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## Analysing scenario approaches for forest management – One decade of experiences in Europe

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### ABSTRACT

In forest management, scenarios are often used to envision what the future might look like to account for uncertainties associated with, for example, climate change, changing socio-economic conditions, and technological developments. There are, however, many different methodological approaches to scenario building. In order to be able to make better use of the diversity of approaches at hand, a systematic overview of the scenario methodologies, which is currently missing in the forest sector, is needed. This paper analysed and reviewed 129 forest-management-related scenario studies that have been carried out in Europe during the past decade. The studies were classified by means of cluster analysis in four groups: (1) management scenarios, (2) environmental scenarios, (3) optimization scenarios, and (4) participatory scenarios. Despite differences between the four groups, almost all scenario studies can be characterized as rather quantitative, non-participatory, and single factor in nature. The analysis also found a temporal trend reflecting a broadening of the scenario methodology for forest management over time towards scenarios that incorporate longer time horizons, reflecting issues on a larger scale, including land-use considerations. Considering the complexity and urgency of the issues in forest management that need to be addressed and the opportunities offered by the scenario methodologies not yet fully used, we expect to see a further broadening of the scenario methodology with mixed-method, participatory, and complex scenarios.

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### 1. Introduction

Thinking about the future is essential to dealing with the challenges of today. As Shearer (2005, p. 67) wrote, “*the ultimate success of decisions made today rests on the situation tomorrow*”. Unfortunately, the future is in principle unknowable and therefore inherently uncertain (Weber, 2000), which forms an obstacle to effective decision-making. Although this applies to almost every decision taken, it seems to be even more relevant to forest management, where rotation periods span decades and in some cases even generations (Hoogstra and Schanz, 2008). At best, this far-off future is “*dimly seen, veiled in the manager’s uncertainty*”, as Duerr and Duerr (1975, p. 31) explained. Just imagine how much easier it would be (e.g. to decide which tree to plant) if we would know the future, and we could foresee chances and obstacles before they occur.

Fortunately, there are a variety of tools and methods available to the forest sector to cope with the uncertainty arising from the long time horizons, from the concept of sustainable forest management to the Normal Forest model to forest growth models and many more. Some of these have origins that can already be traced back as far as 17th and

18th century Central Europe (Convery, 1973; Hoogstra, 2008; Speidel, 1972). Relatively new to the sector is the use of scenarios. This has, however, over the past decade gained a strong foothold in the forest sector as an approach that could help inform forest management decision-making in the frame of future uncertainty. Examples include the European forest sector outlook studies (Schelhaas et al., 2006; Schelhaas et al., 2009; UNECE/FAO, 2011), scenario studies analysing the impact of climate change (e.g. Hanewinkel et al., 2013; Karjalainen et al., 2003), scenario analyses for sustainable forest management (e.g. Biber et al., 2015; Mohren, 2003), and scenarios for stakeholder communication (e.g. Carlsson et al., 2015).

The scenario approach differs from most of the above-mentioned ‘traditional’ approaches in that it assumes the future to be inherently uncertain, and therefore unpredictable. By envisioning different futures that might happen, decisions can be evaluated, ‘what if’ questions can be explored, and strategies can be tested. Such an approach shifts away from the rational idea to determine what is the best in the situation that is most likely to occur, towards an exploration of different circumstances in different possible futures (Duinker and Greig, 2007; Varum and Melo, 2010). In the words of Martelli (2001), “*building scenarios means speculating about the uncertainty surrounding the future: basically it means envisaging a few different possible future outcomes for*

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the situation under scrutiny". In this way, scenario analysis facilitates better knowledge among decision makers in terms of the future, and thus possesses an important function in preparing and sensitizing the decision makers to possible developments that might evolve in the time to come.

As several reviews (e.g. Amer et al., 2013; Bishop et al., 2007; Chermack et al., 2001) on scenario studies have shown, many different approaches to scenarios exist. Understanding the differences between the various types of scenarios would better equip scientists and practitioners to design scenario studies that effectively address the issues at hand. Many scholars (Millett, 2003; Varum and Melo, 2010) therefore agree that "systematizing and organizing the existing literature is a necessary step in developing the field and bringing the value of scenarios to a wider public" (Varum and Melo, 2010, p. 356). Despite the popularity of scenarios in the forest sector, so far such an overview is lacking. The objective of this paper, therefore, is to systematically examine and evaluate the methodological approaches used in scenario studies in the forest sector. In order to limit ourselves, we decided to focus our analysis of scenario studies on (1) forest management, (2) in Europe, and (3) in the past decade. First, we provide an overview of the current state of the scenario studies on forest management, based on different dimensions that are considered to reflect the main elements of a scenario approach (as will be described in the theoretical and analytical frame). Second, within the diversity of research approaches on scenario studies analysed, we identify clusters of studies that address scenario studies in similar ways. Third, based on our findings, we highlight some important challenges for the future of scenario studies.

## 2. Theoretical and analytical frame

Despite being a popular tool, scenarios are a topic of much debate in the literature, and a field full of "conceptual and definitional confusion" (Mulvihill and Kramkowski, 2010, p. 2454). Mietzner and Reger (2004, p. 50) even talk about scenario as "a fuzzy concept that is used and misused, with various shades of meaning". Table 1 presents a sample of descriptions of a scenario we culled from the forestry literature

**Table 1**  
Overview of different conceptualizations of the term 'scenario' in the forestry literature (1990–2015).

Author(s)	Conceptualization
Valsta (1992)	A scenario is here defined as one realization over time of the stochastic processes. Even though there may be several stochastic processes, they are all combined to a joint realization, a scenario.
Wollenberg et al. (2000)	Scenarios are stories of what might be. Unlike projections, scenarios do not necessarily portray what we expect the future actually look like.
Bishop et al. (2010)	An alternative future created by some method – even if not presented in the form of a story.
Alonso-Ayuso et al. (2011)	A scenario is a particular realization of uncertainty through the whole time horizon.
McKenzie et al. (2012)	Scenarios are storylines that describe possible futures. They explore aspects of, and choices about, the future that are uncertain.
Moore et al. (2013)	Scenarios are plausible futures that allow you to envision and evaluate the outcomes of means plausible to those engaged in the scenario planning exercise
Den Herder et al. (2014)	Scenarios are plausible descriptions of how the future may develop, based on a coherent and internally consistent set of assumptions about key relationships and driving forces (Van der Heijden, 1996). A scenario can be regarded as a story or, more precisely, a series of events leading to an end point typically answering a 'what if?' question.
IPCC (2015)	A scenario is a coherent, internally consistent, and plausible description of a possible future state of the world. It is not a forecast; rather, each scenario is one alternative image of how the future can unfold. A projection may serve as the raw material for a scenario, but scenarios often require additional information (e.g. about baseline conditions).

between 1990 and 2015. Finding descriptions of what a scenario is, was already a challenge; most of the authors use the term assuming that everybody knows (and shares) what they are talking about. The table, however, illustrates some of the conceptual confusion present also in the forest sector. Wollenberg et al. (2000), for example, see projections and scenarios as two different approaches; the IPCC (2015) also mentions that scenarios are no projections, but consider them as a possible way of building a scenario. Some authors explicitly describe a scenario as a story or narrative of the future (e.g. McKenzie et al., 2012), while others state that stories may be part of a scenario (e.g. Bishop et al., 2010). It is not the intention of this paper to dwell upon what the right definition is, but to explore what the authors of the reviewed articles see as a scenario. The definition used here therefore is the broadest definition encompassing all different interpretations of a scenario, i.e. a scenario is a description of a possible future.

Next to the conceptual confusion, there is also methodological chaos. Methodological chaos can be indicated as "there are almost as many ways of developing scenarios as there are practitioners in the field" (Bradfield et al., 2005, p. 800). Masini and Vazquez (2000, p. 49) even state that scenario analysis has become "a sort of Swiss pocket knife of multiple uses, [...] that supposedly makes it possible to rapidly visualize the future, like a soup to be served up quickly at table". This is exactly the reason that Kosow and Gaßner (2008) write that the scenario method does not exist as such. Reasons listed for the canon of approaches are manifold. Hughes (2009) mentions, for example, the conceptual confusion, which gives room for different interpretations and, hence, different approaches. Other reasons are the different kind of users applying scenarios in different contexts and with different goals and objectives (Hughes, 2009; Kosow and Gaßner, 2008), the different skills and resources (such as time and money) users have (Hughes, 2009), the varying positions of importance of scenarios in projects, and the different schools of thoughts and paradigms working with scenarios (Kosow and Gaßner, 2008).

In order to cut through the chaos, several studies have developed typologies of scenario studies (e.g. Börjeson et al., 2006; Ducot and Lubben, 1980; Duncan and Wack, 1994; Godet and Roubelat, 1996; Heugens and van Oosterhout, 2001; Kosow and Gaßner, 2008; March et al., 2012; Pérez-Soba and Maas, 2015; Rounsevell and Metzger, 2010; Van Notten et al., 2003). These typologies, however, not only create more order and understanding of the different approaches, they also form important tools to communicate, to compare and to develop approaches (Börjeson et al., 2006). This research, therefore, also sets up a classification of scenario studies in forest management. We decided not to use an existing typology, but to develop our own classification using our own framework based on insights from other scenario typology studies. The reason for this is that typologies "reflect a field's state of play at a fixed point of time" and, consequently, "become outdated as the field they address evolves (Van Notten et al., 2003, p. 423).

The framework we use in this research is based on the insights from the typology as developed by Van Notten et al. (2003), who developed a general typology for scenario studies, and the framework developed by March et al. (2012), who specifically characterized water management scenario studies (March et al., 2012). The framework of Van Notten et al. (2003) is based on three overarching themes (project goal, process design, and scenario content) comprising, in their view, the key aspects of scenario development. These three dimensions are each subdivided in several characteristics, which together determine the 'score' on the theme. Based on these scores (which are binary), eight different types of scenario studies can be distinguished: explorative-intuitive-simple; explorative-intuitive-complex; explorative-formal-simple; explorative-formal-complex; decision support-intuitive-simple; decision support-intuitive-complex; decision support-formal-simple; and decision support-formal-complex.

The framework of March et al. (2012) is based on a review of theoretical and methodological literature on scenario analysis for environmental issues and builds on previous typologies including (in part)

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