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Integrating adaptation behaviour in drought risk analysis: How can we model the relation between future agricultural drought impacts and human adaptation responses in a rural catchment?

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Climate change and socio-economic development are expected to increase drought risk in the Horn of Africa. Droughts, defined as below-normal meteorological and hydrological conditions, pose a serious threat to the agricultural sector and to food security in countries with a high agricultural dependence. Emergent adaptation strategies to cope with this increasing risk can be expected in these countries. Current drought risk assessments do not incorporate dynamic human adaptation, however. As these studies lack the integration of interactions between drought impact and human adaptation decisions, they cannot fully include the effect of such adaptation decisions on future drought risk, and vice versa.

In this study, we analyse the role of dynamic adaptation behaviour in agricultural drought risk on a catchment scale. A novel socio-hydrologic modelling system is put forward that integrates a land surface model (consisting of a hydrological model and a crop production model) with an agent-based model (ABM) that predicts the anthropogenic response by farmers and local policy makers on future drought events. The ABM simulates the heterogeneous water- and agricultural management decisions of different stakeholders based on their risk perception, perceived response efficacy and the social networks, combining the Protection Motivation Theory and the ConsumatII approach. The direct effect of the adaptation strategies on the severity of hydrological drought hazards and the changes in vulnerability due to these adaptation strategies are investigated. The theoretical model assesses current and future drought risk on agricultural production in catchments in the Horn of Africa under various adaptation pathways and improves our understanding of drought risk dynamics and adaptation behaviour.