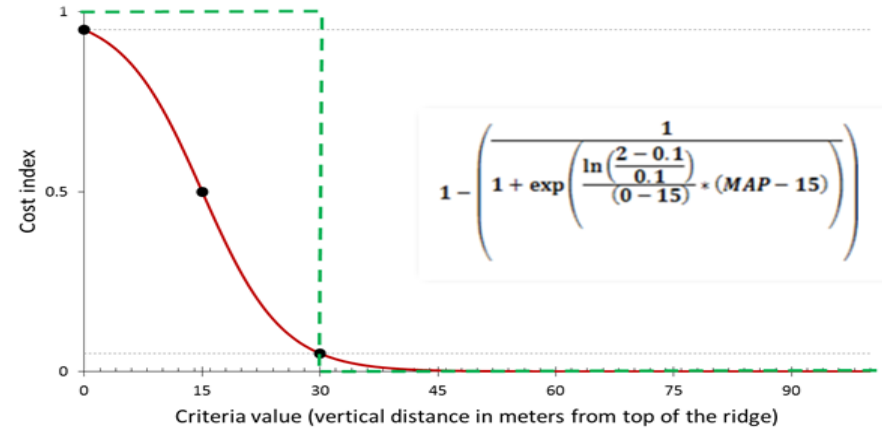
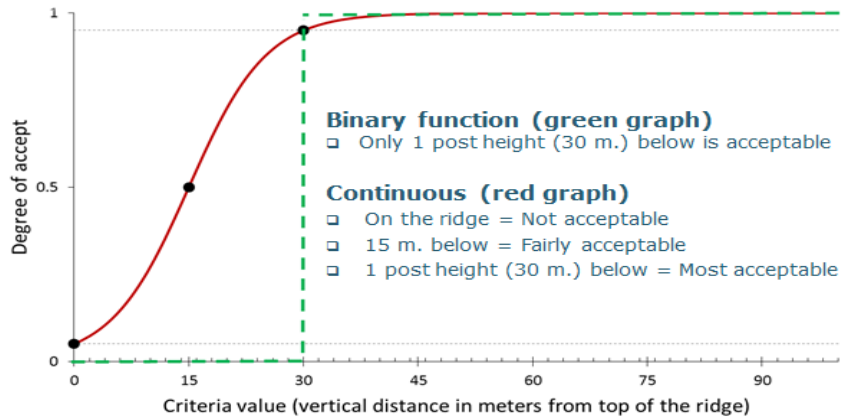
Analysts

Value judgments in formal MCDA analysis

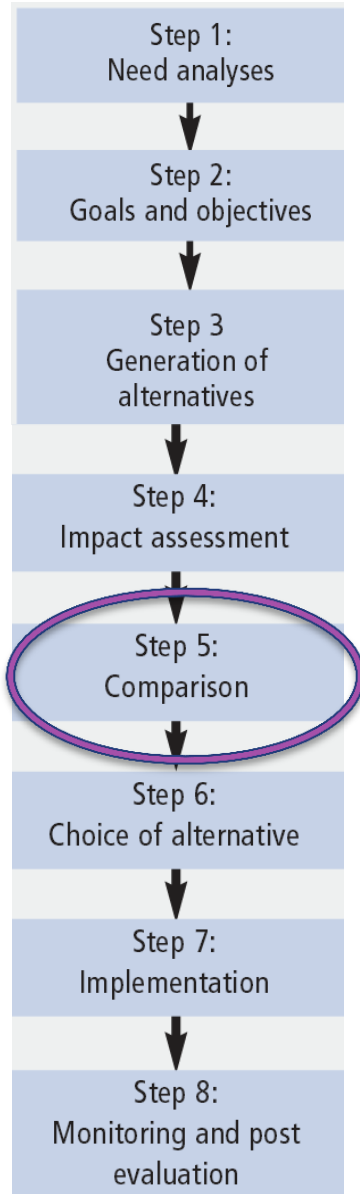


- *subjective* scalings of impact scores, normalised to a common scale
- may have different shapes and steepness for different attributes
- decision makers, different stakeholders or technical experts may have different values.

Other approaches for impact evaluation OPTIPOL



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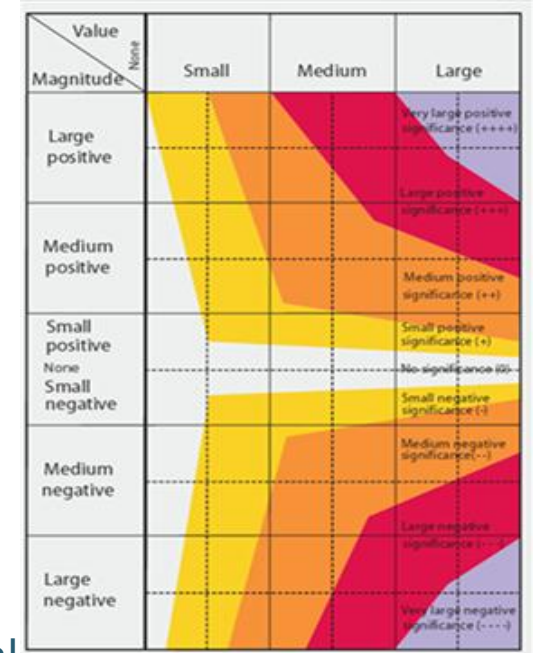


Judgments regarding individual impacts:

- Completely standardized by the guidelines
- invariant across studies
- a matter for technical evaluation (rather than a stakeholder or decision-maker issue)

Weighting:

- completely unstandardized
- subjective preferences of technical experts delegated as representatives of different social interests.
- no guidance on formal approaches to elicit and document and combine the preferences of individual experts (consensus)

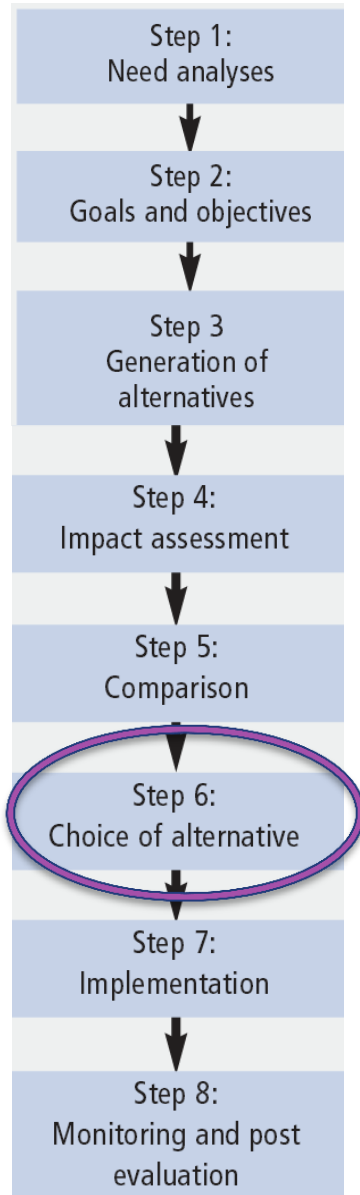


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Non monetized aspects

Theme	Alt. 0	Alt. A	Alt. B
Landscape/ cityscape		--	--
Community life and outdoor recreation		0	++
Natural environment		-	-
Cultural heritage		--	--
Natural resources		0	-
Total evaluation		Negative	Negative
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Impact \ Alternative	Alt. 0	Alt. A	Alt. B
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MCDA can improve the current national guidelines

- Construct project specific value functions with stakeholders
 - Replace standardized value functions implicit in the 'consequence matrix' of Handbook 140
- Weight elicitation, software support
 - replace direct summation of criteria
- Increase transparency: techniques for participatory decision making
 - separate technical evaluation from political judgment in the aggregation of impacts of alternatives across unpriced criteria
 - support public hearings as a process of dialogue between opposing interests.

Conclusions, recommendations

- MCDA potential is greatest where the project evaluation process is least structured at present
- **Highest potential:** the short to medium term in hydropower concession revision and the evaluation of disproportionate costs.
 - harder to integrate MCDA into the appraisal of new hydropower concession because they are subject to long standing EIA practice and established guidelines
- **Least potential:** the evaluation of programmes of measures under the WFD.
 - A single objective – good ecological status (GES).
 - Relative rankings of measures are less important in this process than the identification of cost-effective portfolios of measures (not needing ranking)

Report outline

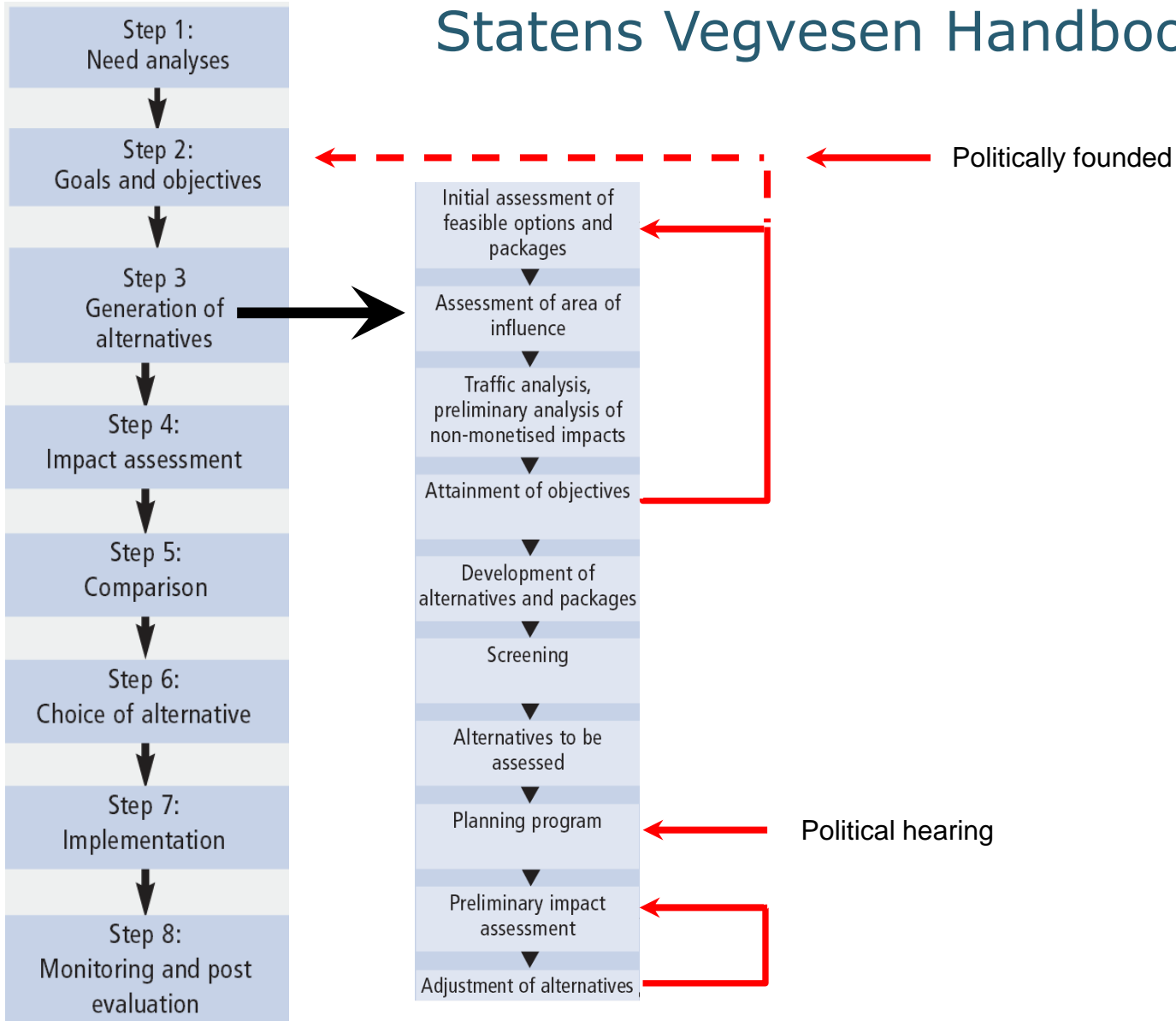
- What is MCDA, how to choose and apply MCDA methods, with or without decision support software
- Elements of MCDA in formal guidance documents in Norway
 - Social economic analysis
 - Choice of concept
 - Impact evaluation Handbook HB140
- Water management processes and MCDA relevance
- Experiences with MCDA in Norway, Finland and the Alps
- Conclusions and recommendations

CEDREN

Centre for Environmental Design of Renewable Energy



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Possible ways of applying MCDA

Level	Integration of MCDA	Interaction of MCDA
Low	MCDA is a separate process, it is unclear how the results of MCDA are used in planning or decision making.	MCDA is realized by the experts.
Moderate	MCDA has some links/impacts to planning or decision making.	Stakeholders participate to the process, but their participation is limited to certain phases and weight elicitation is realized without personal support using e.g. a questionnaire.
High	MCDA brings structure to the planning. The phases of planning and MCDA are well synchronized	Stakeholders are involved in some phases of the process, personal interaction in weight elicitation and analysis of the results, group discussions of the results.
Very high	MCDA provides the framework and roadmap for planning or decision making. MCDA's principles and practices are largely used when designing the planning process	Stakeholders are actively involved in different phases of MCDA, face-to-face personal or small group computer-aided interviews, seminar after the interviews

Levels of integration and interaction in the MCDA process, Marttunen et.al (2013).