Adaptation response surfaces from an ensemble of wheat projections under climate change in Europe

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The uncertainty about climate change (CC) complicates impact adaptation and risk management evaluation at the regional level. Approaches for managing this uncertainty and for simulating and communicating climate change impacts and adaptation opportunities are required. Here we apply an ensemble of crop models for adapting rainfed winter wheat at Lleida (NE Spain), constructing adaptation response surfaces (ARS).

Our methodology has been adapted from Pirttioja et al. (2015). Impact response surfaces (IRS) are plotted surfaces showing the response of an impact variable (here crop yield Y) to changes in two explanatory variables (here precipitation P and temperature T). By analyzing adaptation variables such as changes in crop yield (ΔY) when an adaptation option is simulated, these can be interpreted as the adaptation response to potential changes of P and T, i.e. ARS. To build these ARS, we explore the sensitivity of an ensemble of wheat models to changes in T and P. Baseline (1981-2010) T and P were modified using a delta change approach with changes in the seasonal patterns. Three levels of CO_2 (representing future conditions until 2050) and two actual soil profiles are considered. Crop models were calibrated with field data from Abeledo et al. (2008) and Cartelle et al. (2006). Most promising adaptation options to be analyzed by the ARS approach are identified in a pilot stage with the models DSSAT4.5 and SiriusQuality v.2, subsequently simulating the selected adaptation combinations by the whole ensemble of 11 crop models.

The adaptation options identified from pilot stage were: a cultivar with no vernalisation requirements, shortening or extending a 10 % the crop cycle of the standard cultivar, sowing 15 days earlier and 30 days later than the standard date, supplementary irrigation with 40 mm at flowering and full irrigation. These options and those of the standard cultivar and management resulted in 54 combinations and 450.000 runs per crop model. Our preliminary ARSs show some adaptation options allow recover up to ca. 2000 kg/ha. Compared to the historical yields recorded at Lleida province (2550 kg/ha in 1981-2010) our results indicate that adaptation is feasible and may help to reduce detrimental effects of CC.

Our analysis evaluates if the explored adaptations fulfill the biophysical requirements to become a practical adaptive solution. This study exemplifies how adaptation options and their impacts can be analyzed, evaluated and communicated in a context of high regional uncertainty for current and future conditions and for short to long-term perspective.

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