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Application of the Model-Based Knowledge System LandCaRe DSS to Pilot Regions for Climate Change Adaptation in Germany – Analyses at Regional and Local Scale

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During the last years intensive research programs on climate change adaptation have evolved model-based knowledge systems to support climate impact analyses and decision making in agriculture. The decision support system (DSS) of the project LandCaRe (Land, Climate and Resources) 2020[1] (Köstner et al. 2008) has been developed within the frame of the German research programme klima*zwei* and is now applied to a region around Dresden in Saxony. This is the model region of the project REGKLAM[2] (Development and Testing of an Integrated Regional Climate Change Adaptation Programme for the Model Region of Dresden) funded within the research programme KLIMZUG. Since adaptation of agriculture takes place at the local level while impact analyses and scenarios are usually provided at the regional level, the model systems have to bridge not only time scales from the past to future scenarios but also spatial scales from regions to individual fields. It has to be considered that on the one hand climate change will directly affect functions of agro-ecosystems, on the other hand adaptation measures of agriculture will influence ecosystem services in rural areas. Therefore, an integrative view of possible interactions is required.

Methodology

The LandCaRe DSS consists of data bases related to past and future regional climate or climate projections, agricultural and ecological models, plant parameters and GIS-based data of land use, topography, hydrology and soil characteristics. The various statistical and process-based models are for example predicting information on climate statistics, plant phenology, crop ontogeny, evaporation, transpiration, seepage, nitrate leakage, soil carbon, photosynthesis, and crop yield. Spatial resolutions of atmospheric variables reach from local climate stations to grids of 1 or 18 km length, spatial resolutions of model results at the land surface are either directly related to local climate stations or to grids of 100 m length representing the highest resolution of the soil map. The temporal resolution of process simulations is usually 1 day while results from climate scenarios are typically evaluated for time periods of 30 years. The prototype of the interactive usable knowledge system has been developed as a desktop version and is currently transformed for web-based access. The DSS allows to investigate plant production and other ecological functions at local and regional level (Fig. 1).

Results and discussions

The development of the knowledge system is continued and will be extended with respect to crop species, cropping systems and the transfer to other regions requiring the implementation of further GIS-based data and validation of model results. As a basic study, regional yield of the main crop types winter wheat, winter barley, winter rye, winter rape and silage maize have been simulated with the statistically-based

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model YIELDSTAT for whole Saxony up to the year 2050 (Mirschel et al. 2009). For validation of model results, various statistical data from agricultural authorities as well as from political districts of Saxony were used. To consider the CO_2 fertilisation effect results of FACE experiments (Weigel et al. 2008) were evaluated and integrated within the ecosystem models. Overall, it can be stated that differences in realisations of climate projections (Spekat et al. 2007) had significantly less effect on future yield than assumptions on the CO_2 fertilisation effect or the future technological progress.

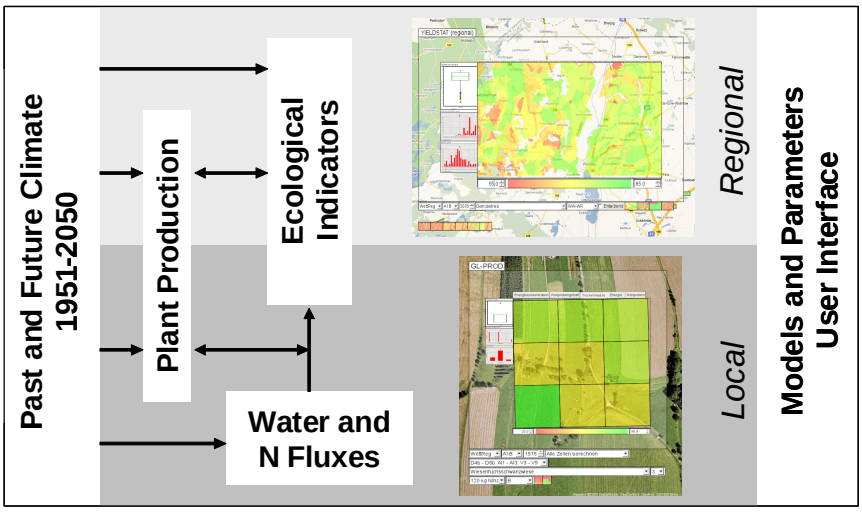

Fig. 1: Scheme of selected functions in the LandCaRe DSS

Experiences of recent dry summers revealed an increasing interest of farmers and consultants on options for irrigation as well on maintenance of high yield quality (e.g., proteine content) by supplementary fertilisation. Consequently, adaptation measures related to the selection of crop species, crop rotation, fertilisation, irrigation and plant protection, may increase detrimental effects on the environment.

It is concluded that model frameworks of climate impact analyses and decision support should make it possible to link spatial levels. Side effects of adapted management at the local level should be testable at the regional level. Predicting effects of adaptation on water fluxes, water quality as well as on greenhouse gas emissions will remain a continued challenge to the LandCaRe DSS.

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