

ATV: Gå hjem!

**Decision support tool for choosing between treatment options:
method, criteria and criteria weighting**

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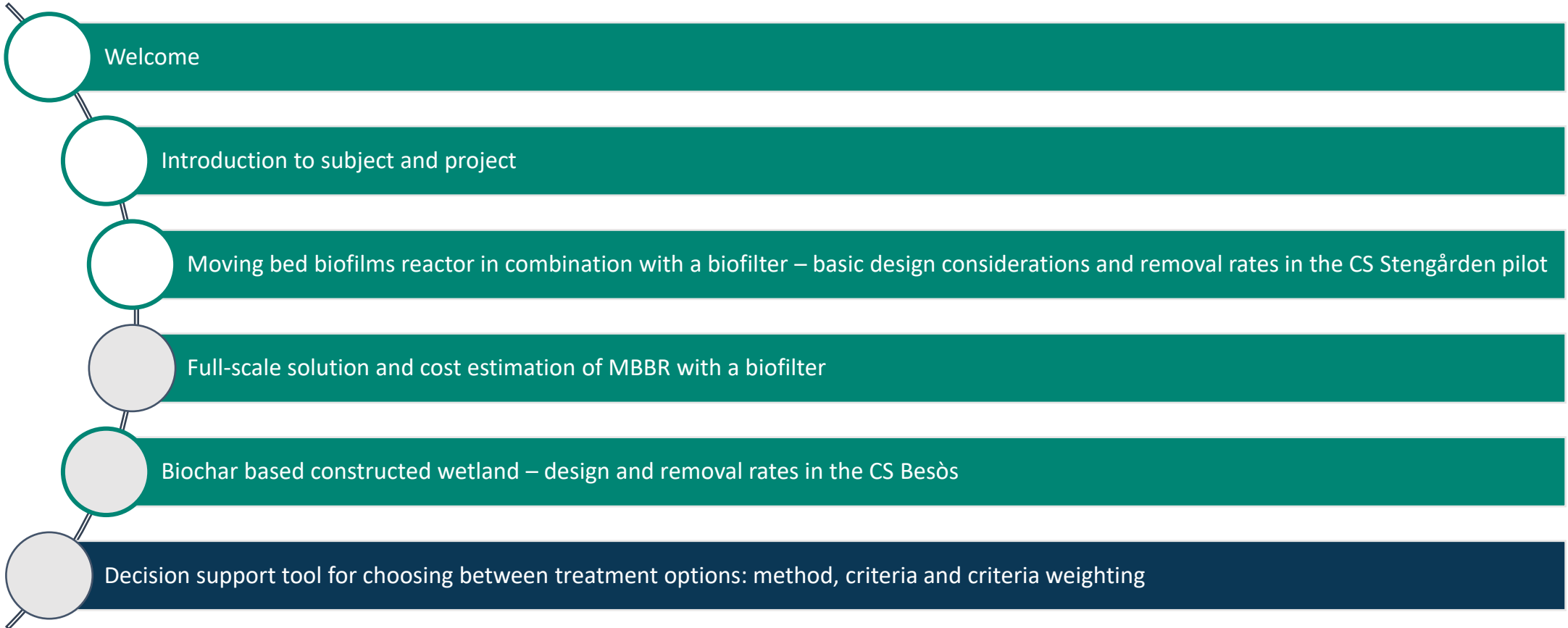


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(Understanding groundwater Pollution to protect and enhance WATERquality)

Agenda



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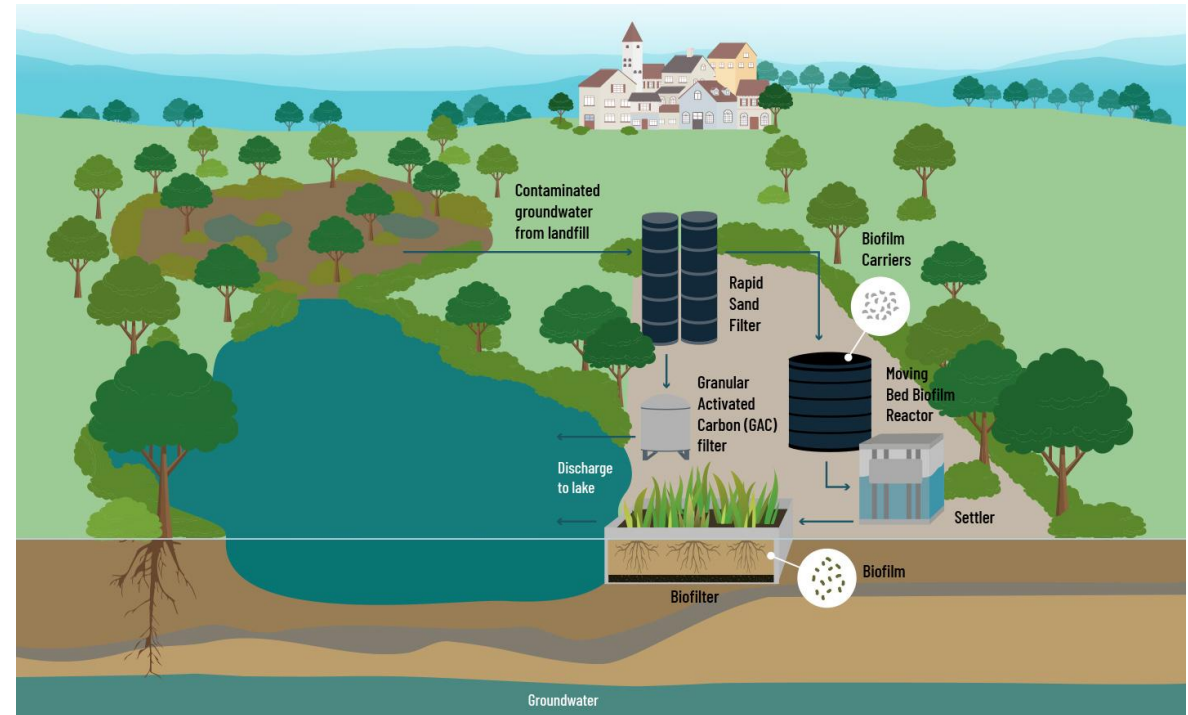


Introduction of a decision support approach

- Different mitigation measures can be applied to treat the pollutants
- Many different aspects need to be considered
- How to solve this?



Multi-Criteria Decision Analysis (MCDA) with
a focus on mitigation of groundwater pollution



Method: Multi-Criteria-Decision Analysis (MCDA)



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Definition:

Analysis for decision problems, which have:

- (i) several **objectives**, which
 - (ii) are usually **in conflict** with each other, and
 - (iii) are usually **incompatible by different standards**. The decision problem
 - (iv) is solved either by **calculating** or **selecting** the **best alternative**.
- The **best alternative** is the **one** that is **preferred** by the **decision-maker** or by a **group of decision-makers**, taking all objectives into account.

(Source: Zimmermann & Gutsche, 1991):

Components of a MCDA – Hierarchy of Criteria



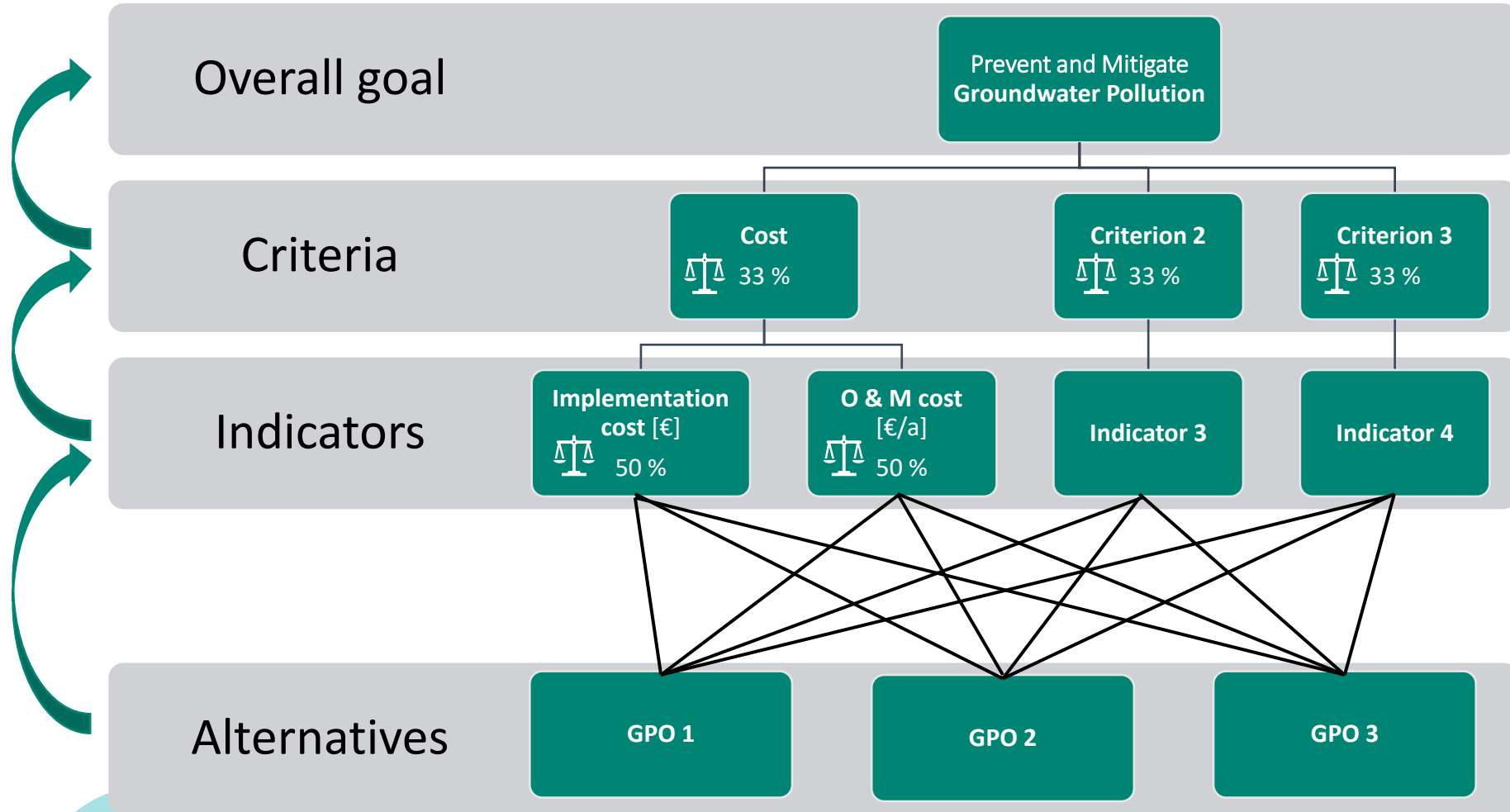
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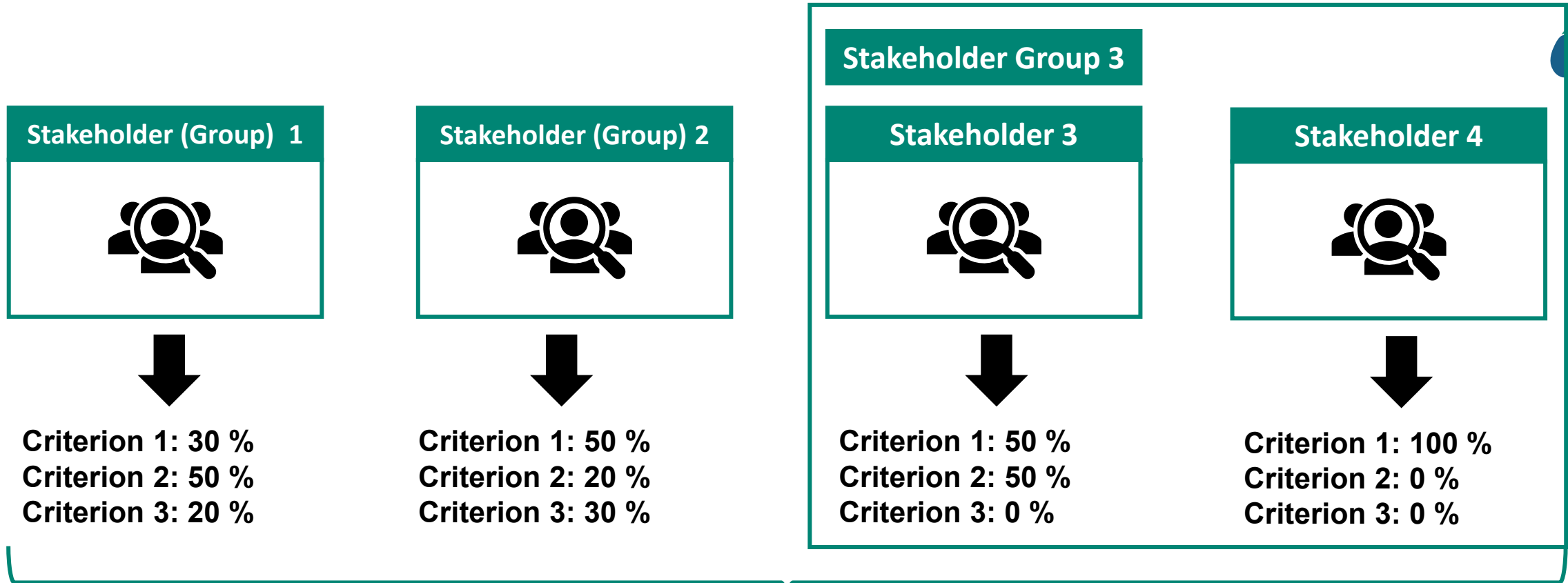
Appropriate
criteria in
relation to the
overall objective

Measurable
indicators for
evaluating the
criteria

Alternatives that
are evaluated in
terms of the
indicators



Weighting of Criteria – Stakeholder Process



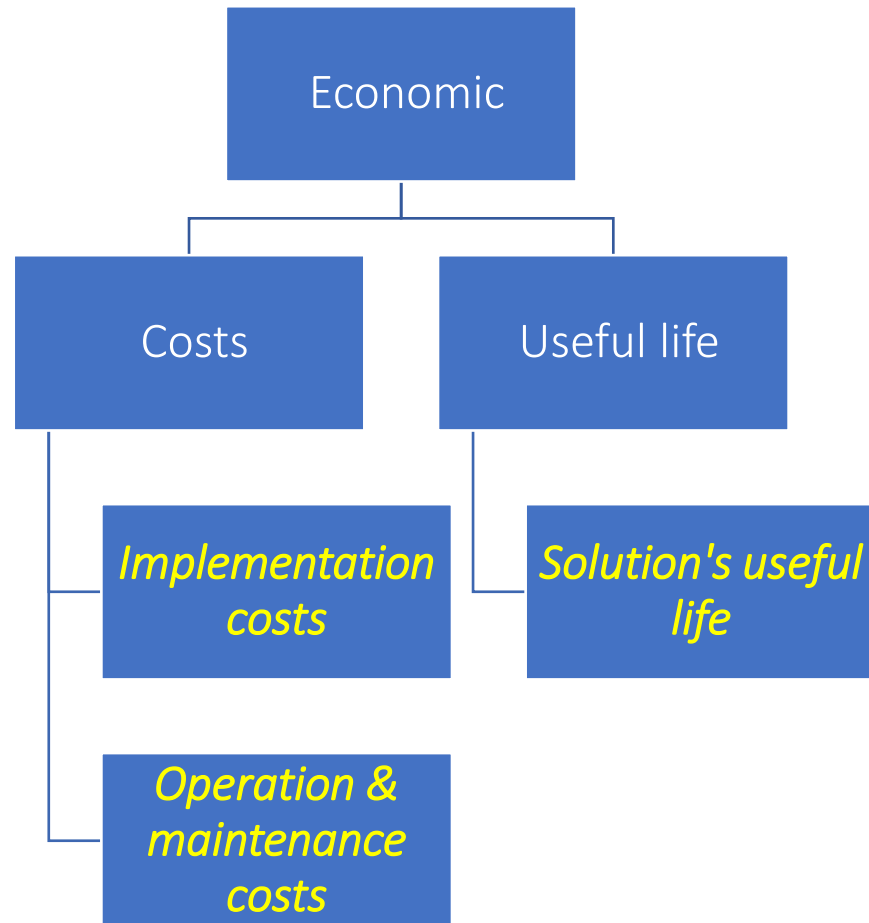
Overall Weighting

Criterion 1: 51,7 %
Criterion 2: 31,7 %
Criterion 3: 16,7 %

Analytical Hierarchy Process (AHP)

- Different dimensions of criteria (economic, social...) and different criteria -> different levels of importance
- AHP = method used to help **decide the right level of importance for each criteria -> criteria weights**
- AHP = supporting decision-making through two specific features:
 - **Hierarchy of criteria:**
 - Criteria are grouped in different dimensions (economic, environmental, technical and social).
 - **Grouping the criteria -> decomposing the problem -> easier to understand**
 - **Pairwise comparison:**
 - Criteria in each dimensions and dimensions themselves are **compared by pair using verbal evaluations**
 - Easier method to elicit weights -> **Saaty scale**: similar to a Likert scale used in standard surveys, it gives a **framework for comparison**
- The results will be used for an evaluation of the measures

Criteria Hierarchy: example



- **Dimension: Economic** criteria
- Criteria
 - **Most criteria = 1 indicator** (ex: useful life)
 - **Some criteria = multiple indicators**
 - Ex: costs: implementation costs + operation & maintenance costs
 - Each **indicator is compared by pair**



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Principles to select criteria

- Selection of criteria needs to follow **two principles to perform MCDA**:
 - **Relevance:**
 - Criteria selected need to capture **differences between alternatives**.
 - Otherwise: alternatives with same scores → no new information for discussions → rank reversal
→ difficult to have a final ranking
 - **Independence:**
 - Criteria selected need to be **unrelated to one another**.
 - Otherwise: the aggregation of results is not possible → difficult to have a final ranking
- Some potential criteria have already been considered and have been excluded because of non-independence or non-relevance. The current list of criteria follows these two principles.

Economic Criteria



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Criterion	Indicator	Definition	Unit
Costs	Implementation cost	Describes the costs to set up the solution in order to be operable.	€
	Operation & maintenance cost	Describes the cost per cubic meter to operate and maintain the solution.	€/m ³
Useful life	Solution's useful life	Describes the useful life of the solution (an estimate of the number of years it is likely to remain in service) from implementation to end of operation.	a (years)

Ecological Criteria (1/3)



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Criterion	Indicator	Definition	Unit
Greenhouse gas emissions	CO ₂ -emissions due to energy consumption in operation	Describes the emissions of CO ₂ created due to the energy used to operate the solution.	t CO ₂ -eq/m ³
Improvement of water quality by treatment	Pollutant removal performance by the mitigation measure	<p>Describes the performance in reducing the concentrations of several pollutants after the solution being implemented at the outlet of the measure compared to before implementation (difference between inlet water quality and outlet water quality).</p> <p>*Note: removal performance is used for the calculation of a risk index that is combining the removal of each pollutant and the hazard from each pollutant (outlet of the solution).</p>	%

Ecological Criteria (2/3)



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Criterion	Indicator	Definition	Unit
Improvement of groundwater quality	Pollutant concentration decline in groundwater	<p>Describes the decrease in the concentration of several pollutants in the groundwater after it reached a stationary status, which is caused by the implementation of the mitigation measure.</p> <p><small>*Note: removal performance is used for the calculation of a risk index that is combining the removal of each pollutant and the hazard from each pollutant (in the groundwater).</small></p>	%
Impairment of groundwater quality	Formation of transformation products	<p>Describes the formation of several by-products created by the solution due to its operation, which represents the negative side-effect of the solution.</p>	µg/l

Ecological Criteria (3/3)



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Criterion	Indicator	Definition	Unit
Biodiversity	Impact on biodiversity	Describes the relative impact of the implementation of a solution on biodiversity. This includes e.g. the species diversity or the ecosystem diversity.	qualitative [very negative; negative; none; positive; very positive]

Technical Criteria



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Criterion	Indicator	Definition	Unit
Efficiency of the solution in groundwater	Speed of pollutants removal in groundwater	Describes the time needed to reach 100% of the legal concentration thresholds/limits for the selected pollutants in groundwater.	a (years)
Robustness	Sensitivity to external influence	Describes the impact of external factors on the performance of the solutions on pollutants removal. External influences impacting the performance of solutions can be groundwater flow, temperature, physico-chemical conditions.	qualitative [no; low; medium; high]

Social Criteria (1/2)



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Criterion	Indicator	Definition	Unit
Competing area use	Area required for measure implementation	Describes the area used by the solution, which could be alternatively used for other activities (e.g. recreational activities).	m ²
Changes to the landscape	Relative improvement or deterioration of the visual appearance	Describes the negative or positive side-effect of the solution due to an impact on the aesthetic of the landscape.	qualitative [very negative; negative; none; positive; very positive]

Social Criteria (2/2)



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Criterion	Indicator	Definition	Unit
Level of knowledge	Level of common knowledge shared by stakeholders on the solutions	Describes the level of knowledge of the stakeholders (e.g. ecologists, industry, local communities, public administration, political parties) on the solutions.	qualitative [no; low; medium; high]
Administrative barriers	Administrative barriers to the implementation of the solutions	Describes the administrative barriers to the implementation of the solutions, due to the difficulties for the changes required to practices and norms necessary for the implementation.	qualitative [no; low; medium; high]



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Criteria Weighting Results

Dimension	Indicator	Relative Weighting	Factor Dimension	Absolute Weighting
Economic	Implementation cost	22,07%	29,81%	6,58%
	Operation & maintenance cost	44,01%	29,81%	13,12%
	Solution's useful life	33,92%	29,81%	10,11%
Ecological	CO2-emissions due to energy consumption in operation	7,58%	35,88%	2,72%
	Pollutant removal performance by the mitigation measure	27,77%	35,88%	9,96%
	Pollutant concentration decline in groundwater	29,45%	35,88%	10,57%
	Formation of transformation products	28,66%	35,88%	10,29%
	Impact on biodiversity	6,55%	35,88%	2,35%
Technical	Speed of pollutants removal in groundwater	59,93%	27,18%	16,29%
	Sensitivity to external influence	40,07%	27,18%	10,89%
Social	Area required for measure implementation	29,31%	7,13%	2,09%
	Relative improvement or deterioration of the visual appearance	25,86%	7,13%	1,84%
	Level of common knowledge shared by stakeholders on the solutions	12,97%	7,13%	0,93%
	Administrative barriers to the implementation of the solutions	31,86%	7,13%	2,27%
Total				100%

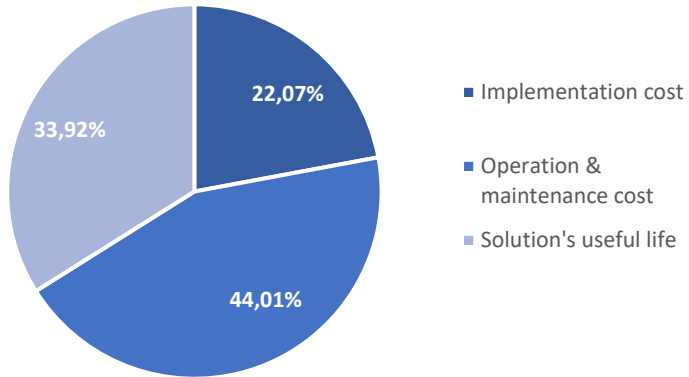
Criteria Weighting Results



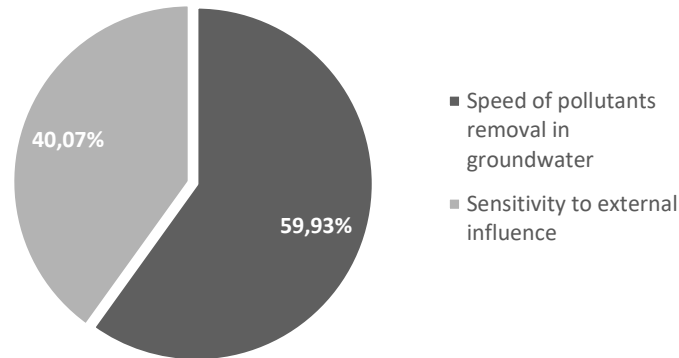
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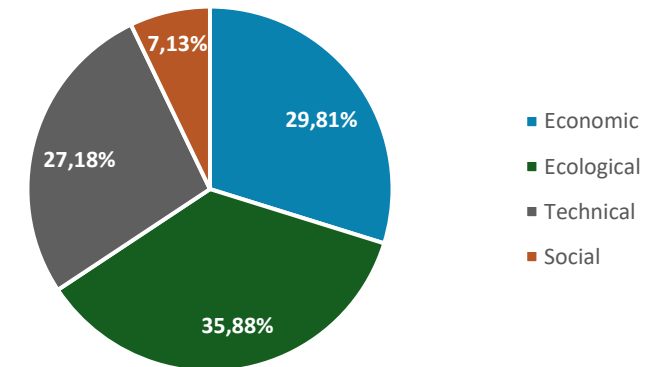
Relative Weighting:
Economic Indicators



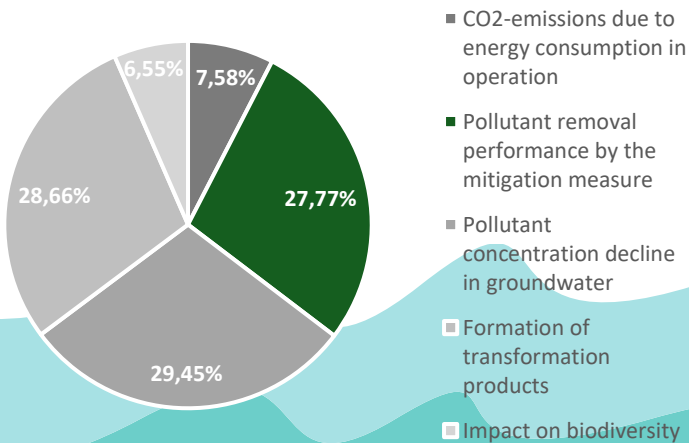
Relative Weighting:
Technical Indicators



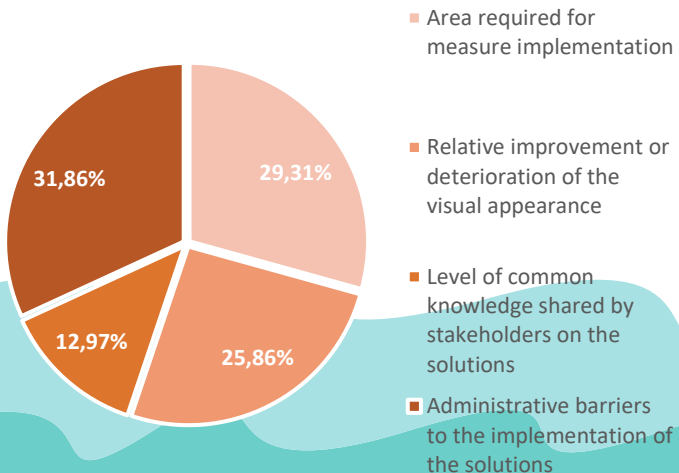
Relative Weighting:
Dimensions



Relative Weighting:
Ecological Indicators



Relative Weighting:
Social Indicators

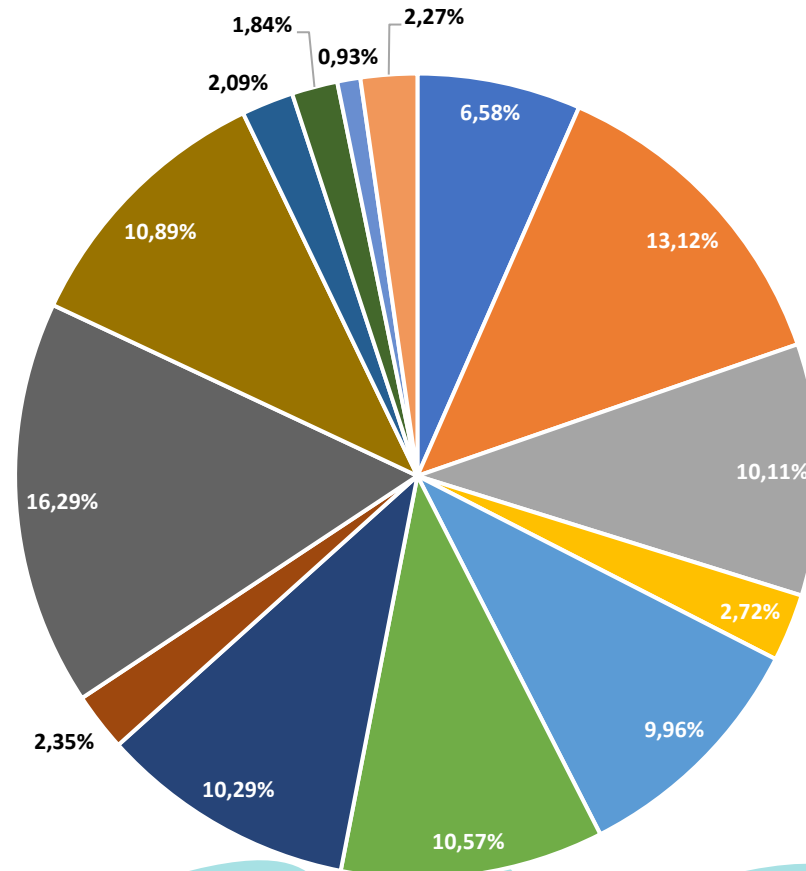


Criteria Weighting Results

Absolute Weighting: Indicators



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- Implementation cost
- Operation & maintenance cost
- Solution's useful life
- CO2-emissions due to energy consumption in operation
- Pollutant removal performance by the mitigation measure
- Pollutant concentration decline in groundwater
- Formation of transformation products
- Impact on biodiversity
- Speed of pollutants removal in groundwater
- Sensitivity to external influence
- Area required for measure implementation
- Relative improvement or deterioration of the visual appearance
- Level of common knowledge shared by stakeholders on the solutions
- Administrative barriers to the implementation of the solutions

THANK YOU FOR ATTENDING!



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