Integrating farmers adaptation dynamics in drought risk modelling:
assessing individual vulnerability dynamics under climate change and policies

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The effectiveness of top-down disaster risk reduction policies is influenced by how smallholder farmers react to droughts with drought adaptation measures and how they respond to the proposed policies. Ongoing research on the drivers of these sociohydrological feedbacks and the role of farmers' adaptive behaviour in drought management, has brought agent-based modelling (ABM) tools to the fore. In this research, we developed an innovative agent-based drought risk model that explicitly takes into account the two-way relationship between heterogenous individual agricultural adaptation decisions and the agro-hydrological system modelled using AquacropOS. The ABM, named ADOPT, is able to evaluate the impact of drought risk policies on the dynamics of poverty, food security and relief needs, and is applied to a case in Kenya.

First, we created a conceptual framework that focuses on agricultural water management decisions of individual farmers and their interaction with drought hazard, exposure and vulnerability. In addition, we created an overview of existing theories on adaptive behaviour under drought conditions. Furthermore, to better understand the individual adaptive behaviour of smallholder farmers, we conducted a multi-method data survey among stakeholders and households in semiarid Kenya. Based on the collected theoretical and empirical data, we were able to identify the drivers and barriers that determine the adoption of drought adaptation measures in this context. This information was used to calibrate the decision rules in ADOPT.

We showed that ADOPT is able to estimate the evolution of adopted measures and trends in crop yields when bounded-rational adaptive behaviour, described following the Protection Motivation Theory, is used. We also demonstrated the benefit of estimating drought risks at the level of individual households. In addition, we applied ADOPT to simulate how smallholder farmers in Kenya respond to government drought policy interventions such as bettering extension services, improving early warning systems, distributing ex-ante rather than ex-post cash transfers and widening access to credit market. We analysed the effect of such top-down decisions on the household and community vulnerability to droughts, and evaluated their robustness under different climate change scenarios.