Topic: Projecting climate change impacts on agriculture in European regions
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Multi-scale Modelling of Adapting European Farming Systems.

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European farming systems are challenged by an increasing global population, income growth, dietary changes and last, but not least, by a changing climate threatening future harvests, especially through increased frequency and severity of extreme events such as drought and heat waves. Therefore, there is a clear need to sustainably intensify and effectively adapt agricultural systems to climate change. Yet, increase in food production and adaptation are just two of many claims on agriculture, which is also supposed to meet growing demands on feed, fibre and fuel and to play a key role in mitigating climate change. The multiple claims on ecosystem services expected from agri-ecological systems call for an integrated assessment and modelling (IAM) of agricultural systems to adequately evaluate the multiple dimensions of the potential impacts as well as promising adaptation and mitigation options. This includes agriculture's responses to global change in the context of other sustainability aspects. Biophysical and socioeconomic analyses need to be integrated across different disciplines and spatiotemporal scales. In recent years the agricultural systems modelling community has made great efforts to use harmonized climate change, socio-economic and agricultural development scenarios and run them through a chain of models, e.g. by selected ensembles of biophysical and economic models at multiple scales, from farm to global. In phase 2 (2015-17) the European MACSUR knowledge hub has put its main focus on the regional (sub-national) level in the EU, with due consideration of the whole farm context.

The aim of this paper is to compare three regional cases from the pool of MACSUR case studies across Europe, i.e. North Savo region in Finland, the Mostviertel region in Austria and the Oristanese region in Sardinia (Italy) representing different European farming systems along a north-south climatic gradient in Europe. These case studies represent a sample of some prominent farming systems, though only a fraction of a much larger diversity of farming and environmental conditions prevailing in Europe. We describe how adaptation options are analysed within an integrated set of linked models or model outputs combining information from different spatial scales, i.e. from region-specific crop, animal and farm level models to an analysis at regional and national level changes in agriculture and food production. First results show that adaptation to climate change affects agricultural production and farm income very differently. For some regions, e.g. in Finland there are both negative and positive effects while for the Sardinian case study adaptation to climate change have negative effects on farm income.

Biophysical models, especially crop simulation models are first applied to analyse climate change impacts on yield, water use, biomass etc. and provide the outputs (i.e. delta changes) as input to economic models that contain the regional specificities of the case studies. Likewise, biophysical models are applied to analyse effects of various adaptation and mitigation options to provide information on effects of management changes on reducing damage/loss or taking opportunities from climate (adaptation) or reducing greenhouse gas emissions (mitigation). The economic models analyse economic impacts, for example the viability of management changes at farm and regional scales. Farm and regional scale economic models, backed by more detailed data and regional expert knowledge, can supply better representations of developments in each of the regions than this could be done by larger-scale (e.g. EU-wide or global) models. Sector or national economy-wide models are less specific in technical changes in agriculture, productivity changes, or in its use of inputs, due to higher level of aggregation. Nevertheless the market level view offered by sector models put the farm level changes and adaptations in a wider global context. Agricultural markets are highly integrated globally and the analyses for the case study regions also require information on global and European market developments. For example, significant changes in food demand due to changes in tastes and preferences, including aspects of climate change mitigation, may imply major changes for regional production structures. In MACSUR, this information – although not fully implemented in the case studies yet – is provided by the economic agricultural sector model CAPRI. The main strength of CAPRI in this context is that it is a global model with European focus. As such CAPRI can capture global developments and translate them to the regional level in the EU. The coupled analysis using global, EU and national level models side by side with farm level models provides unique results and much more insights on future possibilities and challenges for farmers and the food chain, than separating and restricting the analyses to either low or high aggregation level analyses.

Market and policy changes often dominate longer term climate change considerations in the decision making of food chain actors, even if unfavourable weather events have become more common in recent years. Socio-economic scenarios from global to national and regional levels are needed to put adaptation and mitigation strategies in a wider context. Models, especially those that are able to accommodate biophysical, economic and policy changes are needed to show the value added from adaptations to climate change.

Benefits and costs of mitigation strategies may be highly dependent on market developments. The current integrated assessment and modelling approach of MACSUR focusses on adaptation scenarios. It will be extended for the analysis and impact of mitigation policies in a later phase.