Scenario Building and its Application

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Introduction and 'State-of-the-art'

Assessing uncertain futures Perceived uncertainties and risks can be considered to be the main motivation behind 'Futures Thinking' or 'Futures Studies' to assess potential economic, environmental, social or technical developments and their expected consequences on society and environment (or from a systems perspective – feedbacks between the components of complex social-ecological systems, e.g. Liu et al., 2007). A broad range of approaches such as Forecasting, Predictions, Trend Analysis or Visions is used to assess future developments and their consequences on the economy, society or the biophysical environment, of which scenarios are just one, though frequently applied method of 'Futures Thinking'. Many of the approaches and methods can be combined, which is frequently done in practice e.g. (participatory) scenarios and mathematical models. In the context of 'global change – policy – impact assessment' studies (OpenNESS belongs to this category), scenarios are one of the dominant approaches for assessing uncertain futures, for example the IPCC SRES scenarios, the scenarios of the Millennium Ecosystem assessment or UNEP's Global Environmental Outlook (e.g. UNEP, 2007). Within the broad set of scenarios available, actually a limited set of scenario families can be recognised (van Vuuren et al., 2012).

What are scenarios? The term scenario is widely used in different ways and contexts, making it necessary to arrive at a common understanding of how the term is used. Scenarios are defined here as "a plausible, simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces". Scenarios are no predictions of what will happen, but are projections on what might happen or could happen given certain assumptions about which there might be great uncertainty.

There are several **types of scenarios** that can be distinguished along different lines (van Notten et al., 2003). *Trend scenarios* explore the continuation of (and deviations from) currently dominant trends in society and policy and are often combined with *policy scenarios* to show consequences of future policies, while *explorative scenarios* explore plausible alternative futures. Another option is to develop *normative scenarios*, for instance possible futures versus desired futures, often used in combination with *back casting*. Which type of scenarios to develop depends on the objectives and the intended use and the users of the scenarios (e.g. quantified drivers as input for models; "policy-free" storylines to test different policies).

For the **development of scenarios** different *inputs* can be used, e.g. based on stakeholder or expert consultations during workshops, interviews or questionnaires, but also using input from other scenarios or literature in general. Likewise different methods can be applied, like *back casting, visioning, storytelling, fuzzy cognitive maps*, and others (Alcamo et al., 2008; Keune et al., 2013; Kok, 2009). There are also multiple ways to check scenarios for internal consistency, e.g. using *expert rounds, models* or *cross table* approaches. Beyond, multiple forms exist to present the possible future states, for example as *qualitative storylines* or visualized as sketches, pictures or (hypothetical) maps, or quantitatively as tables or graphs. The applications of scenarios are likewise manifold, common uses including scenarios as research or decision support tools, for example, to assess possible impacts of alternative climates, impacts of policies or socio-economic changes on ecosystems and ecosystem services, integration of different knowledge domains or the establishment of scientifically based consensus (Acreman, 2005; Kok et al., 2011; Biggs et al., 2007; Liu et al., 2008; Mahmoud et al., 2009; Palomo et al., 2011; Walz et al., 2007). In order to ensure legitimacy and relevance of scenarios for the intended users it is considered advantageous to include/involve decision makers and other stakeholders in identification and selection of key drivers, the development of assumptions and corresponding scenarios (Alcamo et al., 2008; Kok, 2009; Priess and Hauck, 2014), while in practise stakeholder involvement may vary between expert consultation and full collaboration. In subsequent steps scenarios maybe quantified e.g. using simulation models. Evaluation of

simulation results, and in some instances also model development may be components of the participatory discussion process.

This short introduction already shows, that many options exist to develop and use scenarios and we do not intend to provide an exhaustive methodological overview here. Instead, we will lay out the approach that we suggest for this cross-cutting methodology in OpenNESS, and explain the suggested approaches.

Scenario development in OpenNESS

Thematic focus of the OpenNESS scenarios: The EU level OpenNESS scenarios will show the influence of different drivers of change on natural capital, ecosystems and their services. The details, e.g. which EU policies are considered as relevant drivers and which ecosystems are addressed, will be identified by the user groups, primarily the OpenNESS case studies of WP5, EU-level stakeholders (WP2) and OpenNESS scientists e.g. modellers.

Scenario design: The OpenNESS scenarios serve different purposes. Therefore, we consider a generic set of EU level scenarios in the form of **storylines** and **quantified assumptions about drivers** as the most useful approach. Drivers and uncertainties identified by the primary users and the scenario team are organised along axes of key-uncertainties, in a similar fashion as the IPCC or GEO4/5 scenarios. Previous studies and scenario-manuals repeatedly point out that a low number of scenarios (3-6) is advantageous in participatory processes in order to avoid overburdening voluntary participants, scientists to be consulted, as well as the scenario team (Henrichs et al., 2010). In OpenNESS, a scenario period until 2050/60 is considered adequate, based on discussions with intended users, considering climate change, a period probably the lower limit for climate drivers and differences between climate scenarios to become relevant.

The conceptual framework and methods for integrative scenario development mainly follows Priess and Hauck (2014). They based their participatory scenarios on three components of a scenario framework: 1) User and stakeholder participation, 2) Knowledge integration, and 3) Quality control, all of which are considered prerequisites to develop integrative scenarios that serve as common boundaries for case studies as well as for decision making needs at different levels. Scenarios typically are developed in a series of steps, e.g. the procedures suggested by Alcamo (2001) or Kok (2009). Similarly, a six step procedure is suggested for the participatory scenario development, including iterative cycles / components: Establishing a scenario team - Review of drivers - Selection of drivers (and indicators) - Development and review of storylines - Application of scenarios at EU / case study levels – Synthesis and feedback to case studies and EU level. Considering the degree of participation as a range between expert rounds (low) and full co-design (high), stakeholder involvement in the OpenNESS development process can be considered intermediate. The scenarios are built on a priori results identifying drivers of change in case study questionnaires and repeated discussions with case studies and an EU-level stakeholder workshop, while most of the details and the quantification of drivers have been elaborated by the scenario team involving additional experts.

Issues to be discussed (incl. open questions to be addressed during lifetime of OpenNESS)

1. The development of the scenarios in the case studies will be explored through the participatory activities being undertaken in Task 2.4, and will test the saliency and relevance of the scenarios at the case study scales and the utility of scenario methods in different decision-making contexts. Other applications and user groups are welcome (e.g. Non-OpenNESS studies in ES/NC), but not in the focus of this approach.
2. Beyond, it is planned to analyse drivers of ecosystem change at EU level, especially considering the added value of including ES/NC in current (or potential new) EU regulatory frameworks in view of the goals the EU wants to achieve, but also the external impacts of the EU policies on regions outside Europe. The analyses will involve modellers of WP3 and provide input for the recommendations to decision makers planned in WP6. Inputs from different stakeholders and experts are expected to ensure relevance and saliency, first for the OpenNESS case studies, and second for other potential users (Alcamo and Henrichs, 2008; Priess and Hauck, 2014), for example, at EU or other levels.
3. By providing common boundary conditions for case studies and simulation models, it is expected to increase comparability and facilitate integrative analyses.

Significance to OpenNESS and specific Work Packages

WP1: The scenarios and their applications address the four challenges. Beyond, it is expected that the application and stresstesting of the scenarios will reveal different strategies and policy frameworks addressing NC and / or ES.

WP2 - 3: In WP 2 the scenarios are being developed (task 2.3) and also serve as an example in the scenario guidelines (task 2.4). WP3 scientists contribute significantly to scenario development co-designed the list of scenario drivers and lead their quantification to serve as input for simulation models of WP3 and others.

WP 2 - 5: The objective of Task 2.3, as described in the proposal, is to develop an integrative multi-scale scenario approach to analyse drivers of ecosystem change on the EU level and to develop guidelines for undertaking a participatory scenario approach at case study level. Together this is the cross-cutting methodology "**Participatory Scenario Building Methodology**". Thus, the scenarios contribute to achieving the use of common assumptions about factors driving ecosystem change or changes in ecosystem service provision, indicators and methods, across WPs 2-4 and WP 5 case studies with the final goal to facilitate and enable synthesizing, e.g. impacts of different modes of governance on different ecosystem services, or compare indicators across regions and case studies. The latter could use the European scenarios directly, adapt / downscale them to their scales, or use them as input for their own scenario development.

WP6: The scenarios are intended to be made available on OPPLA and may also serve as input into additional dissemination processes within and beyond OpenNESS.

Relationship to four challenges

Human well-being: The OpenNESS case studies and modelling approaches focus on different contributions to human well-being from ecosystems influenced by different drivers of change. The participatory approach ensures that these drivers are addressed in the scenarios.	**Sustainable Ecosystem Management:** In the scenarios very different types of ecosystem management are assumed to assess a broad range of their potential positive and negative impacts.
Governance: The storylines facilitate a (participatory) prioritisation and evaluation of policies and regulatory frameworks ensuring the relevance and usefulness of the scenarios for the intended users. Beyond, the common framework of scenario assumptions facilitates testing the robustness of policies e.g. via comparative analyses across OpenNESS case studies.	**Competiveness:** The OpenNESS scenarios make explicit assumptions about changes in different sectors of the economy, lifestyles, urban and rural areas and so forth, several of them with potentially strong impacts on competiveness. It is envisaged that case studies and modellers will analyse the multiple impacts on NC, ES, human well-being etc. in the different scenarios, and their impacts on competitiveness.

Recommendations for the OpenNESS consortium

User and stakeholder participation: In order to achieve the benefits associated with the scenario development process, such as joint learning, the development of consensus about goals or to improve the ability to deal with uncertainty in decision making, it is necessary to involve the relevant stakeholder groups in the development process (case study leaders, modellers, EU-level stakeholders).

Knowledge integration: Scenarios can be used to integrate different types of knowledge from different disciplines as well as scientific and other forms of knowledge.

Scenario application: We strongly encourage case studies, modellers and policy analysts to apply and stress-test the scenarios, to increase comparability and facilitate integrative analyses including the identification of promising policies or policy frameworks both at EU and case-study level.

Three Must Read Papers:

Alcamo, J., Kok, K., Busch, G., Priess, J. et al. (2008): Searching for the Future of Land: Scenarios from the Local to Global Scale. In: J. Alcamo (Ed) *Environmental Futures: The Practice of Environmental Scenario Analysis*. Amsterdam: Elsevier. pp. 67-103.

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Kok, K. (2009): The potential of Fuzzy Cognitive Maps for semi-quantitative scenario development, with an example from Brazil. *Global Environmental Change* **19(1)**: 122-133.

Kok, K. et al. (2011): Combining participative backcasting and explorative scenario development: Experiences from the SCENES project. *Technological Forecasting and Social Change* **78(5)**: 835-851.

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Mahmoud, M. et al. (2009): A formal framework for scenario development in support of environmental decision-making. *Environmental Modelling & Software* 24(7):798-808.

Palomo, I.; Martín-López, B.; et al. (2011): Participatory scenario planning for protected areas management under the Ecosystem Services Framework: the Doñana social-ecological system in southwestern Spain. *Ecology and Society* 16(1):23. [online] URL: http://www.ecologyandsociety.org/ vol16/iss1/art23/.

United Nations Environmental Programme (UNEP) (2007): *Global Environment Outlook 4. Environment for development.* UNEP, Nairobi, Kenya.

van Notten, P.; Rotmans, P.; van Asselt, M.B.A. et al. (2003): An updated scenario typology. *Futures* **35(5)**: 423-445.

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