Knowledge Synthesis Methods

21. Multi-Criteria Decision Analysis[1]

Summary of method

Multi-Criteria Decision Analysis (MCDA) evaluates the performance of alternative courses of action with respect to criteria that capture the key dimensions of the decision-making problem, involving human judgment and preferences (Belton and Stewart 2002).

Key references

Belton V, Stewart TJ (2002). *Multiple criteria decision analysis: an integrated approach.* Kluwer, London. NOT OPEN ACCESS.

Greco, S., Figueira, J., & Ehrgott, M. (2005). *Multiple criteria decision analysis.* Springer's International series. NOT OPEN ACCESS.

Mendoza, G. A., & Martins, H. (2006). *Multi-criteria decision analysis in natural resource management: a critical review of methods and new modelling paradigms.* Forest ecology and management, 230(1), 1-22. NOT OPEN ACCESS.

Examples of application

Multi-criteria Decision Analysis was used to determine which of 60 or 70 environmentally important sites in or next to the Nature Reserve of Crau in Southern France reserve should be part of the reserve, and which areas could be released for development, such as for a gas pipeline scheme (Schmelev, 2010).

Spatial MCDA, incorporating GIS, was used to assess the risks and adaptive capacity of the Bach Ma National Park in Central Vietnam (Quynh Huong Nghiem, 2015).

Schwenk *et al.* (2012) combined MCDA with forest simulation modelling and scenarios (see Scenario Analysis above) to identify optimal forest management strategies in Vermont, USA.

Huang *et al.* (2011) provide an overview of environmental projects described in the published scientific literature that applied MCDA.

Huang, I. B., Keisler, J., & Linkov, I. (2011). *Multi-criteria decision analysis in environmental sciences: ten years of applications and trends.* Science of the total environment, 409(19), 3578-3594.

[1] A guidance note from Dicks LV, Haddaway N, Hernández-Morcillo M, Mattsson B, Randall N, Failler P, Ferretti J, Livoreil B, Saarikoski H, Santamaria L, Rodela R, Velizarova E, and Wittmer H. (2017). *Knowledge synthesis for environmental decisions: an evaluation of existing methods, and guidance for their selection, use and development – a report from the EKLIPSE project.*

Quynh Huong Nghiem. (2015). *GIS-based Spatial Multi-criteria Analysis: A Vulnerability Assessment Model for the Protected Areas of Vietnam.* http://gispoint.de/fileadmin/user_upload/paper_gis_open/GI_Forum_2015/537558013.pdf

Schwenk, W. S., Donovan, T. M., Keeton, W. S., & Nunery, J. S. (2012). *Carbon storage, timber production, and biodiversity: comparing ecosystem services with multi-criteria decision analysis.* Ecological Applications, 22(5), 1612-1627.

Shmelev, S.E. (2010). *Multi-criteria Assessment of Ecosystems and Biodiversity: New Dimensions and Stakeholders in the South of France.* Queen Elizabeth House, University of Oxford. QEH Working Paper Series – QEHWPS181 (33 pages). The paper can be accessed at: www.qeh.ox.ac.uk/dissemination/wpDetail?jor_id=339

Multi-Criteria Decision Analysis

Cost	Depends on • Expertise on decision software • The number of stakeholders/experts involved • Level of disagreement among criteria • Level of detail to and number of links and nodes • Good Facilitator/moderator to ensure transparency and inclusiveness • Scale of the problem and sectors, countries involved/addressed
Time required	Depends on the timescale for public consultations needed
Repeatability	Low. If you do it with two different groups (or individual experts if done individually), you get two different MCA
Transparency	High. Transparency is a crucial factor in MCA and can impact the acceptance of the criteria and the final decisions by the stakeholders involved
Risk of bias	Medium. Depends on representativeness of stakeholders/experts, whether individual input is incorporated or obtained in group discussion, and the quality of any data and predictive models incorporated
Scale (or level of detail)	Flexible. Can address detailed questions or broader problems
Capacity for participation	High. Relies on tacit knowledge and not as technical as Bayesian Belief Networks
Data demand	Depends on scale and sectors involved
Types of knowledge	Scientific, technical, opinion-based and indigenous and local. Tacit

Types of output	A matrix showing how different options perform on agreed criteria A report explaining the context and process
Specific expertise required	Usually requires expertise on decision analysis software For participatory creation of criteria you need skills in facilitation, forming the groups and familiar with the MCA methodology

Strengths	**Weaknesses**
Explicitly addresses trade-offs Suited for knowledge synthesis processes characterized by incomplete information Incorporates both quantitative and qualitative data, including scientific and local knowledge Combines information about the impacts of alternative courses of action with information about the relative importance of evaluation criteria for different stakeholders Deliberative-analytic methodology supports participatory processes and transparent decision making Can be combined with other knowledge synthesis methods (e.g. Systematic reviews, Delphi, focus groups)	Usually requires expertise on decision analysis software Possibly limited representativeness (only a small group of stakeholders usually involved) Some criteria such as cultural heritage or provisioning services vital for sustenance might not be amenable for trade-offs (though some MCA methods can also address these so-called lexicographic preferences) Allows manipulation if not used in a participatory and transparent way