Integrated assessment of agricultural systems - Modular System for Agricultural and Environmental Modelling (SEAMLESS-IF)

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Introduction

Agricultural technologies and agricultural, environmental and rural development policies are increasingly designed to contribute to the sustainability of cropping and farming systems and to enhance their contributions to sustainable development at large. The effectiveness and efficiency of such policies and technological developments in realizing desired impacts could be greatly enhanced if the quality of their ex-ante assessments were improved. *Four key challenges* and requirements to make research tools more useful for integrated assessment in the European Union have been defined (Van Ittersum et al., 2008): (**a**) overcome the gap between micro-macro level analysis, (**b**) decrease the bias in integrated assessments towards either economic or environmental issues, (**c**) ensure reusability of models and their use for indicator assessment and (**d**) overcome hindrances in technical linkage of models. Tools for integrated assessment must have multi-scale capabilities and preferably allow application to a broad variety of policy questions. At the same time, to be useful for scientists, the framework must facilitate state-of-the-art science both on aspects of the agricultural systems and on integration. This paper presents the design of a framework for agricultural systems (SEAMLESS Integrated Framework) and discusses the implications for cropping and farming systems modelling.

Methodology

SEAMLESS-IF has been developed as a component-based system. This supports the process of composing different model chains depending on the application purpose and to facilitate synthesis of scientific knowledge in the domain of agriculture and its environment in relevant model components. The components in SEAMLESS-IF consist of a pan-European data base with data on soils, weather, farming systems, agro-management, prices and trade flows, an indicator framework and a number of quantitative models to assess the indicators. The quantitative models simulate various aspects of the system at different levels of organization and scale (Van Ittersum et al., 2008):

- APES (Agricultural Production and Externalities Simulator) is a modular simulation platform calculating agricultural production and externalities at field level.
- FSSIM (Farm System Simulator) is a bio-economic farm model quantifying the integrated agricultural, environmental and socio-economic aspects of farming systems, using APES outputs.
- EXPAMOD (Extrapolation Model) is used for up-scaling the outcomes from FSSIM to the European scale, in the form of price-supply relationships.
- CAPRI (Common Agricultural Policy Regional Impact Analysis), an existing model but adapted to SEAMLESS-IF, is a comparative static equilibrium model providing information on price-supply relationships, solved by iterating supply (from EXPAMOD) and market modules.

The model components, database and indicators are linked into model chains in SEAMLESS-IF. Through the use of ontologies the conceptual consistency of inputs and outputs of the various components is ensured (Wien et al., 2007), while a technical linkage is enabled through the use of OpenMI (Verweij et al., 2007).

Example application

The framework allows application to specific regions to assess location specific policies or agro-technical innovations, such as those of the water or nitrate framework directive (see e.g. Belhouchette et al., these proceedings) and to the entire European Union to assess EU wide implications of policy reforms, such as those negotiated under the World Trade Organisation. For the latter we provide an example in this paper, i.e. the integrated assessment of a trade liberalisation proposal by the so called G20 group of developing countries at the current Doha Round of the World Trade Organisation. We take the year 2013 as time horizon of the assessment, for which a baseline and policy scenario is defined. The baseline scenario for 2013 is interpreted as a projection in time covering the most probable future development of the European agricultural policy, based on the Luxemburg Agreements on the Common Agricultural Policy Reform, and including all future changes already foreseen in the current domestic, EU and international legislation (e.g. sugar market reform). The baseline is used as a reference point for counterfactual analysis. The policy scenario implements the G20 proposal on tariff reduction for agricultural products and the additional abolition of subsidized exports by the EU.

The application of the *market* model CAPRI within SEAMLESS-IF under the policy scenario results in changes of agricultural market indicators such as prices and corresponding production and consumptions quantities. Prices of products where the original degree of protection is relatively small (cereals, oilseeds or pork meat) do not decrease much, whereas highly protected products like beef and dairy show larger price reductions. The decrease is differentiated by region due to variations in the development of profitability of products competing for limited resources such as land. In a next step, the *farm* model FSSIM within SEAMLESS-IF simulates consequences of the price changes due to the liberalisation proposal, in terms of the supply of commodities at farm level, as well as the associated production plans, input use and a range of externalities including nitrogen surplus and emissions, pesticide use and irrigation water use. The farm model uses information on the various, current and alternative, agricultural activities which can be practiced on the major farming systems across the EU, i.e. annual and perennial cropping activities and livestock activities. Externalities of activities can be assessed using the *cropping system* modelling platform (APES).

Conclusions

SEAMLESS-IF is an innovative modelling system designed to address the introduced *four key challenges* as to quantitative scientific tools for integrated assessment. As such it presents an operational method of how systems analytical tools developed in the agronomic community can be integrated in more holistic and multi-disciplinary frameworks for integrated assessment of agricultural systems. Initial applications demonstrate the merits of this approach; the presentation will also highlight the significant investments needed from research institutions and individuals to allow for integration.

References

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