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Integrating adaptation dynamics in drought risk modelling: The case of smallholder farmers in Kitui

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Ongoing research to capture the socio-hydrologic feedbacks between human adaptation decisions and agricultural drought risk has brought agent-based modelling (ABM) tools to the foreground. We explored how such ABM can be used to integrate heterogeneous individual adaptive behaviour in a drought risk framework. Our ABM framework focuses on adaptation decisions (irrigation, land management) by individual farmers and their interaction with drought hazard, exposure and vulnerability. This framework enables us to more correctly reflect the dynamic nature of drought risk in time and space. Moreover, as the effectiveness of disaster risk reduction policies rests on the complexities of drought adaptive behaviour of the targeted group, we completed multiple data collection activities to understand the adaptation decisions of smallholder farmers under drought risk. These activities, inclusing smallholder farmer questionaires, choice experiments and stakeholder interviews, were based on behavioural theories and their links to socio-economic aspects in semi-arid Kenya, so we could assess what drivers and barriers determine the adoption of drought adaption measures in this context. Moreover, people's preferences towards ex-ante cash transfers, timely extension services, tailored early-warning systems, and access to credit markets were tested.

The framework and data collection results were used to calibrate the decision rules in a new ABM (ADOPT), to simulate small-scale agricultural adaptation decisions in response to drought risk in the past. The protection motivation theory is compared with scenarios of no adaptation dynamics and of economic rationality, so as to test different behavioral assumptions. Capturing the spatio-temporal feedbacks between bounded-rational adaptation decisions by smallholder farmers and seasonal weather conditions, ADOPT is capable of mimicking the evolution of heterogeneous adaptation decisions and trends in historic yields over time. We show the benefit of assessing drought risk (poverty, food security and aid needs) on an individual household level. Additionally, we adjusted ADOPT to simulate how smallholder farmers in Kenya respond to drought policy interventions by the government and (future) drought events, explicitly modelling adoption incentives and constraints and the social interactions among farmers. As such, the effect of pro- and reactive top-down decisions by governmental institutions on the household and community vulnerability to droughts could be evaluated in order to find maximized effects on drought

resilience.