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METHODS

Models for policy-making in sustainable development: The state of the art and perspectives for research

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Abstract

More and more frequently policy-makers are urged to assess the impact of their strategies and policies in terms of sustainable development. This necessitates the use of applied scientific models as tools for identifying and evaluating the likely environmental, economic and social impacts of alternative policies. The objective of this paper is to provide a framework to help decision-makers choose the most appropriate—or the most appropriate mix—of models, by assessing their relative strengths and weaknesses. The paper also allows potential improvements in modeling techniques to be identified. Six modeling paradigms are assessed, both on a general basis and with respect to two specific policy contexts (energy policy, and land use and transport planning).

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1. Introduction: a new discipline or renewed modeling practices?

More and more, policy-makers are urged to assess the impact of their strategies and policies in terms of

sustainable development². So much so that an—allegedly—new discipline named ‘Sustainability Impact Assessment’ (SIA) has been created to address these issues (Lee and Kirkpatrick, 2000, 2001). A crucial stage in SIA is anticipating the likely economic,

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² “Decision makers increasingly seek to design environmental and development policies that will support sustainable development. To support these efforts, practical tools to formulate sustainable development policies and clear methods to assess their acceptability and effectiveness are urgently needed.” (Abaza and Baranzini, 2002, p. ix).

environmental and social impacts of the planned policy. For long-term and complex policy matters, this is only feasible with mathematical or computer-based models. However, there are several different approaches to economic–environmental or integrated modeling and it is not easy for the policy-maker to decide which is the most appropriate for any context. Our objective here is to help users to choose the most suitable modeling tool for a particular sustainable development problem and to better understand what kind of information can be expected from the models. This issue has been remarkably neglected in the literature. The only paper addressing a similar question is that by [van den Bergh and Nijkamp \(1991\)](#) in this journal, but there is no standard procedure for evaluating the strengths and weaknesses of different modeling approaches for sustainable development policy-making. Our contribution is to elaborate a formal methodological framework to tackle this issue and to apply it to existing modeling paradigms and two policy fields.

This problem is a decision-making one. It has to do with the identification of the possible alternatives (the various modeling approaches and tools), the selection of criteria by which to assess them, the assessment itself with respect to the criteria, the weighting of the criteria and, finally, the aggregation of the partial assessment (on each criterion) in an overall assessment. This is, more or less, the way we will proceed in this paper. Several modeling approaches will be assessed in two stages: first with respect to general criteria closely related to sustainable development and then in relation to policy matters (energy and land use and transport policies) considered from a sustainable development perspective. Six modeling paradigms will be assessed, first on a purely a priori and general basis, and then against two specific policy contexts (energy policy, and land use and transport planning).

The paper is organized as follows. We begin by stressing what is specific in sustainable development in order to decide on the most relevant assessment criteria. The modeling paradigms are then compared against these criteria on a purely a priori basis and ranked with respect to their potential performance in dealing with sustainable development problems. The robustness of this ranking is then checked in two concrete policy contexts: energy policy, on the one hand, and land use and transport policy, on the other

hand. These policy domains are considered as collections of still more concrete issues (such as resource exhaustion and energy dependency for the energy case), each embodying the essence of sustainability at different levels. The relative fitness of the various modeling approaches to these policy domains is considered as a function of: (i) the degree to which the policy domains embody sustainable development characteristics; and (ii) the degree to which the modeling paradigms are able to deal with these characteristics. Finally, we look at existing modeling practices in the two policy fields in order to see if they confirm our conclusions about the usefulness of the different modeling paradigms.

2. Methodological answers to decision-making in sustainability

Policy-making, as a kind of rational decision-making³, includes two different types of intellectual activity: knowing and evaluating. Stripped down to its most general characteristics, it requires us to: (i) identify possible alternative actions, plans or programs; (ii) choose relevant criteria on which to assess their performances; (iii) optionally, weight the criteria in terms of their relative salience; (iv) assess the various alternatives with respect to the criteria; (v) optionally, translate the assessment into a partial utility value; (vi) rank the alternatives with respect to their overall utility; and (vii) choose the best option or, alternatively, re-start the process from the beginning.

In this article we restrict our analysis to the cognitive aspect of sustainable development policy-making, and more precisely to one particular kind of cognitive tool, applied scientific models. The role of these models within the decision-making process is to assess the likely reactions of the system to policy instruments under behavioral and structural constraints. Policy-making for sustainable development constitutes a very special kind of decision-making,

³ The adequacy of the rational decision-making model as paradigm for decision making in general ([Gigerenzer and Selten, 2002](#)) and for policy-making in particular ([Fischer and Forester, 1993](#); [Stone, 2002](#)) is disputable. We will not take a stance in this discussion here. It has been dealt within the sustainability impact assessment context in a subtle way by [Koemoev \(2001\)](#), amongst others.

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