Does choice of scaling and aggregations method for multi-criteria analysis influence rankings?

Francis, W.J. [1], N.F. Herron[1] and S.M. Cuddy [1,2]

[1] *Integrated Catchment Assessment and Management (iCAM) Centre, The Fenner School of Environment and Society, The Australian National University, Australian Capital Territory*
[2] *CSIRO Land and Water, Canberra, Australian Capital Territory*
Email: will.francis@anu.edu.au

Abstract: Environmental investment involves making choices between activities which potentially yield a range of environmental outcomes. Evaluating the relative benefits of proposals requires a method for quantifying the value of each environmental benefit in terms of a 'common currency' and, often, prioritizing the various environmental benefits before combining into a single aggregate score. Environmental investment decision support systems (DSS), such as the Site and Catchment Resource Planning and Assessment (SCaRPA) framework in New South Wales (NSW), have been developed to assist catchment managers to quantify and aggregate the environmental benefits from different land management activities into a single environmental index. Various methods have been developed to undertake multi-criteria analyses, but understanding which approach to use remains very uncertain for the majority of environmental investment managers.

The SCaRPA system was developed to assist NSW Catchment Management Authorities in assessing the environmental, social and economic value of landholder proposals to undertake activities to improve environmental outcomes. SCaRPA provides a framework for formalising the funding determination process, and includes environmental assessment models for quantifying the environmental benefits, aggregation functions for combining environmental values, and the means to include other criteria (e.g. community capacity building) and cost information into the investment decision process. The primary aggregation method is the weighted sum method, but some variations around this are available.

As an increasing number of environmental investment DSSs emerge, catchment investment managers must grapple not just with which environmental models to run, but also what method of aggregation of model outputs to use. This paper reviews some of the methods used to aggregate multi-criteria values into a single score, with an analysis of how appropriate scaling functions. Two methods, the *weighted sum* and *reference point* methods, are then applied to some hypothetical environmental investment proposals to determine whether the choice of method influences the ranking of options, and hence the decision to fund.

The results from this hypothetical example show that the choice of aggregation method can impact upon the ranking of options, although in this example the impact is relatively minor. While, only a very preliminary analysis, these results suggest that if the aim of the assessment process is to maximize environmental benefit per unit cost, the *simple weighted sum* approach is better than the *reference point method* because the latter has been formulated to favour a balanced outcome. Standardized and documented scaling procedures for individual models are necessary. A more comprehensive assessment of a number of aggregation methods is needed to test the preliminary findings presented here.

Keywords: Decision Support System (DSS), multi-criteria decision analysis (MCDA), multi-criteria aggregation, weighting techniques, Environmental Benefits Index (EBI), SCaRPA, catchment management

Abstract only