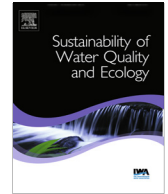




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Reviewing drivers of ecosystem change as input for environmental and ecosystem services modelling



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ABSTRACT

Environmental modelling combined with scenarios provides insights into drivers of change, potential implications of different trajectories, and options for action. So far, there has been no endeavor to assess the breadth of assumptions concerning drivers of ecosystem change on a global and European level as used in various scenario approaches. Our paper fills this gap by reviewing drivers of 27 global and European scenarios to provide an overview of extreme assumptions. Additionally, results can support quantification efforts of storylines to test environmental and ES models and to facilitate participatory scenario development to improve the usefulness of modelling approaches for stakeholders.

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1. Introduction

Models can help us to understand ecosystem complexity, including for example, how ecosystem processes and the supply of ecosystem services (ES) are related (MEA, 2005a). Therefore, the modelling of ecosystem functions and processes is one of the foundations for ES assessments (MEA, 2005a; Seppelt et al., 2011). However, models can do more than contribute to understanding of current systems. Modelling approaches are frequently used to assess how systems react to internal and external drivers of change. Such modelling approaches are often used in combination with scenarios. Scenarios include assumptions about drivers, such as climate or globalization of markets, but also changes in technology or lifestyles, which may have direct or indirect environmental effects. In combination with modelling approaches, scenarios provide insights into drivers of change, potential implications of different trajectories into the future, and options for action (Clark et al., 2001).

Over the last decades, scenarios have become a popular tool for assessing potential consequences of global and climate change, e.g., in UNEP’s Global Environmental Outlook 4 (GEO-4, 2007) or in the fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2013). Among environmental foresight methods (Bengston et al., 2012), results of scenario analyses are one of the most frequently used approaches to support environmental and ecosystem-related decision-making on any level, from global to local (e.g. Busch, 2006; GEO-4, 2007; Özkaynak and Rodríguez-Labajos, 2010; March et al., 2012; IPCC, 2013; Maes et al. 2013; Priess and Hauck, 2014). Scenarios, in which drivers of ecosystem change are directly linked to changes in ecosystem services, are likewise available, such as the MEA scenarios (MEA, 2005b), a prominent example for the global level, the UK National Ecosystem Assessment (UK-NEA, 2011) scenarios for the national level, or Plieninger et al. (2013), who explore futures of ES in cultural landscapes on the regional level.

Scenario development often starts with the development of storylines, i.e., a qualitative and descriptive component of a scenario which creates images of future worlds (Rounsevell and Metzger, 2010). In order to use the assumptions about drivers of ecosystem change provided by storylines as input for environmental and ES modelling, the assumptions have to be quantified. If models are run on a different scale than scenarios, down- or upscaling procedures are needed to bridge gaps between scales (Kok et al., 2007; Alcamo et al. 2008). The usefulness of scenarios for environmental modelling increases with increasing consistency between scenario and modelling approach in terms of (i) spatial and (ii) temporal coverage and resolution, (iii) thematic focus, i.e., the match between scenario drivers and model input variables, and (iv) the quantification of scenario assumptions.

This paper aims at providing a review assessing the breadth of qualitative or quantitative assumptions concerning drivers of ecosystem change on the global and the European level. So far, there has been no endeavor to provide an overview and compare how existing scenario approaches predict the development of different drivers of ecosystem change. Our review tries to fill this gap by providing an overview of extreme assumptions used in recent scenario exercises. In addition, it can support quantification efforts of storylines in any given scenario approach to test environmental and ES models using the extreme drivers and be used to facilitate participatory scenario development to improve the usefulness of modelling approaches for stakeholders.

In the following sections, after presenting the methodology we used for our review, we provide the set of drivers we identified, including the minimum and maximum assumptions of their development, mainly in the form of quantified assumptions. In the end, we discuss our findings in the context of ecological modelling as well as possible uses to facilitate stakeholder processes.

2. Method

A review as envisaged in this paper poses a number of challenges due to the sheer number of environmental scenario exercises conducted in the last decade. In our review, we used a combination of systematic review and expert judgment which is described in the following section.

2.1. Selection process of scenarios for in-depth-review

An initial literature search was conducted between 2012 and 2013, using the keywords (“ecosystem” OR “ecosystem service”) AND, “scenario”, AND (“global” OR “Europe”) yielded a wealth of scenarios. Together with scenario experts of the EU-FP7 research project OpenNESS (Operationalisation of Natural Capital and Ecosystem Services; <http://openness-project.eu/>),

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