Multi-Criteria Analysis

Summary

- Multi-Criteria Analysis (MCA) is a methodology used to assess and score adaptation options against a set of decision criteria.
- MCA can effectively incorporate important dimensions in adaptation such as urgency, co-benefits, no-regret and robustness characteristics.
- MCA can support the consideration of uncertainty in the prioritisation of adaptation options. However the analysis of uncertainty will usually remain subjective and qualitative.
- MCA provides a structured framework for combining expert judgement and stakeholder preferences and is well suited for encouraging stakeholder participation in adaptation decision-making.
- MCA can be used for cross-sectoral analyses which are highly relevant for the assessment of adaptation strategies or action plans which have a broad range of adaptation objectives.

What does Multi-Criteria Analysis do?

Multi-criteria analysis (MCA) provides a systematic approach for ranking adaptation options against a range of decision criteria. The various criteria can be weighted to reflect the relative importance of different criteria. The weighted sum of the different chosen criteria is used to rank the options.

Unlike CBA, MCA allows the consideration of both quantitative and qualitative data in the ranking of options. For example, MCA is able to consider elements like feasibility, equity and acceptability, which can often be hard to quantify. In adaptation, MCA allows the consideration of qualitative characteristics such as urgency, co-benefits, and no-regret characteristics.

When should I use Multi-Criteria Analysis?

MCA can be applied to the analysis of alternative adaptation strategies or for individual projects or investment decisions. Because MCA is able to consider both qualitative and quantitative information, it is especially applicable in scenarios where such a combination of factors must be considered in the ranking of adaptation interventions. In addition, the approach is well suited to encourage engagement with stakeholders as MCA allows for the consideration of stakeholder preferences in the scoring and weighing of criteria.

MCA does not explicitly treat uncertainties. MCA tends to work with individual scenarios against which options are assessed which means that multiple runs of the MCA may be necessary to evaluate how the benefits of different adaptation options vary against different scenarios. The inclusion of criteria for how options perform against uncertainty can be included to address this, but this makes the consideration of uncertainty qualitative.

What are the key strengths and limitations of Multi-Criteria Analysis?

Key Strengths

- Can consider a wide set of criteria, even where quantification is challenging or limited.
- Relatively simple and transparent and can be done at relatively low cost and within a limited time.
- Provides a structured framework for combining expert judgement and stakeholder preferences.

Potential weaknesses

- Subjectivity can be high.
- Giving consistent scores can be difficult.
- Analysis of uncertainty often highly qualitative

The approach involves a number of common steps:

1. Identifying potential options (stakeholder consultation is often used to determine the most important options);
2. Identifying a set of relevant criteria to assess the options against. Each criteria is given a scale, either as a quantitative metric (e.g. costs), or for qualitative metrics, a range (e.g. 1 to 10);
3. Scoring options against criteria. This process can be undertaken through analysis, stakeholder engagement or through expect consultation;
4. Determining the weighting of the criteria. This provides the relative importance of the individual criteria in the overall decision, with more heavily weighted objectives reflecting more significant importance in the objectives. Again, stakeholder engagement and/or expect consultation are usually used to set or validate the weights.
5. Calculating the weighted scores for each option.

Applications of MCA to adaptation use some form of climate change information. In more qualitative studies, this can use climate model information to build up indications of the future impacts of climate change, e.g. in terms of changes in temperature, weather extremes, runoff and sea level rise. Similarly the performance of different adaptation options against these risks can be assessed (i.e. scored). A review of non-monetary metrics used in MCA was carried in ECONADAPT.

The selection of the range and the scoring of criteria are crucial, and require careful consideration. It is essential to make sure that the weighted scores can be added, i.e. all criteria should be formulated in either positive terms or negative terms.

Usually scores are standardized, so that the high and low levels of the scores represent the judgement about the performance of the alternatives as precisely as possible. The weights then need to be made explicit based on the assessment of the decision makers,. This ensures that the influence of the weights on the final ranking can be assessed transparently; decision makers can learn not only about the characteristics of the adaptation alternatives but also the ranking of the alternatives for various sets of scores and weights. There are many methods to establish the ranking of the alternatives. The simplest and most commonly applied is weighted summation although more complicated mathematical methods also exist.

Case study: Adapting to climate change in The Netherlands

The following example combines a qualitative and quantitative assessment and the ranking system of identified potential adaptation options to respond to climate change in the Netherlands in connection to spatial planning.

The first step of the assessment was the **identification and categorization of adaptation options.** The adaptation options have been selected and identified on the basis of literature review and stakeholder consultation in a sectoral approach, in order to obtain the best inventory for the various sectors of the economy. Sectors included in the study are: agriculture, forestry, fisheries, water, energy and infrastructure. Some information is included on health, recreation and transport. A database was constructed to summarize the identified adaptation options and the associated effects, and to make an inventory of the institutional aspects related to their implementation. The interconnections between the adaptation options were also identified, including overlap, synergy

and competition. 96 adaptation options have been identified and they include a wide variety of policy measures, technological solutions and adjustments in behaviour.

The second assessment step was the **definition of the criteria for the raking of the options and the scoring of these criteria**. The adaptation options have been given scores with respect to the following criteria: (i) the importance of the option in terms of the expected gross benefits that can be obtained, (ii) the urgency of the option, reflecting the need to act soon and not later (iii) the no-regret characteristics of the option (it is good to implement, irrespective of climate change) (iv) the co-benefits to other sectors and domains and (v) the effect on climate change mitigation (for instance through changes in landuse that reduce emissions of greenhouse gases as a side effect). The scoring of these criteria for each of the option is based on subjective expert judgement with a broad overview and has been discussed in a workshop with external experts to validate the scores.

The third step includes the **ranking of the adaptation options** based on the importance of the various criteria to make rankings of the options according to the weights attached to the various criteria. The weights for the criteria can be changed interactively by individuals or groups of decision makers. This excel-table presents how. De Bruin et al (2009) have chosen the ranking based on criteria weighting – the weighted summation of the scores on the different criteria. The weights are based on expert judgment and a workshop with key stakeholders. The weights defined by the experts and stakeholders are following: (i) importance (weight 40%), (ii) urgency (weight 20%), (iii) no-regret characteristics (weight 15%), (iv) co-benefits (weight 15%) and (v) mitigation effect (weight 10%).

The following table presents results for the options with the **highest priority** which all obtained a weighted summary of 4.9. To contrast, results for adaptation options with low priority include Subsoil drainage of peatlands with a weighted summary of 1.2 and Reclamation of (part of) southern North Sea with a weighted summary of 1.4.

Adaptation option	Importance (40%)	Urgency (20%)	No regret (15 %)	Co-benefits (15%)	Mitigation effect (10%)	Weighted summary
Integrated nature and water management	5	5	5	5	4	4.9
Integrated coastal zone management	5	5	5	5	4	4.9
More space for water: a. regional water system, b. improving river capacity	5	5	5	5	4	4.9
Risk based allocation policy	5	5	5	5	4	4.9
Risk management as basic strategy	5	5	5	5	4	4.9
New institutional alliances	5	5	5	4	5	4.9

Further information: De Bruin, K., Dellink, R.B., Ruijs, A., Bolwidt, L., Van Buuren, A., Graveland, J., De Groot, R.S., Kuikman, P.J., Reinhard, S., Roetter, R.P., Tassone, V.C., Verhagen, A., Van Ierland, E.C. (2009). Adapting to climate change in the Netherlands: An inventory of climate adaptation options and ran-king of alternatives, Climatic Change, 2009, Volume 95, Issue 1-2, July 2009, Pages 23-45.

Tools

To rank adaptation options, simple xls-tools can be used. One example for an xls-tool to rank adaptation options for the Netherlands was prepared in the Routeplanner-project. The tool ranks adaptation options via ordered or weighted criteria MCA of Adaptation Options in the Netherlands.

Econadapt insights
The Use of Non-Monetary Metrics to Assess Adaptation Actions: Multi-Criteria Analysis (MCA)
Integrated uncertainties and risk management for robust decision making
Uncertainties and causes of uncertainties in climate change adaptation

Uncertainties and risk analysis in climate change adaption
Assessing flood risk management: Czech Republic
Assessing flood risk management: the Netherlands
Assessing flood risk management: United Kingdom
Sourcing and using climate information for economic assessments of adaptation