Towards multifunctional agricultural landscapes in Europe: Assessing and governing synergies between food production, biodiversity, and ecosystem services – TALE

Guidelines on the scenario definition process in TALE

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Guidelines on the scenario definition process in TALE

Content

1. Introduction / Background / Executive Summary

The TALE project shall analyze the pressure on natural resources that increases due to multiple competing demands for land. The resulting demand driven land use changes come at a cost in the form of trade-offs between food or bioenergy production, biodiversity conservation and other ecosystem services (ESS) like clean water, erosion control or soil fertility. By assessing and governing synergies between food production, biodiversity and ecosystem services, TALE will develop related strategies. Across Europe countries differ regionally with respect to biodiversity, landscape structure, structure of the agricultural sector, conflicts regarding the provision of ESS (e.g. production vs. soil protection or water provision) and with regard to preferences for particular ESS (e.g. provisioning vs. regulating or cultural services). Integrated approaches are required that cover a representative range of ESS over contrasting case study landscapes. Within TALE the ESSs are defined by a set of common indicators to be quantified in each case study region. By providing regional indicator assessments, TALE enhances the knowledge base on ESS provision across Europe. Common methods and tools are applied to allow for comparability and to enable the transferability of case study results and related implications to other regions in Europe.

Scenarios fulfil important roles in the TALE project. This report provides guidance on the scenario definition process for the overall TALE team and the case study research teams. It shall guarantee that scenario definition serves the TALE as well as case study research objectives. The aligned process among the case studies improves comparability of results at the TALE project level and consideration of global storylines improves comparability with the scientific literature. These guidelines are the result of intense discussions among TALE researchers. The process is documented by the following files (date):

- Questions on stakeholders and scenarios_151215_v2.docx (15.12.2015)
- TALE_Scenario_Overview.docx (28.1.2016)
- TALE_Scenario_Overview_V2.docx (26.2.2016)
- WP3_skype conf_minutes_160222_fin.docx (22.2.2016)
- TALE_Scenario_Overview_V3.docx (14.3.2016)
- WP3_skype conf_minutes_160314.docx (14.3.2016)
- Vienna Workshop protocol (25.4.2016)
- WP3_skype_conf_minutes_160706_fin.dox (13.7.2016)
- WP3_skype_conf_minutes_160804_final.dox (16.8.2016)
- WP3_skype_conf_minutes_160928_final.dox (9.11.2016)
- Feedback on storylines by ABM_161122_final.docx (22.11.2016)

This report is structured as follows: Chapter 2 presents definitions of major terms and the role and objectives of scenarios in TALE. Chapter 3 describes the scenario definition process and Chapter 4 elaborates storylines. Chapter 5 provides some general conclusions.

2. Scenario objectives and definitions in TALE

The TALE project proposal highlights several overall objectives and guiding principles of land use scenarios in TALE:

- Scenarios support models to reveal synergies and trade-offs between different ESS and biodiversity.
- Participatory scenarios including stakeholder perceptions are developed for each case study, which are used to support multi-objective trade-off evaluation.
- The scenarios in TALE will follow common underlying assumptions.
- The scenarios are aligned with other European research projects to enhance comparability and utilize synergies.
- At least three policy and land use scenarios shall describe contrasting development pathways under either land sharing or land sparing or in balancing both strategies (e.g. farm-level land sharing, local sharing and regional land sparing).

More precisely, the land use scenarios fulfill four particular roles in the methodological framework of TALE:

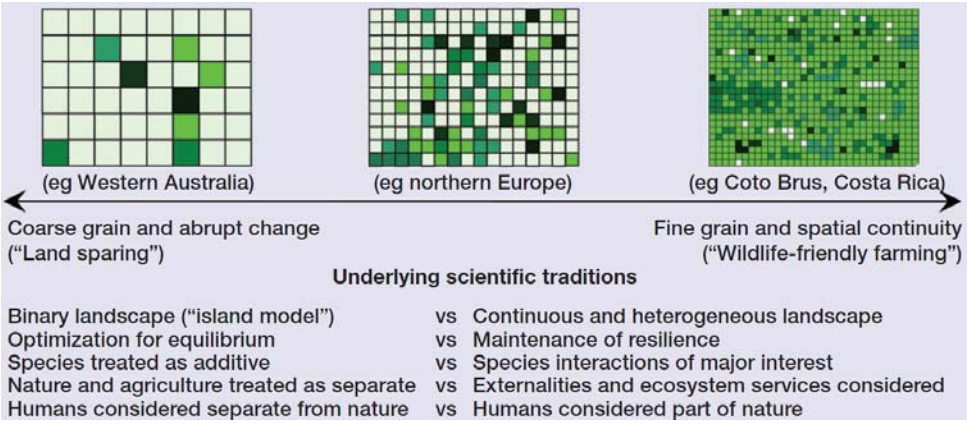
- Scenarios frame modelling in WP2 by determining values for input parameters to the quantitative models.
- Scenarios limit the solution space in WP4 by defining the constraints for the UFZ multi-objective evolutionary algorithm MEA.
- Scenarios provide a tool for stakeholders in the case studies to develop visions on alternative states of future land use.
- Scenarios are a corner stone for policy recommendations in the case study areas, although policy discussions of stakeholders may go beyond regional policies.

Scenarios in TALE describe case study specific alternative states of future land use and its corresponding framework conditions (i.e. land use drivers). They shall be related to both one common global storyline (middle of the road -MOR) and four common EU/national-level storylines but are adapted to local circumstances by stakeholders and the case study research team. Stakeholders develop the four scenarios including qualitative and quantitative parameters to cover a broad range of plausible future land uses along a business as usual situation and three land use strategies, i.e. land sharing, land sparing and a balanced land use strategy.

A *storyline* is a qualitative description (i.e. narrative) of future developments on major global to continental framework conditions. With respect to the agricultural sector, it includes 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, Habitats directive. Quantitative parameters may be included in the storyline description. These framework conditions and parameters are major drivers of land use. TALE will develop one global and four EU/national-level storylines. All EU/national-level storylines will be consistent with the global storyline.

The *Business as Usual* (BAU) situation consists of both an EU/national-level storyline (BAU-st) and one land use scenario (BAU-sc) in each case study region. It captures a future situation, e.g. with respect to policies or market conditions, that prolongs the current situation. If obvious, it can also include current trends.

Land sharing (LSH) and *land sparing* (LSP) refer to opposing land use strategies (Green et al., 2005). LSH is frequently referred to as "wildlife friendly farming", where both nature protection and agricultural land use are maintained at the same plot, e.g. by extensive production methods, or within the same region by including or maintaining semi-natural landscape elements (e.g. hedges) along with agricultural fields. LSP separates agricultural production from nature protection. Intensification of land use on agricultural land shall increase yields, which would reduce conversion of natural habitats and eventually free land for dedicated nature protection (Green et al., 2005). Fischer et al. (2008) provide an overview on concepts and assumptions around both strategies (Figure 1). It becomes obvious that both strategies are at the opposing end of a range of arguments. The third *balanced land use strategy* (LBA) in TALE combines LSH and LSP to eventually manage trade-offs between both extremes. The EU/national-level storylines take these three land use strategies into account.



Note: *"Conceptual model of the continuum of scales at which biodiversity conservation and agriculture can be integrated. Land sparing and wildlife-friendly farming can be considered endpoints on this continuum. The shade of green denotes the value of a given grid cell for biodiversity conservation, with darker shades representing greater value. Different scientific traditions underlie the endpoints of the continuum. These traditions influence how the task of balancing biodiversity and agriculture is conceptualized and accomplished, but they are rarely drawn out explicitly."* Fischer et al. (2008 p. 381).

Source: Fischer et al. (2008 p. 381)

Figure 1: Comparison of land sharing and land sparing

A definition of land sharing and land sparing has to be clear on spatial scales. Land sharing and sparing can be considered i) from a large spatial scale where large regions at national to continental or global level follow a joint strategy – e.g. some regions spare land, some eventually on other continents produce more intensely or all share, i.e. balance production and nature protection. It can also be considered ii) from a small scale perspective where sparing and production is achieved within the same region. In TALE option i) would mean that a case study region as a whole in a sparing strategy would either produce or spare land for nature

conservation. With option ii), land use in a TALE case study region would be defined at landscape or even field level. Due to the systems boundaries in TALE, we opt for ii).

The time frame of the TALE storylines and land use scenarios is 2030.

3. Scenario definition process

3.1 Process overview

Figure 2 summarizes the scenario definition process in TALE (see also Chapter 4.3 on scenario definition in the report "Guidelines on the stakeholder process in TALE"). The subsequent description from Chapter 3.1 onwards explains each blue box in Figure 2.

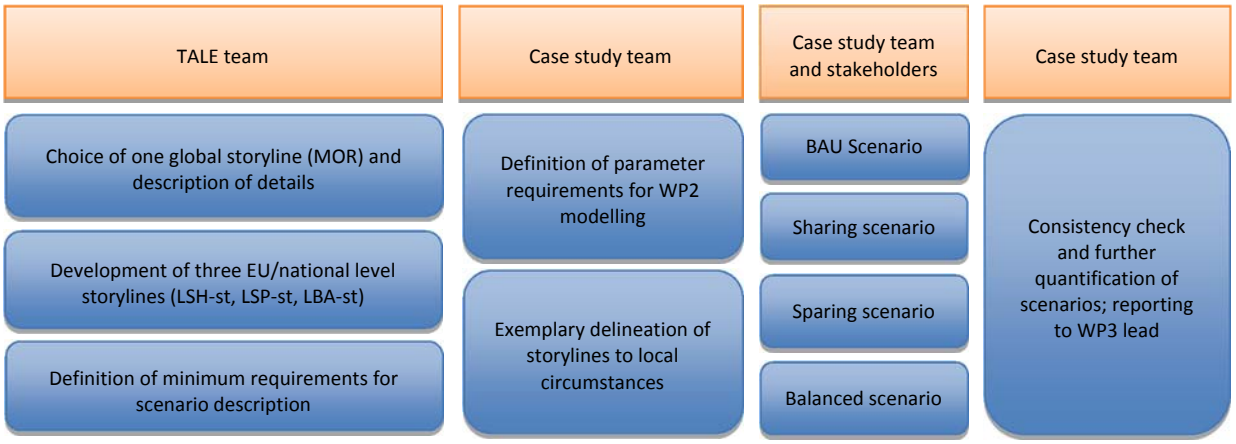


Figure 2: Working steps (blue) and responsibilities (orange) of the scenario definition process in TALE.

Both the process and results of the scenario definition process in TALE follow a clear hierarchical order with respect to spatial scales and working steps. This is depicted in Figure 3: the case study level scenarios have to be designed subsequently to the definition of global and EU/national level storylines and have to be fully consistent with both. Consequently, the EU/national storylines have to be consistent with the global storyline as well.

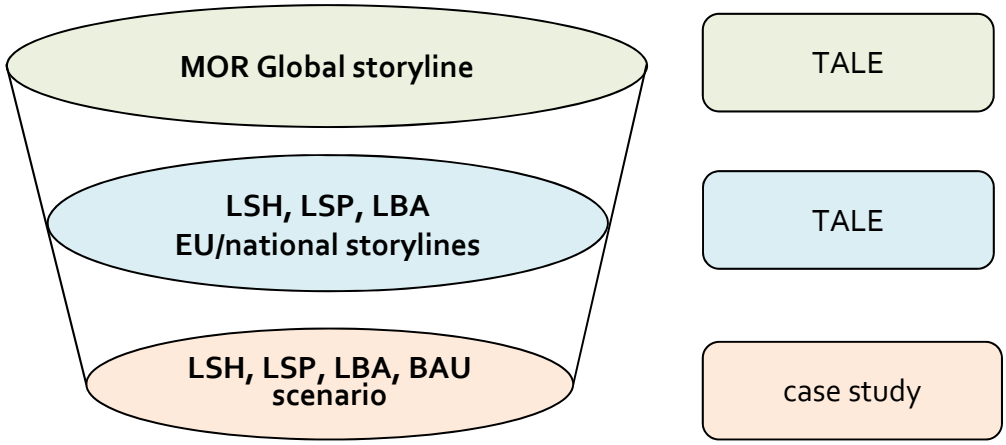


Figure 3: Hierarchical order of storylines and scenarios in TALE.

3.2 Choice of a global storyline

The TALE team chooses one existing global storyline (e.g. MEA, SSPs, SRES) to ensure that TALE results are comparable to other land use change and ecosystem service studies (for arguments in favor of this step, see Seppelt et al. (2013)). The chosen storyline should represent an average future situation based on current trend observations and should include details on global parameters (i.e. land use drivers) such as:

- GDP growth and energy prices
- population growth and change in consumption patterns
- R&D investments and technological change
- global land use change
- global trade
- global climate policies.

Most TALE case studies do not consider climate change explicitly. However, this does not mean that the scenarios shall neglect climate change. In TALE, we assume moderate climate change consistent with the COP21 agreements, i.e. RCP 2.6. Details on the global storyline are presented in Chapter 4.1.

3.3 Definition of EU-level storylines

Three EU/national-level storylines will be defined by the TALE team to support the definition of case study specific land use scenarios. Consequently, BAU will be attributed to one of the three contrasting land use strategies, i.e. LSH, LSP, or LBA. The TALE team provides draft storylines, which are discussed with TALE advisory board members to improve consistency with the global storyline and EU policy and land use developments. An online tool (e.g. google docs) will be developed to facilitate the definition process and the advisory board members will receive questions to describe their duties in the process. This step can help to legitimate the storylines towards stakeholders.

EU/national-level storylines include three storylines on diverging land use strategies, i.e. land sharing (LSH-st), land sparing (LSP-st) and a balanced land use strategy (LBA-st). All EU/national-level storylines will be consistent with the global storyline MOR. They will have in common many parameters (i.e. land use drivers) but will, however, deviate with respect to a qualitative description of policies and/or market mechanisms that support either LSH-st, LSP-st, or LBA-st. BAU-st is a trend extrapolation of current EU land use drivers. It will be attributed to one of the three land use strategies. Major parameters (i.e. land use drivers) to be described at EU/national-level can be:

- Common Agricultural Policy (CAP, e.g. direct payments, less-favored area payments, agri-environmental payments)
- Environmental policies (e.g. Water Framework Directive (WFD), Habitats Directive)
- Consumption patterns towards either regionally or globally marketed products, organic products and animal products

The FAS (factors-actors-sectors) framework presented in Kok et al. (2006) may be helpful to structure the storyline definition process. “The factors, actors and sectors represent a pre-selected number of themes; individuals and groups; and social and economic sectors chosen to help structure and provide focus to the scenario development process.” (Kok et al., 2006 p.

295). To adopt this framework, the TALE team would have to define key factors, actors, and sectors at EU/national level. The list of FAS arguments should repeat and eventually extend 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 sub-sequent studies has been developed in the MedAction Project (e.g. Kok et al., 2006; Patel et al., 2007). In this project, the pre-defined large scale scenarios for the Mediterranean region intended to stimulate stakeholders' imagination without restricting their thoughts (Patel et al., 2007).

A major advantage of common EU/national-level storylines in TALE is to increase consistency among the case studies, to reduce work load of case study research teams and to improve communication of land sharing, sparing, and balanced land use strategies to stakeholders. However, it may also limit the options of stakeholders in defining their visions on future land use and may reduce their flexibility when thinking about national to regional-level policies to achieve a particular land use. To solve this trade-off, the EU/national-level storylines will end up in qualitative descriptions of major policy trends and will give some examples of policies to be implemented in each of the three land use strategies. However it will not provide much details on policies.

Details on the EU/national-level storylines are presented in Chapter 4.2.

3.4 TALE scenario definition standards

The TALE team agrees on minimum requirements for the definition of scenarios in the case studies. It includes the parameters to be defined, their level of spatial and temporal detail, and whether they should be quantified or qualitatively described. This step shall assure that scenarios are comparable among the case studies. Examples of minimum requirements can 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 shall ensure that each scenario describes how biodiversity and ecosystem services are managed.

Details on the definition of minimum requirements to describe the scenarios are presented in Chapter 4.3.

3.5 Case study scenario definition standard

Each case study team has to define its demand on scenario parameters beyond the minimum requirements (see Chapter 3.4) required for modelling in WP2 and WP4. It is case study specific because WP2 models have unique input data and parameter requirements. No further specifications will be provided here.

3.6 Tools for the interpretation of storylines

Stakeholders may encounter difficulties in interpreting the global and EU/national-level storylines. Each case study team has to delineate the storylines from a case study perspective, e.g. by developing examples on how certain land use drivers may trigger land use change in the region. This step should assure that stakeholders fully understand the meaning of LSH-st,

LSP-st, and LBA-st. Shared material and experiences among the case study teams could facilitate this step.

3.7 Development of the BAU scenario

The case study team and the stakeholders will interpret the storyline of the land use strategy attributed to BAU at case study level and will describe its land use impacts. Stakeholders may be asked: ”Consider the policies, markets, etc. defined by the storyline. Which implications may this have on land use in your region concerning *Z*?”. *Z* is a variable for all minimum and additional requirements (see Chapter 3.4 and 3.5) required to define the case study specific BAU land use scenario (BAU-sc). The case study team may want to attract attention to current land use trends to support stakeholders in interpreting future land use based on the selected storyline. MOR is of limited importance in this process. Its major role is in providing a framework to define LSH-st, LSP-st, and LBA-st.

This process will result in one case study specific BAU-sc. The description takes account of at least the minimum requirements (see Chapter 3.4).

The case study teams are free to choose methods to support the definition of scenarios. The literature offers some examples on successful procedures. A multiple-step approach embedded in a stakeholder workshop may be the following based on Patel et al. (2007) :

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 p. 554), i.e. key issues that are important in the region.
4. Present global and EU/national level storylines with some examples (see chapter 3.5). Visualized storylines would be of great help and should be developed/shared at TALE level.
5. Split stakeholders in groups to work on “stories of the future” (Patel et al., 2007 p. 554), 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 is already there – i.e. written on the poster 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.

Steps 4 to 6 are part of a forecasting approach according to Patel et al. (2007). The FAS framework may be helpful also to structure the scenario definition process. To adopt this framework, the TALE team would have to define key factors, actors, and sectors relevant to land use in the case study regions. Stakeholders would be asked to extend the list and specify how the individual arguments impact land use.

3.8 Development of land sharing, sparing and balanced scenarios

The case study team and stakeholders decide, whether one of the three land use strategies is represented by BAU-sc. If so, the case study team will develop at least two further scenarios, i.e. either LSH-sc, LSP-sc, or LBA-sc If BAU-sc at the case study level appears to be different from LSH-sc, LSP-sc, or LBA-sc, three additional scenarios are to be defined to represent a sharing, sparing, and balanced land use strategy. The reason for eventually diverging numbers of storylines (i.e. three) and scenarios (i.e. either three or four at minimum) is that EU/national level storylines can be interpreted differently at case study level. It is reflected by regionally heterogeneous land use outcomes despite a unique CAP.

Questions to stakeholders are similar to those in Chapter 3.7. However, stakeholders may encounter more difficulties in interpreting opposing and eventually rather extreme policy alternatives. The case study teams cannot expect to have examples for each land use strategy readily available in the region. However, current regional land use may be attributed to one of the three land use strategies to give an example. Further examples may be taken from other European regions (e.g. intensive production regions in parts of coastal Germany or the Italian Po valley vs. extensive production in some alpine regions).

LSH-sc, LSP-sc, and LBA-sc will be described in the same way, i.e. based on the requirements to be defined (see Chapters 3.4 and 3.5). It ensures that all scenarios within the case study region and among the case study regions are comparable.

3.9 Specification of land use drivers

Subsequent to the scenario definition, stakeholders will reflect on EU, national or regional level land use drivers that may be necessary to achieve LSH-sc, LSP-sc, and LBA-sc. Basically, this is what Patel et al. (2007 p. 555) describe as back-casting approach. Whether or not this step is useful depends on the level of detail given by any EU/national-level storyline, i.e. LSH-st, LSP-st, and LBA-st. However, stakeholders can at least reflect on national to regional land use drivers, which will not be represented by EU/national level storylines. Stakeholders may be asked: “Which land use drivers do you think are necessary to achieve the previously defined land use?”. Options for drivers include regional policies, market conditions, civil society engagement, etc..

3.10 Scenario review and reporting

In a final step the case study team reviews all land use scenarios. It may quantify parameters if descriptions are qualitative and cannot be immediately used in WP2 or WP4. The case study team may also add parameters if minimum requirements from a TALE perspective are not met because not all information has been provided by stakeholders (see Chapter 3.4). The case study team checks the consistency of each scenario not only with the minimum requirements but also with MOR, LSH-st, LSP-st, LBA-st, and BAU-st. Further stakeholder interaction may be necessary to improve consistency. The TALE case study team reports the final scenarios to the WP3 lead by February 2017. Reporting will follow a unique procedure among all case study teams to ensure comparability (see Annex 1).

4. Details on the scenario process

This chapter provides details on those steps of the scenario definition process, which are coordinated by the TALE team. It includes the development of storylines and minimum requirements with respect to the definition of case study specific scenarios.

4.1 The global storyline

The TALE team has agreed on the SSP 2 storyline "middle of the road" to represent the global storyline MOR. It represents a middle of the road situation of global development in the coming decades (see Figure 4).

Figure 4: Five shared socioeconomic pathways (SSPs) representing different combinations of challenges to mitigation and adaptation to climate change (O'Neill et al., 2015 p. 2).

Shared Socio-Economic Pathways (SSPs) are part of the current IPCC climate change assessment system. They more or less replace the SRES storylines. SSPs consist of "*…a parsimonious narrative capturing the key dimensions of the underlying global scale socio-economic development and a collection of quantitative projections for global socio-economic boundary conditions.*" (Kriegler et al., 2012 p. 808). This includes the major advantage of the SSP system: it will be of great importance in the coming years. Linkages to representative concentration pathways (RCPs) and global climate model simulations (e.g. results from the Climate Model Intercomparison Project CMIP 5) are easy to achieve. Furthermore, a range of quantified scenario parameters has been made available (see the IIASA SSP Database). SSPs are available at global to continental scales and describe major socio-economic situations. A major disadvantage of SSPs for TALE may be the missing link of some case studies to climate change research and a limited focus on biodiversity and ecosystem services. It may become difficult to define land sharing/sparing alternatives within these scenarios. However, O'Neill et al. (2015 p. 2) indirectly respond to this critique by stating that "*… the SSPs can also be useful in other contexts relating more broadly to sustainable development. This is due to the fact that socio-economic challenges to mitigation and adaptation are closely linked to different degrees of socioeconomic development and sustainability…*". The authors further show how the SSPs can be mapped along economic and social sustainability criteria.

Each SSP is described by a storyline and quantitative parameters. The storyline on SSP 2: Middle of the Road is presented in Box 1. Box 2 presents a land use specific storyline, which have been a prerequisite to quantify land use impacts from the SSPs in integrated assessment models (Popp et al., 2016). Quantitative parameters are available from the SSP Database (https://tntcat.iiasa.ac.at/SspDb/dsd?Action=htmlpage&page=about) at country group level and for a range of socio-economic and land use indicators (for examples see Figure 5). Table 1 presents those parameters that are readily available or shall be available soon. For further details see Riahi et al. (2016) and Fricko et al. (2016).

Box 1: Storyline on SSP 2: Middle of the road. Source: O'Neill et al. (2015)

The world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns. Development and income growth proceeds unevenly, with some countries making relatively good progress while others fall short of expectations. Most economies are politically stable. Globally connected markets function imperfectly. Global and national institutions work toward but make slow progress in achieving sustainable development goals, including improved living conditions and access to education, safe water, and health care. Technological development proceeds apace, but without fundamental breakthroughs. Environmental systems experience degradation, although there are some improvements and overall the intensity of resource and energy use declines. Even though fossil fuel dependency decreases slowly, there is no reluctance to use unconventional fossil resources. Global population growth is moderate and levels off in the second half of the century as a consequence of completion of the demographic transition. However, education investments are not high enough to accelerate the transition to low fertility rates in low-income countries and to rapidly slow population growth. This growth, along with income inequality that persists or improves only slowly, continuing societal stratification, and limited social cohesion, maintain challenges to reducing vulnerability to societal and environmental changes and constrain significant advances in sustainable development. These moderate development trends leave the world, on average, facing moderate challenges to mitigation and adaptation, but with significant heterogeneities across and within countries.

Box 2: Land use specific storyline on SSP 2. Source: Popp et al. (2016)

The world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns. Land use change is incompletely regulated, i.e. tropical deforestation continues, although at slowly declining rates over time. Rates of crop yield increase decline slowly over time, but low-income regions catch up to a certain extent. Caloric consumption and animal calorie shares converge slowly towards high levels. International trade remains to large extent regionalized. In SSP2, international cooperation for climate change mitigation is delayed due to a transition phase to a uniform carbon price until 2040. In this transition phase, emissions from agricultural production are priced at the level of energy sector emissions, while avoided deforestation and afforestation are not incentivized before 2030.

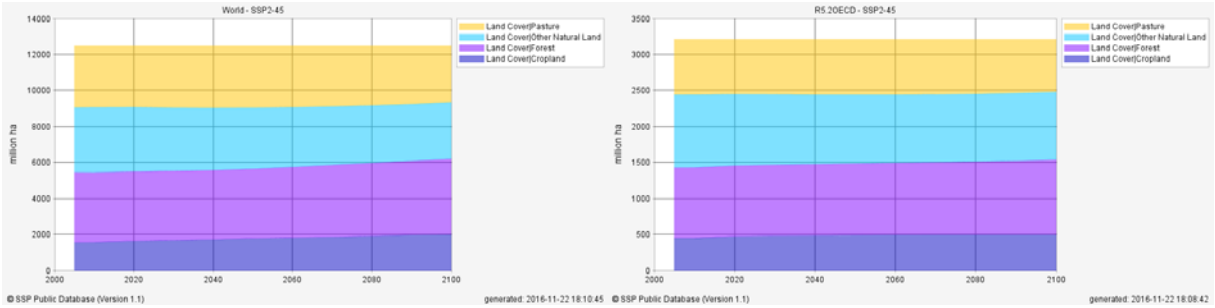


Figure 5: SSP2 (RCP4.5) land use indicators for world (left) and OECD countries (right) for the MESSAGE-GLOBIOM marker scenario. Source: SSP Public Database (www.iiasa.ac.at)

Table 1: Available global storyline parameters for MOR (based on SSP2)

Parameter	Unit	Temporal resolution	Spatial resolution	Climate change	Source
GDP	US$/yr	decadal	country	No[1]	IIASA
Population	Number	decadal	country	No[1]	IIASA
Urban population	Share of population	decadal	country	No[1]	IIASA
Primary energy	EJ/yr	decadal	OECD	RCP 2.6	IIASA
Total biomass for final energy	EJ/yr	decadal	OECD	RCP 2.6	IIASA
Solar for final energy	EJ/yr	decadal	OECD	RCP 2.6	IIASA
Built-up area, cropland, total forest, managed forest, pasture, other arable land, other land, other natural land	ha	decadal	OECD	RCP 2.6	IIASA
Crop energy supply	Kcal/cap/day	decadal	OECD	RCP 2.6	IIASA
Livestock energy supply	Kcal/cap/day	decadal	OECD	RCP 2.6	IIASA
Livestock production	t DM/yr	decadal	OECD	RCP 2.6	IIASA
Non-energy crop production	t DM/yr	decadal	OECD	RCP 2.6	IIASA
Energy crop production	t DM/yr	decadal	OECD	RCP 2.6	IIASA
Food crop demand	t DM/yr	decadal	OECD	RCP 2.6	IIASA
Feed crop demand	t DM/yr	decadal	OECD	RCP 2.6	IIASA
Other crop demand	t DM/yr	decadal	OECD	RCP 2.6	IIASA
Food livestock demand	t DM/yr	decadal	OECD	RCP 2.6	IIASA
Other livestock demand	t DM/yr	decadal	OECD	RCP 2.6	IIASA
GHG emissions (diverse gases)	Mt CO_2/yr	decadal	OECD	RCP 2.6	IIASA

Agricultural productivity growth rates for wheat, coarse grains, sugar, rice, oilseeds,	Index (2050 rel to 2005)	2050	EUR	no	(von Lampe et al., 2014; Popp et al., 2016)
Food prices	Index (2050 rel to 2005)	2050	EUR	no	(von Lampe et al., 2014; Popp et al., 2016)
Climate change induced agricultural productivity growth rates for wheat, coarse grains, sugar, rice, oilseeds,	Index (2050 rel. to 2050 w/o climate change)	2050	EUR	RCP 6.0	(Wiebe et al., 2015)
Food prices	Index (2050 rel. to 2050 w/o climate change)	2050	EUR	RCP 6.0	(Wiebe et al., 2015; Popp et al., 2016)

[1]Difference to RCP2.6 is appears negligible. Any other RCP is available.

4.2 The EU/national-level storylines

Figure 6 categorizes factors, actors, and sectors presented in the storyline above (Box 1 and Box 2). The EU/national level storylines should represent some of these categories again to ensure consistency.

Factors	Actors	Sectors
Global development	Countries/national governments	Environmental systems
Income growth & living conditions	International organizations	Education
Political stability	National institutions	Energy
Markets & market connection	Global institutions	Research and development
Sustainable development	European Institutions	Land Use Policies
Access to education, water, health	NGOs	Agriculture
Technological development	Consumers	Tourism
Resource & energy use	Enterprises	Water supply
Population growth	Advisors	
Equality		
Mitigation		
Adaptation		

Figure 6: Factors, actors, and sectors (FAS) represented in the global storyline (red boxes) and unrepresented actors and sectors relevant to the EU/national level storyline (green boxes)

Based on a full list of FAS, a selection of those FAS relevant to the EU/national level story lines is helpful to improve its communication. In the FAS methodology, actors and sectors describe underlying structures of a system, but actual triggers of change are related to the factors only. Consequently, Table 2 shows the factors that constitute the scenarios once again. Only those

that are either decisive to the land use sector or variable among the scenarios are presented with their directions of change in each scenario. For example, agricultural output prices are basically invariable across all scenarios 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.

At EU/national level, we assume a BAU situation for the future. It can be considered as balanced strategy (LBA), which is between the two more extreme land use strategies LSH and LSP.

Table 2: Factors represented in the global storyline (red boxes) and unrepresented factors relevant to the EU/national level storyline (green boxes) including directions of change in the storylines

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	↗	↗	↗
Resource & energy use productivity	↗	↗	↗
Population growth	↗	↗	↗
Equality	→	→	→
Mitigation	↑	↑	↑
Adaptation	↗	↗	↗
Agricultural input prices[1]	↗	↗	↗
Agricultural output prices[1]	↗	↗	↗
Agricultural productivity growth	↗	↗	↗
Structural change in agriculture	↗	↑	↗
Direct payment funding	→	↘	→
Greening requirements	→	↓	↗
AEP funding	→	↘	↗
Less favoured area funding	→	↓	→
Environmental legislation[2]	→	→	↑
Nature protection legislation[2]	→	↑	→

EU livestock consumption	→	→	↘
EU org./regional food consumption	↗	→	↑
Urban growth	↗	↑	→
Leisure activities in landscapes	↗	→	↑
Overall water demand by different sectors (including agriculture)	↗	↑	→

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

Notes: [1]These factors are an aggregate of all input or output prices. Although there may be short term variations, such as among different crops, long-term trends of agricultural prices likely are similar for all outputs or inputs. [2]Environmental protection policies mainly cover the abiotic environment such as the water framework directive or emission control. Nature protection policies focus on habitats and biodiversity, such as the development of national parks or Natura 2000.

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 then 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-orients 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 dis-advantages 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.

4.3 TALE minimum requirements for scenario definition

Minimum requirements on the scenario definitions shall ensure that the scenarios developed for each case study are i) sufficiently described and documented for later use and ii) are comparable among the TALE case studies. Table 3 presents scenario parameters that are considered as minimum requirement by the TALE team.

Table 3: TALE minimum requirements for the scenario definition

Parameter	Unit	Description
Land cover		
Built-up and residential area	% of total or ha	Includes land for infrastructure and recreation (e.g. ressorts)
Cropland (annual crops)		
Other cropland (incl. permanent crops)		
Forest		
Meadows (incl. mixtures of meadows and pastures)		
Pastures		
Other agricultural land (e.g. agro-forestry)		
Designated area for nature protection (not used for agriculture or forestry)		
Other land		
Designated area for nature protection (used for agric.)	% of total or ha	e.g. land under nature conservation contracts; part of any other agricultural land category
High nature-value (HNV) farmland	% of total or ha	See national standards for definition
Land use & management		
Fertilization intensity, cropland	kg/ha or % of current	Either as average or for intensity classes (e.g. low/medium/high)
Fertilization intensity, grassland		Either as average or for intensity classes (e.g. low/medium/high)
Irrigated cropland area	% of total cropland or ha	
Irrigation intensity, cropland	m^3/ha or % of current	Either as average or for irrigation classes (e.g. low/medium/high)
Fertilization options	% of land	No, organic, mineral N-fertilizers or mix of latter two

Organic farming		
Soil management – plough	% of cropland	
Soil management – minimum tillage		
Cover crops		
Ecological focus areas, harvested		
Ecological focus areas, not harvested (e.g. set-aside land, flower strips)	% of total or ha	Either total or for classes of ecological focus areas
Landscape elements outside ecological focus areas (e.g. hedges)	% of total or ha	Either total or for classes of landscape elements
Crop rotations		Either typical crop rotations or shares of crops
Pesticide management		As average, for intensity classes (e.g. low/medium/high) or qualitatively described
Livestock		
Livestock Density	units/ha	Either as average or for livestock classes

5 Concluding remarks

This document shall provide guidelines to support and harmonize the definition of land use scenarios in each TALE case study. It is considered as living document that may be adapted and modified subject to the learning process during the case study research. Deviations from the guidelines, particularly with respect to the minimum requirements in Table 3 should be communicated to the TALE team level to improve common learning and to allow for comparable case study results.

6 Annexes

6.1 Annex 1: Reporting format

1. Short description of case study region or link to description if available
2. Description of the scenario definition process
    a. Initial workshop procedure (planning document)
    b. Final workshop protocol
    c. Major steps and deviations from guidelines
    d. Participating stakeholders
    e. Description of the stakeholder process (challenges, achievements)
3. Scenario description
    a. Qualitative description and maps (if available)
    b. Minimum requirements (see Table 3)

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