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Carbon-, nitrogen- and water-fluxes of agricultural landuse types in the Upper Danube catchment under global change: integrating natural and agroeconomic effects

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Climate change will not only modify water, carbon and nitrogen fluxes of agricultural ecosystems as a result of the direct impact of climate parameters. The adaption of farming practices (e.g. time of management activities, selection of crops) will also affect theses fluxes. An important driver for changes in agricultural management is the improvement of economical viability which requires both the optimization of the spatial distribution of crops over arable land and the adjustment of cultivation procedures. Thus, investigating climate change effects for agricultural land use types requires that both, direct natural and indirect anthropogenic effects, must be accounted for.

The model assembly 'agriculture' within the DANUBIA decision support system has been designed to assess interactions between environmental and anthropogenic effects of climate change. It consists of dynamically interacting models describing plant growth, soil nitrogen transformation, water- and energy-fluxes. In addition, a farm-actor model simulating management activities and economic decisions concerning agricultural land use is coupled to the environmental models. Thus the model assembly 'agriculture' allows for the analysis of environmental and agro-economic effects as well as for the feedbacks between these effects.

In this study changes in transpiration, biomass production and nitrogen uptake for two different agro-political scenarios area analyzed: a 'baseline' scenario assuming unchanged agropolitics and a 'performance' scenario, where the payment of agricultural subsidies ends in 2015. Two exemplarily districts with contrasting agricultural land use were examined. Dingolfing in the northeastern part of the Upper Danube catchment is dominated by arable land, whereas in Ostallgäu in the southwest region of the catchment grassland prevails. The model was run for the period 2011 till 2058 assuming a climate scenario based on the IPPC A1B emission scenario. Ten year averages for the scenario period from 2049 till 2059 and a reference period from 1996 till 2005 were compared.

In general, the model results for the reference period shows an increase in biomass production and an improvement of nitrogen use and water use efficiency for both districts. Nitrogen uptake is higher in the crop dominated district (Dingolfing) whereas it remains almost unchanged in the grassland region (Ostallgäu). Transpiration amounts show only slight changes, increasing in Dingolfing and decreasing in Ostallgäu. A comparison of the two management scenarios shows that the effects of climate impacts upon the fluxes are significantly larger than effects arising from farm management decisions.