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Global Representative Agricultural Pathways for Europe

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Abstract
Agricultural elements have been covered in the scenario process on shared socio-economic pathways (SSPs) incompletely and pathways have not been specified for the future development of the European Union. We will therefore devise a general framework on European Representative Agricultural Pathways (EU-RAPs), where we cover different aspects of agricultural development, as for example European and domestic agricultural and environmental policies, or different livestock and crop management systems, and describe future developments of the confederation of the countries of the European Union. For the agricultural elements we distinguish between elements that can be derived from the definitions in the Shared Socioeconomic Pathways, as for example irrigation efficiencies which are linked to technological development, and elements that have to be newly devised such as the development of the Common Agricultural Policy. For the future of the European Union we develop five different worlds which correspond to the SSPs. Finally both frameworks are combined.

1. Background of SSPs and RAPs

1.1. The SSP framework in the context of agriculture

The framework of the Shared Socioeconomic Pathways (SSPs) is the most recent development of alternative socio-economic pathways used for climate change studies (O'Neill et al., 2015). The SSPs depict five different global futures defined in different degrees of challenges to adaptation (ability to deal with climate change impacts) and challenges to mitigation (ability to reduce greenhouse gas emissions). Each SSP is described by a narrative (qualitative) scenario. Here we present summaries of the five narratives focusing on agriculture (adapted from Popp et al. 2015):

SSP1: Sustainability—Taking the green road: The world shifts gradually, but pervasively, toward a more sustainable path, emphasizing more inclusive development that respects perceived environmental boundaries. Land use is strongly regulated, e.g. tropical deforestation rates are strongly reduced. Crop yields are rapidly increasing in low- and medium-income regions, leading to a faster catching-up with high income countries. Healthy diets with low animal-calorie shares and low waste prevail. In an open, globalized economy, food is traded internationally.

SSP2: Middle of the road: 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.

SSP3: Regional rivalry—A rocky road: A resurgent nationalism, concerns about competitiveness and security, and regional conflicts push countries to increasingly focus on domestic or, at most, regional issues. Land use change is hardly regulated, i.e. tropical deforestation continues at current rates. Rates of crop yield increase decline strongly over time, due to little investment. Unhealthy diets with high animal shares and high waste become widespread. A regionalized world leads to reduced trade flows.

SSP4: Inequality—A road divided: Highly unequal investments in human capital, combined with increasing disparities in economic opportunity and political power, lead to increasing inequalities and stratification both across and within countries. Land use change is strongly regulated in high income countries, but tropical deforestation still occurs in poor countries. High income countries achieve high crop yield increases, while low income countries remain relatively unproductive in agriculture. Caloric consumption and animal calorie shares converge towards medium levels. Food trade is globalized, but access to markets is limited in poor countries, increasing vulnerability for non-connected population groups.

SSP5: Fossil-fueled development—Taking the highway: Driven by the economic success of industrialized and emerging economies, this world places increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development. Land use change is incompletely regulated, i.e. tropical deforestation continues, although at slowly declining rates over time. Crop yields are rapidly increasing. Unhealthy diets with high animal shares and high waste prevail. Barriers to international trade are strongly reduced, and strong globalization leads to high levels of international trade.

1.2. The necessity for RAPs

The SSPs describe plausible alternative changes in aspects of society such as demographic, economic, technological, social, governance and environmental factors, and are as such able to sketch alternative developments that are plausible, but on the other hand insufficiently specific for answering more detailed research questions. Therefore, for many applications, „extended SSPs“ are likely to be required, containing additional and more detailed information for particular regions and sectors (van Ruijven et al., 2014, O'Neill et al., 2015). These extended SSPs should use assumptions that are consistent with the basic SSPs, but should support analysis that goes beyond the key variables (O'Neill et al., 2015).

Based on this insight and in the context of the Agricultural Model Intercomparison and Improvement Project (AgMIP, www.agmip.org) which aims at enabling consistent model comparison at all scales, Valdivia et al. have developed an approach with which it is possible to develop consistently regional agricultural pathways. The authors want to improve on a framework use where individualized scenarios using various data, often without transparent documentation, are used, making model intercomparison difficult. The methodology that they develop is based on finding that regional agro-economic models need information that cannot be delivered by higher scale models, but that these parameters should be defined consistently with global pathways. Contrasting to the SSPs, the RAPs developed by Valdivia et. al and Antle et al. are based on key biophysical and socio-economic drivers, arguing that the climate-centricity of the SSPs (which are based on challenges to adaptation and mitigation), neglects the strong interlinkages between climate impacts and socio-economic drivers (See Figure 1). Another important component of the regional RAPs is the strong participative component. Scenario parameters are defined here, not by scientists alone but in a transdisciplinary approach and close cooperation with stakeholders. In order to help regional model developers to define consistent RAPs, Valdivia and Antle (2012) have developed a tool to guide this process, which has by now been applied by several teams (cite recent papers, trade-off webpage). In the context of AgMIP the goal of this exercise is to design RAPs for all agricultural regions of the globe and to scale them up in order to create a consistent set of linked global and regional RAPs.

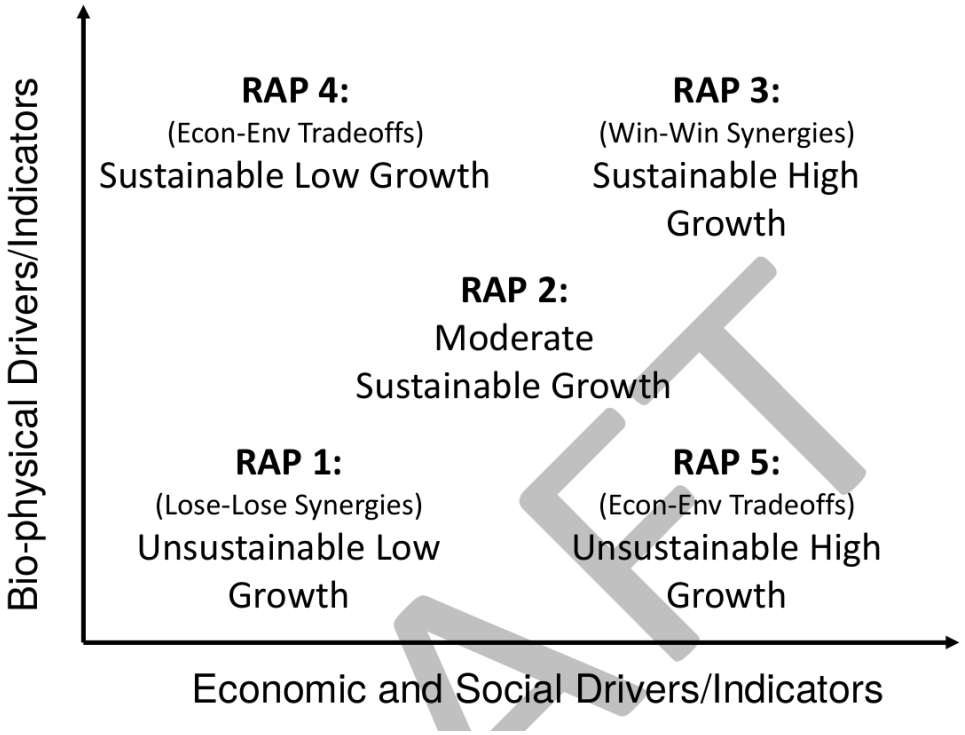

Figure 1: Pathway "Synergies and Tradoffs" Matrix with Pathway description (Source Antle et al. 2014)

Rather then following the approach by Valdivia and Antle, we will define EU-RAPs in the context of the SSP framework, sticking as closely as possible to the terminology but complementing elements when necessary. This paper therefore intends to define extended SSPs for the agricultural sector in Europe, enabling agro-economic models, such as CAPRI (citation) or MAgPIE (Lotze-Campen et al., 2008) to specify their assumptions consistently with the SSP framework.

2. Identification of Key Agricultural Elements in the SSP Framework

While the SSPs are the decisive framework for the development of our EU-RAPs, not all important elements are included and elements are partially not described in sufficient detail. We want therefore to complement important elements in the SSPs in such a way that they can be a useful base for modelling exercises for the European agriculture. On the other hand, we do not aim at quantifying any scenario-parameters, beyond the already existing quantification, as this has to be done specifically for each model. In *Figure **2** : Specification of elements relevant for the agricultural development in Europe according to the quality of their description in the SSP framework.*Figure 2 we distinguish between relevant elements in the context of agricultural production in Europe and their level of detailing the SSP framework description. In the following we list all the pathway elements relevant for the agricultural production in Europe, sorting them according to their level of description and making

suggestion on how the should be complemented in order to be used as an framework for EU-RAPs

1. Elements which are not considered in the SSP framework

   These include all agricultural policies on domestic and European level. We come to this in more detail in chapter 4.

2. Elements which are considered in the framework, but at different levels of detail

   a. Elements which are sufficiently described and quantified.
      - Population growth (in the category Demographics)
      - Per capita GDP growth (in the category Economy and Lifestyle)
        ➔ national data are available on the IIASA data base (citation), no additional description necessary

   b. *Elements which are described in a qualitative way, but need some specification*.
      - International trade and globalization (category economy and lifestyle):
        -Determining trade agreements under consideration (e.g. Finalizing the Doha-Development round,TTIP, Ceta and other bilateral trade agreements)
        -Defining preference of regional production in the context of agricultural production, how strong is the preference in the context of price differences, what about products which cannot be regionally produced, e.g. coffee
      - Policy orientation and institutions (Policies & Institutions):
        -translating this in the context of Environmental Policy
      - Land use :
        Definition for land use protection, e.g. protection of pristine forests only or forests in general, other natural areas ?

   c. *Elements which are mentioned, but not sufficiently described nor quantified.*
      - Consumption and diet (category economy and lifestyle):
        -besides meat, also waste and overall per capita consumption needs to be defined
        -food specific demand elasticities
      - Technological development :
        -Defining the term in the context of agriculture, e.g. agricultural productivity, closing of the yield gap, sustainable intensification (increase in input and output ?)
        -Defining this rate crop and livestock dependent
      - Environmental Policy (Policies & Institutions) :
        -which European Environmental Policies should be considered, e.g. Water Directive Framework, Nitrate Directive

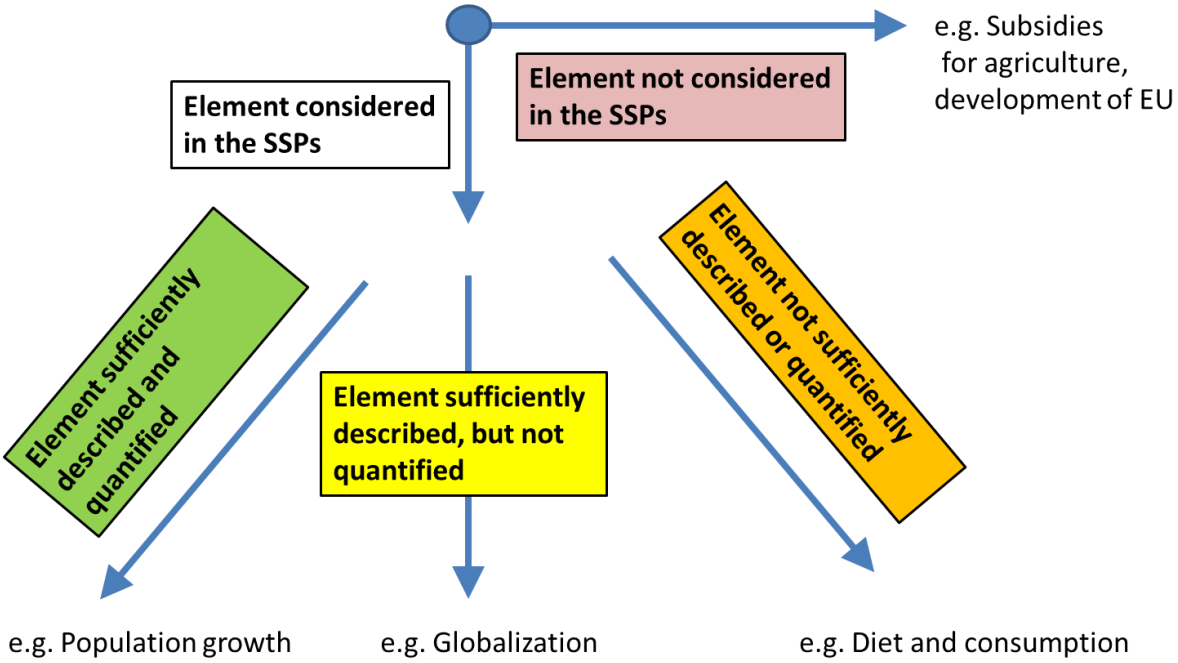

Figure 2 : Specification of elements relevant for the agricultural development in Europe according to the quality of their description in the SSP framework.

Table 1: Lists of elements described on different levels of detail in the SSP framework. Specification of these elements in the context of the Representative Agricultural Pathways. Colour specify the existing level of description in the framework. HIC – High Income Countries, MIC – Middle Income Countries, LIW – Low Income Countries.

Element sufficiently described and quantified	Element sufficiently described, but not quantified
Element not sufficiently described or quantified	Element not considered in the SSPs

SSP Elements	**Relevant in the context of agriculture for**	**SSP1**	**SSP2**	**SSP3**	**SSP4**	**SSP5**
Demographics						
Population growth	*Global agricultural demand*	Relatively low	Medium	High (LIC, MIC) Low (HIC)	Relatively High (LIC,MIC) Low (HIC)	Relatively low
Economy and Lifestyle						
Growth of GDP per capita	*Global agricultural demand*	High (LIC, MIC) Low (HIC)	Medium	Slow	Medium (LIC, MIC) Low (LIC)	High
International trade (Result of globalization)	*Spatial distribution of agricultural production in- and outside Europe*	Moderate	Moderate	Strongly constrained	Moderate	High
Globalization (WTO-Doha round and bilateral trade agreements, and		Connected markets, regional production	Semi-open globalized economy	De-globalizing, regional security	Moderate	High, with regional specialization in production

preference for regional production)						
Consumption and diet	*Overall agricultural demand and regional distribution of production*	Low meat diets, first in HIC *spec: also low waste, and overall per capita consumption*	Medium meat consumption *spec: medium waste, per capita consumption*	*Spec: High meat and per capita consumption in HIC, MIC; Low meat and pc consumption in LIC; high was everywhere*	High per capita consumption in HIC, low per capita consumption in LIW, MIC *spec: high meat consumption in HIC, MIC; low meat consumption in LIC; high waste, everywhere*	High meat consumption *spec: high waste,* *Per capita consumption*
Policies and Institutions						
Environmental Policy	*Relevant for European and domestic environmental policies*	Improved management of local and global issues	??	Low priority for environmental issues	Focus on local environment in MICs, HICs; little attention to vulnerable areas or global issues	Focus on local environment
Policy orientation	*Relevant for CAP, European environmental policies, and domestic environmental and agricultural policies*	Strong focus on sustainable development	Weak focus on sustainable development	No focus on sustainable development	Strong focus in HIC, MIC; no focus in LIC	Weak focus on sustainable development
Institutions		Effective	Medium effective	Not effective	Effective only in HIC, MIC	Effective

European and domestic agricultural policies	*Agricultural production in Europe*	To be defined in chapter 4.				
Technology						
Development	*Increases in productivity*	Rapid	Medium	Slow	Rapid in HIC, MIC, Low in LIC	Rapid
Environmental and Natural Ressources						
Land use (Forest protection, nature conservation)	*Agricultural land expansion*	Strong regulations	Medium regulations	Hardly any regulations	Hardly any regulations (MI, HI): Lack of regulation (LI)	Medium regulations

3. Scenarios for the Europe

In order to specify RAPs, especially with respect to the CAP, it is necessary to define the development of the European Union.
Cite and describe here the impressions project with EU-SSPs ammended to our purposes.

EU-SSP1:

- Further integration of European financial, fiscal and agricultural policies.
- Integration of new countries into the EU.

EU-SSP2:

- Middle of the road scenario.
- The EU will remain and continue to struggle.
- There will be EU-policies, but with a trend to decentralization.

EU-SSP3

- A fragmented and divided Europe with strong regional rivalry and conflict.
- Eventually the EU will break down.

EU-SSP4

- The EU will consist of a small number of rich countries and become an important economic player.
- Poorer countries will drop out and become even poorer.

EU-SSP5

- Europe regains its leading position in the global economy.
- Strong EU, with focus on policies related to human and social capital, neglecting environmental protection.

4. The Common Agricultural Policy and its Future under different EU-RAPs (Franz)

SSP Elements	Indicator for	EU-RAP1	EU-RAP2	EU-RAP3	EU-RAP4	EU-RAP5
Policies & Institutions						
European agricultural policy (CAP)	*Agricultural production in Europe*	Strong CAP	Middle of the road	None	Strong CAP in EU, none in rest of Europe	None
Basic Payment Scheme (Pillar I)	*Agricultural production in Europe*	None	As currently	None	Strong in EU, none in the rest of Europe	None
Greening (Pillar I)	*Agricultural area, production, SI measures*	Strong focus	As currently	None	Exists in EU, not in the rest of Europe	None
Disaster funds (Pillar I)	*Agricultural production in Europe*	Exists	As currently	None	Strong in EU, none in the rest of Europe	None
Rural development scheme (Pillar II)	*Promotion of SI measures*	Exists, shift to sust. issues	As currently	None	Exist in EU, not in the rest of Europe	None

Part of Pillar II that goes to the environment	*Agricultural production in Europe*	Large	As currently	None	Exist in EU, not in the rest of Europe	None
National agricultural policy	*Agricultural production in Europe*	No domestic policies	Weak domestic policies	Strong domestic policies in HIC	No domestic policies in EU, weak agr.pol in the rest of Eur.	No domestic policies

5. Conclusions

This is a first draft for the development of RAPs. In a following report we are going to specify how RAPs will develop in different policy settings, as for example for the Common Agricultural Policy.