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Raising the bar? – The challenges of evaluating the outcomes of environmental modelling and software

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ABSTRACT

The intention of this paper it to open up debate within the environmental modelling and software (EMS) community on how best to respond to the increasing desire to evaluate the success of EMS projects in terms of outcomes rather than outputs. Outcomes in these regards are changes beyond the walls of the research organisation (typically to values, attitudes and behaviour). The authors recognise that outcome evaluation is essential in ensuring the relevance and effectiveness of activities. To date, however, there is a limited appreciation within the EMS community of the nature of the challenge inherent in outcome evaluations. The paper presents an exploratory analysis of the challenges that outcome assessment raises for EMS. It does so using mutually reinforcing conceptual and practical perspectives. The paper presents a conceptual framework of three loosely coupled phases – research, development and operations. The nature of activities and their interactions within these phases is outlined and the forms of evaluation associated with each stage set out. The paper notes how existing forms of evaluation (e.g. peer review, validation and relevance) underpin the delivery of outcomes but do not of themselves evaluate outcomes. The paper proposes that outcomes need conceptually to be seen as an element of complex social processes mediated by government, regulation, markets and the media rather than as simply another form of output from research and development projects. As such outcomes of EMS are: less easily tangible than are outputs; more likely to occur at a significant time lag after any intervention; more difficult to assign causality for and to be subject to significant contestation. Thus EMS activity, however well conducted technically, may only have a minor influence on outcomes and EMS practitioners will have limited control over those outcomes that do occur. The paper uses a series of linked EMS projects to populate the conceptual framework showing the role of evaluations in research, development and operations phases. The paper then presents two forms (quantitative and qualitative) of outcome evaluation used as part of an operational phase evaluation of a project communicating the consequences of climate change to remote-rural land managers in Scotland. The authors conclude that while the challenges of EMS evaluation can be met, there needs to be care from the EMS community not to raise expectations of outcomes that cannot be met.

1. Introduction

1.1. Rationale

The desire to evaluate the success of research in terms of *outcomes* (changes in values, attitudes and behaviour in the world beyond the walls of the research institute) rather than *outputs* (in the form of knowledge embodied in peer reviewed articles, software or datasets) is increasingly seen within policy-directed research programmes in the United Kingdom (UK) and European Union (EU). This generates new challenges for the environmental modelling and software (EMS) community because outcome evaluations are qualitatively different to other EMS evaluations. The key difference is in the reduced level of control that the researcher/developer has over outcomes, even when working directly with stakeholders. In such circumstances it is easy for an "expectation gap" to occur between research stakeholders (particularly funders) and the attributable (or even observable) outcomes arising from the EMS. The aim of this paper is to raise awareness in the EMS community that evaluating outcomes "raises the bar" in defining what is success for EMS. The authors agree that outcome evaluations are necessary but believe the EMS community needs to

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recognise how difficult it may be to deliver outcomes where science interacts with society. Thus, a new field of inquiry, how to evaluate outcomes, has opened up for the EMS community.

1.2. Approach

The aim of the paper is delivered through two objectives, the first conceptual and the second practical.

1. To outline the outcome evaluation challenges and how these go beyond the existing evaluations of EMS undertaken already. To do this the paper presents a conceptual framework based on the literature and the authors' experiences and identifies some key issues.
2. To show how the conceptual framework works in practice. To do this the paper presents a case study focussing on the additional outcome evaluation phase, showing possible approaches and what was learnt from this case study.

This paper presents a conceptual framework that situates outcome evaluation within the wider context of EMS activity and reflects on the application of such a framework. The authors argue that the combination of conceptual and practical approaches is particularly appropriate for EMS applications where real world outcomes are sought. Conceptual frameworks without evidence of how to operationalise them are of unknown utility but the significance of lessons from case studies alone is difficult to interpret. There is a very limited literature by EMS developers on the formalised evaluation of outcomes. Partly this reflects outcomes being a new requirement for EMS developers. It also reflects the interdisciplinary (and perhaps transdisciplinary) nature of this subject meaning it falls between several academic literatures. The authors further argue that without a deep understanding of the specific circumstances of EMS development, or access to the (largely) unreported cases where EMS fail to deliver the intended outcomes, it is difficult to draw conclusions from the literature on what leads to outcomes. Therefore, all the examples cited within this paper are ones where the authors have had opportunities to discuss the application of the EMS with other development teams.

Where limited published evidence on outcome methodology or results exists, exploratory research is most appropriate. The positivist scientific ideals of falsifiable hypotheses, replication and statistical testing are not possible within the scope of projects that are endeavouring to explore new areas and build up a body of evidence from inductive analysis (Chalmers, 1999; Robson, 1993). The conceptual framework and case study presented here are therefore intended not as a definitive answer to the issue. The authors wish to open up a debate on what are reasonable expectations of EMS and to inspire other EMS developers to reflect on their own experiences and contribute further examples to the literature via this journal. Therefore, the combination of the objectives above makes the most appropriate means to tackle this new field of enquiry.

2. Conceptual framework

This paper argues that it is useful to differentiate between EMS *outcomes* (changes in values, attitudes and behaviour in the world beyond the walls of the research institute) and *outputs* (in the form of knowledge embodied in peer reviewed articles, software or datasets). Recent evaluation literature has highlighted the importance of understanding the relationship between context, process and outcomes (Blackstock et al., 2007; Patton, 1998). Therefore, a focus on outcomes requires understanding *how* and *under what conditions* information produced by EMS is interpreted and used by stakeholders. This has been accompanied by a move away from an *information deficit* model where an identified "gap" is filled using knowledge derived and packaged by "expert" researchers and then delivered for use by "lay" practitioners. Instead a less linear and directed model of *knowledge exchange* (Ekboir, 2003) is preferred. Drawing on these literatures, we recognise that EMS follows three loosely coupled *adaptive cycles* – science, development and operations (see Fig. 1). This conceptual framework is a generalisation of the "consultancy" model for successful Decision Support System (DSS) use proposed by (McCown, 2002a) where knowledge (or data) is passed between phases rather than software tools.

The Research phase (the left column in Fig. 1) is where the basic, strategic and systems science is undertaken that underpins later

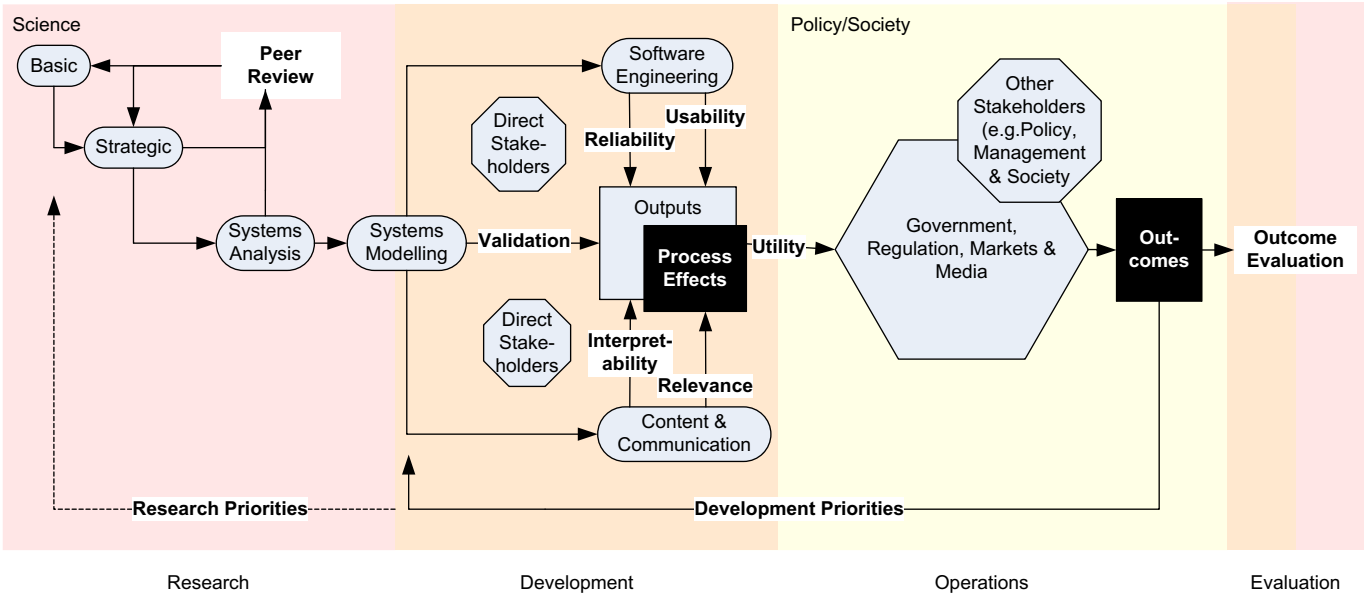

Fig. 1. A conceptual framework linking EMS research to outcomes.