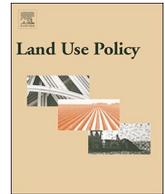




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## Bringing the sharing-sparing debate down to the ground—Lessons learnt for participatory scenario development

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### ABSTRACT

The concepts of Land Sharing (LSH) and Land Sparing (LSP) shall help to manage trade-offs between land use and biodiversity conservation but applications in real world contexts are scarce. We review the literature on scenario and stakeholder processes and present a participatory approach to translate the LSH/LSP concept into practice. It is based on a scenario definition process harmonized across five case studies in Europe and resulted in semi-quantitative participative LSH and LSP scenarios. Harmonization eases comparability among case studies despite fundamentally different scenarios due to heterogeneous conditions across the regions. A key challenge was the right level of standardization for the scenario process to reach a common understanding across case study regions while acknowledging regional peculiarities. The resulting scenarios support for regional specific planning recommendations and can be input to quantitative ecosystem service and biodiversity models.

### 1. Introduction

Improving our ability to understand and manage complex, rapidly changing social-ecological systems (SES) is a major challenge that requires the cooperation and integration of knowledge from multiple sources and perspectives (Biggs et al., 2015; Reed, 2008). Science can support decision making when dealing with complex problems in SES, but to be successful it needs to acknowledge and take into account the different socioeconomic and political contexts in which problems are described. Hence, stakeholder engagement in research projects such as participation of decision makers or individuals that have a direct interest or capacity to influence the process and outcomes of the research, has been increasingly sought and embedded into sustainability science (see, for example, Neßhöver et al., 2013; De Vente et al., 2016). It enhances the quality and relevance of the research by considering more comprehensive information inputs (Reed, 2008, 2009; Alcamo et al., 2008).

Scenario analysis has been increasingly used as a tool to envision

the future of complex SES, e.g. by looking at changes in ecosystems, ecosystem management and human well-being (Carpenter et al., 2005; Biggs et al., 2007; Priess et al., 2018). The participation of stakeholders is key in most of the integrated scenario studies but their role can vary, from active construction of the scenarios and interpretation of impacts on SES to be only informed about the outcomes (Biggs et al., 2007; Haklay, 2013). Within SES research, the importance of participatory scenarios to address pressing environmental challenges, such as improving the sustainability of agricultural systems and reversing biodiversity loss at multiple scales (Kok et al., 2007), increased over the last years (e.g. Sleeter et al., 2012; Carpenter et al., 2005; Kirchner et al., 2015; Griewald et al., 2017).

We argue that such participatory scenario processes are also needed to test the land use strategies of land sharing (LSH) and land sparing (LSP) – both explained in chapter 2 – and their impacts on SES in regional contexts. Despite the number of already existing scenario papers (see, for example, Popper, 2008; Oteros-Rozas et al., 2015; Oliveira et al., 2018 or Priess et al., 2018 especially on land-use), most of them

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lack details on how one can actually replicate and implement a similar process. Therefore, a very detailed and fit for purpose approach is required to reproduce the method of a stakeholder driven comparative scenario development process that aims at i) testing the implementation of LSP/LSH in a stakeholder process, ii) achieving comparable case study results and iii) using the results in quantitative models (see Section 2).

This paper, therefore, presents such a methodology and answers the following research questions: “How to derive comparative quantitative scenarios taking into account LSP and LSH in European landscapes?” (Q1). The following three questions support answering this research question: “How to translate LSP and LSH to the local realities of stakeholders?” (Q2), “How much standardization for scenario development is needed for comparability, how much freedom required to adequately represent local conditions?” (Q3), and finally “What are the pros and cons of standardizing these kind of science-based scenarios?” (Q4). The objective of Q2 is to illustrate the steps needed to derive scenarios that take account of the LSP/LSH. Q3 is particularly relevant because of the heterogeneity of SES in Europe.

The methodology presented hereafter has been applied to design scenarios in the FACCE-BiodivERsA-funded project TALE (“Towards multifunctional agricultural landscapes in Europe: Assessing and governing synergies between food production, biodiversity, and ecosystem services”). TALE included five case studies in Austria, Germany, Spain, Switzerland, and The Netherlands. They represent heterogeneous European SES. While this paper does focus on the methodological procedures for the operationalisation of the LSP/LSH approach for stakeholder involvement, the resulting scenarios are presented and compared by Karner et al. (2019).

Section 2 of the paper specifies the methodological challenges in the context of this specific scenario process. Section 3 provides the discussion of the methodology applied and the experiences that were made. The paper concludes with an overview of lessons learnt in Section 4.

## 2. Methodological considerations for the scenario process

Scenarios in SES studies are often used to envision possible alternative futures and consider pathways for decision making under uncertainty (Carpenter et al., 2006). Scenarios are often developed along previously identified key-uncertainties or challenges (O’Neill et al., 2013), keeping the number of scenarios to 4–6, especially when co-developing them in stakeholder processes (e.g. Kok et al., 2011; Priess and Hauck, 2014). Many different types of scenarios exist. While the “Story and Simulation” approach of Alcamo et al. (2008) for instance focuses on quantitative scenario analyses, others favour qualitative assessments or adjust the type of analysis to stakeholder preferences.

### 2.1. Using LSP and LSH in a stakeholder process

The research concept in TALE is distinct from most land use scenario processes so far due to its consideration of the ongoing debate on land sharing (LSH) and land sparing (LSP). LSP refers to the separation of production and nature conservation on agricultural land. This debate has emerged as response to the vivid discussion on how to make global food systems more sustainable taking into account growing demand on a resource constrained planet (Green et al., 2005; Phalan et al., 2016). LSH in contrast to LSP refers to the integration of production and conservation on the same agricultural land. Agricultural land is typically used less intensively, which may preserve biodiversity as well as ecosystem functions (Fischer et al., 2008, 2014). There is an increasing debate and interest in exploring how LSH/LSP will translate into practice, in obtaining science-based evidence on the benefits and trade-offs associated to these different land use management strategies, and in finding optimal policies to manage the trade-offs (e.g. Merckx and Pereira, 2015). So far, not many LSH/LSP studies have involved

stakeholders (Fischer et al., 2014) which make the operationalisation of the concept for the purpose of participatory scenario developments even more relevant.

### 2.2. Achieving comparable case study results

The results of the case studies shall be comparable with respect to methodologies and assumptions to allow overarching conclusions from each case study. However, the required standardization of processes creates a trade-off with the freedom necessary to engage stakeholders in a creative and deliberate scenario definition process. Protocols are means to standardize research processes (Rosenzweig et al., 2013). Therefore, our approach relied on a protocol mandatory for each case study (see Section 3.1).

### 2.3. Applicability in quantitative models

The scenarios were intended to support quantitative land use simulations. Therefore the land management information had to be parameterized to quantify bio-physical and economic indicators for ecosystem services and biodiversity. In order to do so, high resolution data with richness in the scope of land use management were required. However, this posed a challenge as stakeholders typically neither consider land use change at grid cell level nor are prepared to discuss storyline impacts on land management in such detail. Recent combinations of long-term narratives with quantified scenarios attempt to combine the advantages of approaches (Kok and van Delden, 2013; Carpenter et al., 2015; Kok et al., 2015; Rao Mallampalli et al., 2016). Consequently, with respect to spatial details, we needed a reasonable segregation of the region in homogeneous sub-regions aligned with stakeholders’ perceptions of the region for the scenario development process. It requires downscaling procedures to come up with grid resolution data and several rounds of iterations to manage complexity and maintain consistency in a stepwise approach (Priess et al., 2018).

## 3. Methodological procedure towards scenarios on LSH/LSP

Based on the methodological considerations in Section 2, we present a participatory scenario development protocol.

### 3.1. Translating LSP and LSH to the reality of stakeholders

#### 3.1.1. Overview on the stakeholder process

A major function of the stakeholder process was the definition of land use scenarios. In the context of this paper we define a storyline as a qualitative description (i.e. narrative) of future developments on major global to continental framework conditions, integrating the EU policy context within one global narrative, whereas scenarios describe case study specific alternative states of future land use as response to this framework conditions (i.e. land use drivers).

For the selection of stakeholders, guidelines were drafted to be used by all case studies (Schönhart et al., 2016). Durham et al. (2014) served as a basis for these guidelines. As a starting point for the stakeholder selection process the team identified expectations towards stakeholders and benefits to stakeholders if they participate. With respect to the latter, the scenario exercise should deliver both, important process outcomes (i.e. social learning or inclusion of local knowledge), and product outcomes (i.e. the scenarios themselves) (Carpenter et al., 2006). Based on the guidelines, the following stakeholder groups were identified: Public authorities, semi-public authorities, food and other businesses (e.g. tourism), researchers of regional to national organizations, teachers at agricultural schools, farmers and land owners in the case study area, and local residents with particular interests in land use, environment, and nature conservation issues. Stakeholders should represent regional to local stakes because they more reliably translate regional contexts of drivers (Priess and Hauck, 2014) and are mainly

affected by land use changes. Furthermore, previous experiences have also shown that the incorporation of local stakeholders within a participatory process is easier and less costly than engaging stakeholders at higher governance levels (Kok et al., 2007).

The steps for stakeholder selection to be conducted by each case study team were:

- 1 Listing potential stakeholders from each identified stakeholder group (see above)
- 2 Categorizing potential stakeholders along the following three criteria: i) their personal and institutional interests for participation, and ii) the benefits of participation for the quality of the scenario results, and iii) their influence, i.e. potential to disseminate, further improve and apply the results. There are linkages between these criteria since the latter (iii) fundamentally determines stakeholders' interests (i) and both (i) and (iii) determine the value for the research process (ii).
- 3 Ranking stakeholders based on their likely contribution to the project, i.e. according to the criteria of (i) interest and influence (iii) (Durham et al., 2014).
- 4 Developing a core and extended stakeholder group. Each case study team had to establish a stakeholder core group since a limitation of participants – around 5–10 persons – appeared necessary to ensure efficient participatory processes in each case study.

With respect to step 1, stakeholders were identified based on the analysis of relevant literature and documents as well as existing contacts. This was followed by a snowballing approach to identify further relevant stakeholders in each case study area. For the number of stakeholders in each case study and their background see Table 1.

In addition to the stakeholders at regional case study level, an advisory board was set-up at the European TALE project level. The project team aimed at having a balanced representation from different professional sectors and governance levels. Therefore, representatives from regional, national and EU-level, and representatives from academia, agricultural administration, and a non-governmental organisation were selected. All were known to have expertise in the field of agricultural, ecosystem services and biodiversity. At least one advisory board member per case study country was required. Each case study team nominated one or two members based on these criteria and their personal contacts as these persons were thought to be more willing to accept the task. Finally, the advisory board consisted of seven persons.

### 3.1.2. Scenario process

The ultimate purpose of this scenario exercise was to support case study analyses in European regions that are linked to national and global storylines. A common method to link different scales in scenarios is to incorporate themes from global scenario archetypes into local scenario development exercises or using higher level scenarios for regional or local assessments (Ash et al., 2010; Biggs et al., 2007). There is an increasing amount of “multiscale” scenario studies, which are a set of linked scenarios constructed at two or more scales (Biggs et al., 2007; Wardropper et al., 2016; Kok et al., 2019; Wada et al., 2019).

The scenario exercise therefore includes three major steps, the choice of i) global and ii) EU/national level storylines, and iii) the

development of case study specific explorative land use scenarios along the common storylines. Explorative scenarios describe how future developments could unfold based on different types of exogenous and endogenous driving forces. They frequently start from two main external drivers or groups of drivers (“scenario-axis technique”; van Vliet and Kok, 2015). Normative scenarios, in contrast to explorative scenarios, focus on how certain targets can be reached or a certain state be avoided. Finally, predictive scenarios focus on the foreseeable future. They support the planning for situations that are strongly dependent on the present situation (Börjeson et al., 2006). The EU/national level storylines are explorative: Its components, the parameters as drivers of the scenarios, were predefined and discussed with project advisory board members.

Obviously, the scenario process follows a clear hierarchical order (see Zurek and Henrichs, 2007) with respect to spatial scales but also the working steps. The case study level scenarios can only be designed subsequently to the choice of a global and the definition of EU/national level storylines and have to be fully consistent with both. Consequently, the EU/national level storylines have to be consistent with the global storyline as well. This process shall ensure the project claim of comparable case study scenarios. The final scenarios shall cover a broad range of futures within respect to LSH/LSP in order to help stakeholders and scientists to widen the scope of future land use options (van Vuuren et al., 2012). However, they don't have to appear extreme (i.e. dubbed “possible” according to Voros, 2003) compared to the current situation but should rather be considered plausible (compare to Voros, 2003) by stakeholders and scientists.

Storylines at larger hierarchical scales can ease the definition of more detailed scenarios (Zurek and Henrichs, 2007). By defining boundary conditions of economic, social and political framework conditions, they may guide stakeholders and establish a common understanding on land use drivers. Therefore, the common global and EU/national level storylines can enhance comparability among the case studies. In case, global level storylines are chosen from the scientific literature, also comparability with other research becomes easier. Consequently, all choices on storylines have been taken by the team of researchers and the advisory board without input from stakeholders at regional case study level.

Among the pool of global storylines available in the scientific literature, the shared socio-economic pathways framework (SSPs; O'Neill et al., 2017) turned out to be most promising for the following reasons: Firstly, SSPs support the required land use futures within which regional LSH/LSP strategies can evolve. Secondly, the parsimonious SSPs are easier to enrich with case study specific narratives than other storylines too rich in detail. Third, SSPs are available at global to continental scales and describe major socio-economic conditions with some quantitative information available that can support the scenario definition process. Fourth, the SSPs are likely familiar to some stakeholders already, which would facilitate storyline communication and acceptance among stakeholders. Finally, they became a standard in climate change research in recent years, which is particularly valuable to those case studies that tackle climate change.

After deliberately choosing the bundle of storylines, a choice has to be made among single storylines within the framework, i.e. among the distinct SSPs. Such choice faces the trade-off between the diversity and

**Table 1**  
Background of stakeholders.

Case Study	Administration (different sectors and scales, i.e. local to regional)	Farmers and farmer associations	Politics	NGO	Citizens	Other (e.g. academia, tourism, etc)	Total
Broye catchment (CH)	3	1	0	1	0	0	5
Mulde (GE)	4	1	–	2	–	–	7
Kromme Rijn (NL)	1	3	–	1	–	3	8
Cega- Eresma- Adaja (ES)	9	6	–	3	3	3	24
Mostviertel (AT)	2	3	1	2	1	3	13

**Table 2**

Factors and directions of change. (For interpretation of the references to colour in this table, the reader is referred to the web version of this article.)

Factors	LBA	LSP	LSH
Global development	↗	↗	↗
Income growth & living conditions	↗	↗	↗
Political stability	→	→	→
Markets & market connection	↗	↗	↗
Sustainable development	↗	↗	↗
Access to education, water, health	↗	↗	↗
Technological development	↗	↗	↗
Resource & energy use	↗	↗	↗
Population growth	↗	↗	↗
Equality	→	→	→
Mitigation potentials	↑	↑	↑
Adaptation potentials	↗	↗	↗
Agricultural input prices <sup>1</sup>	↗	↗	↗
Agricultural output prices <sup>1</sup>	↗	↗	↗
Agricultural productivity growth	↗	↗	↗
Structural change in agriculture	↗	↑	↗
Direct payment funding	→	↘	→
Greening requirements	→	↘	↗
AEP funding	→	↘	↗
Less favoured area funding	→	↘	→
Environmental legislation <sup>2</sup>	→	→	↑
Nature protection legislation <sup>2</sup>	→	↑	→
EU livestock product consumption	→	→	↘
EU org./regional food consumption	↗	→	↑
Growth of urban areas	↗	↑	→
Leisure activities in landscapes	↗	→	↑
Overall water demand by different sectors (including agriculture)	↗	↑	→

Legend: ↑strong increase, ↗moderate increase, → no change, ↘moderate decrease, ↓strong decrease.

Red colored boxes: Represented in the global storyline; Green colored boxes: Unrepresented factors relevant to the EU/national level storyline including directions of change in the storylines.

richness resulting from different storylines, in its most extreme case different for any subsequent lower level storyline, on the one hand and the risk to confuse or even frustrate stakeholders confronted with such diversity in the scenario process on the other. The strength of SSPs, i.e. the diversity of five fundamentally distinct plausible future global states to capture uncertainty of future global developments, can become burdensome for stakeholders at regional level if they are unfamiliar with scenario processes. The team of researchers decided to put the focus on processes of LSH/LSP at case study level. Given the limited number of scenarios that can be developed in typical stakeholder processes, this decision determined other choices such as the feasible number of global storylines. Consequently, we decided to minimize risks and kept the number of global storylines at the lowest possible level by adopting a one-to-many nesting approach (Absar and Preston, 2015).

Among the SSPs, the SSP2 “Middle of the Road” storyline (O’Neill et al., 2017) has been chosen by the research team. This single storyline appeared appropriate to frame LSH and LSP land use processes in the EU. SSP2 prolongs current trends at global level with a balance between agricultural production and environmental protection at global scales. Thus it may be more familiar to the stakeholders who are rather sceptical towards extreme scenarios (see for example Priess and Hauck, 2014) than any other storyline. Furthermore, our short timeframe until 2030 makes a storyline close to current trends even more plausible. The feedback loop among the researchers and advisory board members confirmed this choice with respect to the storyline’s ability to cover LSH and LSP land use processes. Building on current trends allowed us to focus on specific regional land use strategies reducing the risk that stakeholders become overburdened by both a fundamentally changing global system and new and alternative regional land use systems. The trade-offs of this choice in terms of uncertainty management are discussed in Section 4.3.

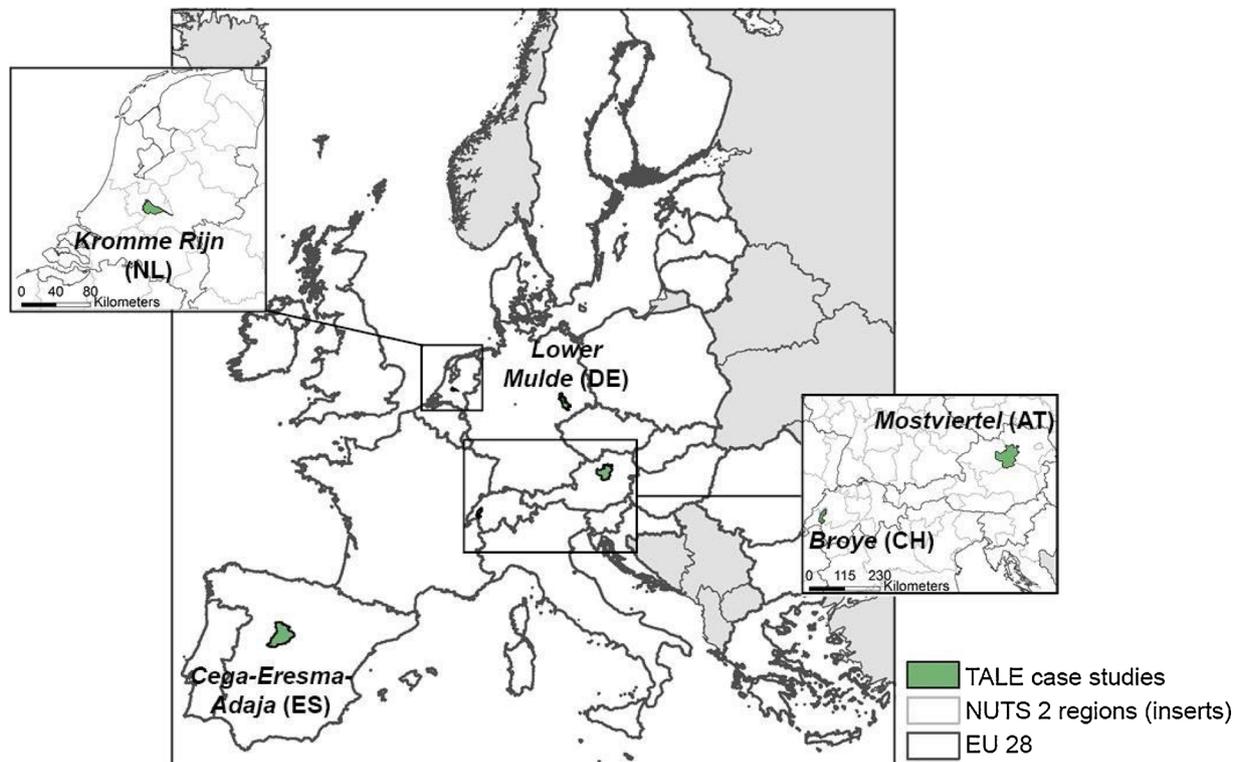
The global storyline (SSP2) provides background information on

global socio-economic developments, which are helpful to frame the development of EU/national level storylines on LSH/LSP. Absar and Preston (2015) describe two challenges for nested storylines with SSPs, i.e. the insufficient spatial resolution of SSPs and the lacking coverage of storyline elements. While the first problem was of limited relevance here due to the definition of intermediate EU/national level storylines, the second was pressing due to the fact that the EU/national level storylines had to be enriched by details on LSH and LSP, which are totally absent to the SSPs. Hence, rounds of iteration including the researchers involved in the project and the advisory board became obligatory. The researchers finally drafted three EU/national level storylines consistent with SSP2 and the overall project objective, i.e. to analyse the land use strategies of LSH and LSP. The storylines are set for 2030 and illustrate also how dominant policies will evolve in these storylines. This timeline shall give orientation to the stakeholders particularly when discussing the plausibility of the scenario outcomes. It shall help to parameterize any model application but should not be seen as strict. Similar to the SSPs (see O’Neill et al., 2017), the EU/national level storylines rather describe pathways. The storylines LSH and LSP were complemented by an intermediate balanced storyline (LBA) that more strictly follows current trends with respect to land use and agricultural sector developments. Choosing more radical changes embedded in LSH and LSP should enhance the discussion among stakeholders when specifying the scenarios (Chermack et al., 2001; Peterson et al., 2003).

With respect to the agricultural sector, the EU/national level storylines include GDP growth, population growth, R&D investments, global trade, global climate policies, and land use affecting policies e.g. Common Agricultural Policies, Water Framework Directive, Habitat Directive. The FAS (factors-actors-sectors) framework presented in Kok and van Delden (2009) turned out to be helpful to structure this storyline definition process. “The factors, actors and sectors represent a preselected number of themes; individuals and groups; and social and economic sectors chosen to help structure and provide focus to the scenario development process.” (Kok and van Delden, 2009: 295). FAS has been applied in many scenario processes so far, for example, to downscale SSPs to the sub-national level (Absar and Preston, 2015). Following the FAS framework, the TALE team has defined key factors, actors, and sectors at EU/national level. The list of FAS arguments repeats and partly extends those presented in the global storyline. A similar process of defining multi-scale storylines and scenarios with different groups of actors at different process levels and based on subsequent studies has been developed in the MedAction Project (e.g. Kok and van Delden, 2009; Patel et al., 2007).

Based on an extensive list of FAS defined by the TALE team, a selection of those most relevant to the EU/national level storylines has been made to facilitate communication with stakeholders. In the FAS methodology, actors and sectors describe underlying structures of a system, but actual triggers of change are related to the factors only. The factors that constitute the storylines are presented in Table 2. Only those factors that are either decisive to the land use sector or variable among the storylines are presented with their directions. For example, agricultural output prices are basically invariable across all storylines but given by the global storyline. However, there can be impacts on farm incomes such as by changing consumption habits towards organic or regional products with higher farm added value.

Based on the selected factors and their direction of change storylines were drafted for each scenario. These drafts took the LSP and LSH literature into account with reasonable assumptions on the direction of factor changes. Subsequently, the draft storylines, FAS selection, and direction of factor changes have been discussed with all advisory board members of the project based on a qualitative survey to improve consistency with the global storyline and EU policy and land use developments. This step helped to legitimate the storylines for the stakeholders in the case study regions. The final storylines are presented in Annex I.



Map 1. Location and outline of TALE case study regions.

### 3.2. Scenario workshops

For the scenario development, stakeholder workshops were convened in the five case study regions (see Map 1) to initiate knowledge exchange between stakeholders with various backgrounds (see Table 1). The five selected case studies all have an agricultural profile and represent contrasting European agricultural and climatic conditions with a particular focus on intensive arable systems.

The TALE team agreed on minimum requirements for the definition of scenarios in the case studies. It included the parameters to be defined, their level of spatial and temporal detail, and whether they should be quantified or qualitatively described. This step should assure that scenarios were comparable among the case studies. Examples of minimum requirements could be either quantitative or qualitative specifications of land use categories (e.g. extend of cropland or more specific individual crops), farm structure (e.g. change in number of farms or farm size), production intensity (e.g. level of fertilization, irrigation) and agricultural policies. The minimum requirements should ensure that each scenario describes how biodiversity and ecosystem services are managed. The workshop preparations included for all case studies the selection of participants, sending invitations, and preparing documents. Post-processing of workshop results included protocol writing, scenario writing and finalization of parameter specification.

In three case studies scoping interviews were conducted with a larger group of stakeholders that helped framing and understanding the key challenges and drivers of current land use, and also building and establishing relationships. In the German case study, for example, semi-structure interviews were conducted including questions on the relevance of different ecosystem services in the case study region and the trade-offs between them; the relevance of different policy instruments as well as the design, implementation and monitoring process; the expectations towards the project and the amount of time the interview partner would be willing to contribute to the project. This first contact was helpful because the stakeholders learnt about the project, which saved valuable time during the first workshop. Moreover, stakeholders gave valuable input on the most relevant challenges in the region. This

allowed the moderators of the workshop to be prepared for the discussion since they learnt which information would be difficult to gain from participants.

The case study teams were free to choose methods to support the definition of scenarios. However, the literature offers some examples on successful procedures. Following Patel et al. (2007), a multiple-step approach for a stakeholder workshop was suggested in the protocol and more or less applied by all teams (see also Karner et al., 2019):

- 1 Present project idea and scenario demand to stakeholders.
- 2 Ask stakeholders for their functions and major concerns towards land use in the region.
- 3 Discuss and document the “Story of the present” (Patel et al., 2007), i.e. key issues that are important in the region.
- 4 Present global and EU/national level storylines with some examples. Visualized storylines would be of great help and should be developed and shared among teams.
- 5 Split stakeholders in groups to work on “stories of the future” (Patel et al., 2007), i.e. detailed land use scenarios. Designing a collage (e.g. Patel et al., 2007) or filling in existing land use maps (Pérez-Soba et al., 2015) can be visualization techniques to support this process. The world café method may be applied as alternative to separated group work: the scenarios are displayed on individual tables on posters. Small groups of stakeholders consecutively proceed to each table, review what has been written by the previous group(s), and add further comments.
- 6 Present and discuss results of the group work in the plenum. If world café is applied, a reporter for each table, e.g. a research group member, documents the process and summarizes the results in the plenum.

Within this framework, each case study team conducted its workshop. The workshop durations varied between 5 and 6 h. In some case studies this time was broken up into two workshops. Table 3 provides an overview of the resources dedicated to the scenario process. Previous experiences from participatory scenario processes show that in general,

**Table 3**  
Description of resource demand for stakeholder workshops.

Case Study	No. of work-shops	Duration (hours)	Time for preparation (person weeks)	Additional actions
Broye catchment (CH)	2	4 per workshop	6 weeks (3 per WS)	Scoping interviews Pre-workshop: Scoping interviews; Post-workshop: Preparation of stakeholder newsletters Scoping interviews Validation of results through communication with stakeholders
Mulde (DE)	1	5	5 weeks	
Kromme Rijn (NL)	2	2.5 per workshop	6 weeks (3 weeks each)	
Cega-Eresma- Adajaja (ESP)	1	6	6 weeks (3 weeks preparation, 3 weeks post-processing workshop outcomes)	
Mostviertel (AT)	1	5	8	

stakeholders have difficulties discussing futures (Patel et al., 2007), especially those which deviate much from reality and current trends. Therefore, the value choices during scenario generation should be discussed (Oteros-Rozas et al., 2015). All case study workshops used presentations, posters and maps to illustrate the tasks of the workshop, the LSP/LSH concept and to encourage discussions among stakeholders. Most relevant were posters with the parameters (see Table 2) and large format maps of the case study regions, used to indicate land use changes for each scenario during the workshops.

Based on the three EU/national level storylines, stakeholders developed three scenarios including qualitative and quantitative parameters for each case study – partly spatially explicit – to cover a broad range of plausible future land uses. Stakeholders in all case studies agreed on one of the three scenarios to represent the BAU scenario. This helped to classify the region along a LSH-LSP gradient. After the workshop the case study teams drafted narratives and tables for each scenario and reported these back to the stakeholders for further written comments. These scenarios and especially the specified parameters – see Karner et al. (2019) for further details – were than used for trade-off analyses, e.g. in optimization models (Verhagen et al., 2018).

#### 4. Discussion: lessons learnt

##### 4.1. Knowledge gains on LSP and LSH perspectives

LSP may be scale-independent by definition (Merckx and Pereira, 2015) but many discussions in the literature are about implementation at large regional scales. It means the intensification of productive agricultural land in favourable climatic zones to free large land resources for nature conservation elsewhere, eventually on other continents. Alternatively, LSP may be achieved at small spatial scales as well, for example, by introducing patches of natural vegetation in an agricultural landscape. Stakeholders responded strongly to the idea of implementing LSP at the regional scale which led to vivid discussions on the bio-physical prerequisites for intensification, the spatial distribution of intensified and spared land, the limits for intensification particularly under strict European legislation, the options from new technologies such as precision farming but finally also the impacts from a LSH strategy on the provision of ecosystem services.

It became obvious that any region tends towards one of the two extreme LSH or LSP land use strategies, although most stakeholders considered their own region as rather balanced. The tendencies in the case studies are a result of the top down approach chosen for these scenario processes to become comparable. If stakeholders would have been free to choose the extremes themselves, scenarios would have probably looked differently and would likely follow a more case study specific logic (e.g. based on cultural and geomorphological conditions).

Despite the rather structured approach, the information received through the workshops was extensive. Opening questions such as “what are key challenges for the region in the future” allowed all participants to contribute valuable information about the case study area. Land-use and management details as well as strength and weaknesses of regional ecosystem services provision could be identified. The discussion on defining data for parameter provided additional insights into the conditions in the case study region.

##### 4.2. Added value of stakeholder participation

A mutually beneficial stakeholder engagement requires a purposeful recruitment of stakeholders: “It needs to be clear what role(s) stakeholders could play, what they could contribute and how this could be organised. At any stage of the project mutual expectations need to be made clear, including considerations of costs (e.g. time, effort) and benefits (e.g. influence, access to results)” (Jolibert and Wesselink, 2012: 108). This is a major prerequisite to prevent stakeholder fatigue, i.e. disappointment and disengagement (see, for example, Curtis et al.,

2014; Durham et al., 2014). However, in many research calls stakeholder contributions are demanded by definition ignoring constraints from research issues, budget and skills of researchers.

Our approach aimed at a win-win situation for the research teams who were interested in deriving scenarios and learn more about the case study area but also for the participants to get to know other stakeholders, exchange knowledge, get an opportunity to advertise for burning research questions but also take new information back home. The process evaluation after the case study workshops show that the majority of the participants regarded the workshops as useful for their daily work. More than 85% of stakeholders reported that they were satisfied after the scenario development in each case study (34 out of 38). The reasons mentioned for the usefulness were mainly new information (e.g. on the case study region) and the networking opportunity. Processes like these allow stakeholders to abstract from their daily businesses and to turn to more strategic thinking. From the researchers' perspective, stakeholders provided very useful information for models and overall knowledge about the study area and learnt themselves about facts and issues related to ongoing land use dynamics.

To summarize, the specific design of the participatory scenario process led to vivid discussions on the LSP/LSH approach, created common visions, coproduced knowledge, and fostered information exchange between different stakeholders, which largely confirms findings of other authors (e.g. Palomo et al., 2011). However, the outcome of such a process may be biased towards researchers' initial ideas. The trade-off is between innovation, efficiency and openness.

#### 4.3. Operationalizing the LSH/LSP concept

Transforming the LSH/LSP concept into practical changes of land use and management proved to be very challenging, especially because of the complexity of the concept of LSH/LSP where scales matter a lot (see discussion in Section 4.1). In all workshops, for example, moderators had difficulties to explain the concept of LSP and LSH, because the level of abstraction was too high for many practitioners. Experiences from the case study workshops showed that a stepwise procedure for quantifying changes in land use categories for each scenario separately can be recommended. For example, urban land as straight forward category can be chosen as starting point. After making clear that loss of arable land is only due to urbanization in the region, land use changes for arable land can be derived more easily and with greater comparability. An alternative approach that also proved to be very successful for operationalizing the LSH/LSP concept was to identify particular options of change, attributable to either LSH, LSP or LBA during the open discussion part and to quantify and allocate these options in accordance with the presented background information (i.e. maps) on spatial characteristics during the structured discussion.

While SSPs provide general descriptions of alternative futures, sectorial specifications are necessary and under way such as in the case of agriculture (Mitter et al., 2019). We used SSP2 as background information to frame the development of focused EU/national storylines. SSP2 has not been downscaled to the continental or national level as presented in Kok et al. (2019) but enriched with sectorial information on drivers of LSH/LSP processes and developments. This did not include a full representation of agricultural sector developments such as pursued by the Eur-Agri-SSP initiative (Mitter et al., 2019). Ensuring consistency when linking different scales and scopes (i.e. general economy vs. sector specific changes) is a major challenge (Popp et al., 2017), which can be confirmed by the experiences of the scenario process presented in this paper.

The choice of a single global storyline (i.e. SSP2) to frame the EU/national level storylines was at the cost of storyline richness but turned out to be necessary. The SSPs provide a range of "plausible" (O'Neill et al., 2017, p.170) but fundamental changes of current socio-economic systems. We could not utilize this diversity to cover uncertainties of global conditions in our scenario process. Another contrasting global

storyline would have doubled the number of land use scenarios in each case study region, while most case studies had challenges already to define three scenarios. They are spatially explicit and rich in management detail (see Karner et al., 2019), which requires considerable time resources during the stakeholder workshops. Since this study focusses on LSH/LSP, the research team acknowledged this trade-off and considered the choice of a single storyline, and more precisely SSP2, reasonable. The most relevant factors for LSH/LSP processes, such as agri-environmental and nature protection policies, consumption trends, farm structure, or technological developments are not constrained by SSP2 and consequently are plausible within this single storyline. The advisory board members confirmed this choice. Although contrasting, the EU/national level storylines emerge from the same policy targets, i.e. to support biodiversity while balancing ecosystem services. The stakeholders did neither challenge the choice of SSP2. On the contrary, some stakeholders even criticised the three EU/national level storylines for their seemingly extreme positions, although they are trend prolongations in one or the other way and, hence, less extreme than any of the SSP alternatives.

Nevertheless, it remains unclear how the scenario process would have emerged with alternative sets of global storylines – a methodological research question for subsequent studies. Furthermore, a revised process would certainly take recent scientific achievements in extending SSPs to the European level (Kok et al., 2019) and to the European agricultural sector (Mitter et al., 2019) into account.

#### 4.4. Comparability of LSH and LSP scenario

The links between scenarios across scales can be of different intensity, e.g. hard links, soft links or no links at all (Zurek and Henrichs, 2007). "Comparability" of scenarios belongs to the group of soft links as they "address the same focal issue" but can lead to very different scenarios (Zurek and Henrichs, 2007: 1289). The protocol-based procedure and common drivers of LSH/LSP at EU/national level limited the options of stakeholders in defining their own visions on future land use and reduced their flexibility when thinking about national to regional-level policies to achieve a particular land use. To solve the trade-off between comparability and flexibility, the EU/national-level storylines describe major socio-economic trends only qualitatively and are not specific to regional land uses and land use policies to maintain flexibility for stakeholders.

Nevertheless, it was partly criticized in the workshops. For example, stakeholders argued that scenarios were too theoretical and disconnected from the actual context (e.g. too extreme). However, for the purpose of deriving comparable scenarios in a research project, the methodological design was appropriate. For a project aiming at education and information or strategic planning and decision support, process and linkage would likely have to be different (Zurek and Henrichs, 2007).

#### 4.5. Request for specific parameter data

There is a clear trade-off between narratives and quantitative scenario information: Narratives offer texture, richness and insight, while quantitative analysis offers structure, discipline and rigor (Nakicenovic et al., 2005). For creating maps and modelling optimal land use in the follow-up process of TALE, quantitative information was required and requested in form of parameters. For some parameters data could be gained quite easily, e.g. changes in urban area could be allocated, however, the allocation of changes for all parameters turned out to be much more challenging and for some only qualitative information was gathered through discussions and expert assumptions applied for its quantification (see also Karner et al., 2019). However, according to the EEA (2007: 60), the benefits of triggering strategic conversations and learning processes among scientist and stakeholders during the scenario development process can outweigh the problems of quantification.

Some of the information requested from stakeholders required a high level of knowledge about the local context, which was not available among the group of stakeholders in each case study. Detailed spatially explicit background information (e.g. maps, land use statistics) turned out to be helpful to support participants in such a situation. Still, specifying all parameters and especially the level of change remained challenging. Some stakeholders were reluctant to envision changes of parameters. Some just did not know and tried to avoid wild guesses, while others seemed to be afraid that research results may influence agricultural policies and lead to the introduction of new regulations that may constrain regional land use in the future.

## 5. Conclusion

In this paper, we present an approach for operationalising the LSP/LSH concept for the development of local/regional land use scenarios to answer the question “How to derive comparative quantitative scenarios taking into account LSP and LSH in European landscapes?” The choice of an existing global storyline, i.e. SSP2, and the design of common narratives, i.e. EU/national level storylines, to be used by all five case studies, was the first step towards the translation of LSP and LSH. This allowed the case studies to define their own scenarios which were comparable with those of other case studies. To improve the stakeholder integration into participatory scenario development on LSH and LSP stakeholders became engaged in an early stage of the process (see also [Chakraborty, 2011](#)), such as through interviews. It was important to be precise and explicit with the aim of the scenario process and the definitions of the concepts during the workshop. Providing visualisation material such as posters and giving time for a discussion on the LSH and LSP strategies were the cornerstones to guarantee that participants reach a common understanding first about the LSP and LSH concept and later on the scenarios.

The key question for future research remains “How much standardization for scenario development is needed, how much freedom required”? At the end, the degree of standardisation always depends on the aim of the scenario process as highlighted by [Zurek and Henrichs \(2007\)](#). We used a set of standardized drivers and also standardized the workshop process because we aimed at the comparability of the case studies, which was finally achieved (see [Karner et al., 2019](#)).

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## Appendix A

### *Annex I: EU/national level storylines in TALE*

#### *Storyline for a balanced land use strategy (i.e. BAU)*

The EU Common Agricultural Policy (CAP) in the early 2020s does not show major shifts in the principles of EU funding and policies. Since the 1990s, the CAP has gradually shifted towards environmental protection and extensive land use via horizontal measures, such as agri-environmental policies established in all member states, less-favored area payments to maintain farming in remote areas and on marginal land, as well as the decoupling of direct payment from production, coupling to cross compliance and finally to greening. EU member states

maintained further extensification policies. For example, environmental legislation such as the Nitrate Action Programs limited fertilization. However, considerable spatial heterogeneity remained among European regions. There were marginal areas with high shares of high-nature-value farmland on the one side and highly productive intensive arable and livestock production regions on the other. In those regions, agri-environmental programs could not compete with forgone market incomes. Funding of agricultural technological development in these decades was at rather low levels.

With the 2020 CAP reform lasting until 2030, the CAP follows these historical pathways. There is slow market liberalization within the EU following the rational of ceased quota systems for milk and sugar. However, market interventions – so called security nets for farmers – are provided during phases of low market prices such as experienced in 2016 for milk. This is made possible by unchanged international trade rules. While increasing globalization stimulates international trade of agricultural products gradually, no fundamental changes in trade flows are observed. The CAP budget is slightly increasing in nominal terms but decreasing in real terms. This is justified by ongoing though moderate structural change in agriculture, moderate price increases, and technological development. The latter improves productivity of inputs slightly showing a moderate trend towards “sustainable intensification”. Greening as prerequisite for 1st pillar direct payments is an established policy instrument for nature protection. Other environmental and nature protection policies further increase protection of threatened ecosystems and aquatic systems. However, this is achieved by a better enforcement of policies already implemented in 2016 and better training by farmers. Natura 2000 is fully implemented due to pressures of environmental NGOs and lead to gradual improvements of ecosystems. With respect to the WFD, progress is made to improve the status of water bodies through the full implementation of program measures, but improvements are rather slow. With respect to agricultural water demand, no particular changes occur compared to the past, which leads to increasing competition for water mainly in arid and semi-arid regions. These improvements in law enforcement may reduce rates of biodiversity loss but likely cannot reverse trends. There is limited targeting of these policies towards environmental hot-spot areas across European regions such as observed in the past. Agri-environmental programs are insignificantly expanding in some member states at the cost of pillar one payments, which are at insignificantly lower levels than in 2016. People continue to settle more likely within and around major cities as it has been observed in the past. A higher real income of the population increases environmental concerns of consumers and fuels demand for leisure activities in rural areas. Consequently, demand for organic products increases but at lower growth rates than observed around 2016, while food demand in general, such as for livestock products, follows past trends.

#### *Storyline for a land sparing land use strategy*

While increasing globalization stimulates international trade of agricultural products gradually, no fundamental changes in trade flows are observed and world agricultural output and input prices develop moderately. The up-coming reform of the EU Common Agricultural Policy (CAP) in the early 2020s leads to a major shift in EU's funding and policy principles. The CAP re-orientates itself towards its early years, where stimulation of production to achieve self-sufficiency in food has been a major policy objective. Early signs of this re-orientation has been the abolition of quotas for milk and sugar. However, these days, the former objective of food-sufficiency is replaced by the EU's aim to reduce burden on public budgets from agricultural spending and to increase its contribution to global food security. Food security is still challenged by a growing population shifting its food demand increasingly towards livestock based products. Policies follow the critique by societal groups that the EU is maintaining a comparably high level of environmental protection at the cost of other major food importing countries. The EU is keen to avoid former failures in agricultural land

use. However, where high agro-chemical inputs created substantial environmental burden, the new strategy follows what is known as “sustainable intensification”. Such strategy is based on a highly productive agricultural land use in areas with fertile soils, mild climates, or sufficient irrigation water. A reform of environmental legislation with better targeting towards environmental hot-spot areas and adapted emission thresholds increases competitiveness of these highly productive zones. Consequently, they no longer need substantial income support from pillar 1. Field consolidation further increases productivity, planting of new crops and varieties, eventually including genetically modified organisms, and agro-technologies such as precision farming help to limit the environmental burden. This is financed by shifting funds from the 1st pillar direct payment system. Technological, structural and funding changes further stimulate structural change in agriculture. Therefore, the EU and member states invest in technological development and technology diffusion. Pressure on abiotic environmental resources is moderate, but some conflicts are inevitable. For example, high irrigation water demand in the productive regions may increase competition for water. With respect to biodiversity, further declines in habitat quality and species richness are likely in those landscapes, particularly as the 1st pillar greening measure no longer is effective. However, the EU member states are aware that biodiversity losses can have significant impacts on human well-being. Therefore, intensification is compensated by the set-aside and re-wilding of former less productive farmland. To maintain biodiversity levels within the regions, marginal areas within each region are taken out of production for re-wilding to achieve what is considered as land sparing strategy. This is achieved by ceasing less-favoured area payments and increasing conservation payments. Agri-environmental payments become more targeted towards environmental hotspot regions with high cost-benefit ratios. Its measures support nature protection rather than extensive production systems, such as organic farming. Consumers, which are mainly located in urban centers, are increasingly aware of international environmental pressures from land use and favor EU products even if they are from GMO origin. However, consumption of organic food and regional products does not increase due to an increasing awareness of the need of highly efficient production systems with high land productivity. General food demand patterns, such as for livestock products, follow past trends. The demand of city dwellers for outdoor activities in the country side is concentrated to experience wildlife mainly in forests and natural grasslands. Other leisure activities require parks within or around cities because the intensive agricultural production landscape is of limited recreational value to them. However, some holiday resorts emerge, where farmers are paid to maintain what is considered a historic farming style.

#### *Storyline for a land sharing land use strategy*

While increasing globalization stimulates international trade of agricultural products gradually, no fundamental changes in trade flows are observed and world agricultural output and input prices develop moderately. The up-coming reform of the EU Common Agricultural Policy (CAP) in the early 2020s, however, leads to a major shift in its funding and policy principles towards broad-scale nature and environmental protection. It acknowledges major international obligations on its territory with respect to biodiversity maintenance, water or climate protection. There is a clear objective to improve ecosystems all over its territory but particularly in regions with high environmental pressures from agriculture. Sharing land for environmental protection and agricultural production is fully implemented at EU and member states level. It is achieved by a mix of policies including tighter and better enforced nutrient thresholds for nitrogen and phosphorus, ammonia and greenhouse gas limitations for agricultural production, and expanding nature protection areas under agricultural use. With respect to the latter, the public perceives environmentally friendly farming as preferred way towards nature protection with little ambitions towards further national parks. Direct payments from pillar one remain at

constant nominal terms compared to 2016, but greening and cross compliance requirements are tightened. For example, highly intensive livestock regions need to reduce livestock numbers to meet those policies. Irrigated water is constrained to limit water stress of aquatic ecosystems, which may lead to changes in crop rotations. While there are some technologies available towards “sustainable intensification”, the public considers a reduction in levels of agricultural inputs as pivotal. To limit financial disadvantages for farmers, budgets for agri-environmental programs are increased. Consequently, agricultural production is maintained in most European regions. As in the past, less favored area payments support rural development as one of the major CAP objectives. Marginal areas are supported to maintain its extensive production. It shall protect high nature value farmland while at the same time utilizing the biomass production potential of these areas. Technological progress is rather low due to limited public means and private farmer demand. The strong financial support – its total nominal value is above funding levels in 2016 – combined with moderate productivity growth in agriculture moderates structural change as well. As a consequence of European wide extensification of production, EU food and feed imports further increase and reduce EUs self-sufficiency rates. To better balance production and consumption and to ease further pressures on global agricultural markets however, policies are in place that impact dietary patterns of European citizens towards lower consumption rates. The ongoing trend in reduced consumption of livestock based products is fueled particularly. Consumers acknowledge the value of environmentally friendly production and increasingly demand regional and organic produce. There is a declining trend of urbanization with some re-settlements in rural areas due to the increasing value of cultural landscapes and stronger orientation towards sustainable lifestyles in harmony with nature. This significantly increases the demand for leisure activities in agricultural landscapes.

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