



## GEB: A coupled socio-hydrological agent-based adaptation model for drought and flood risk management

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GEB is a new socio-hydrological model coupling an agent-based adaptation model, a fully distributed hydrological model (CWatM), a hydrodynamic model (SFINCS), and a forest evolution model (plantFATE). The model simulates hundreds to millions of individual households, such as crop farmers, which can dynamically respond to their environment, for example, through switching crops and irrigation techniques. Moreover, households can dynamically adapt to changes in flood risk and respond to flood events by wet- or dry-proofing their house. All adaptation decisions consider heterogeneity in the agent population and are grounded in well-known behavioural theories, such as the subjective expected utility theory and the protection motivation theory.

Households also interact with each other (e.g. network effects) and with governmental or private sector stakeholders. Higher-level agents, such as water boards and governments, can test the effectiveness of investing in a wide range of measures and policies (e.g., increasing forested areas, creating water buffers and levees) or (dis)incentivize behaviour through subsidies or pricing.

GEB simulates hydrology and drought impacts at a daily to sub-daily timestep at field-scale resolution, while floods are simulated at a resolution of up to 5 meters. The model can simulate well-known human-natural feedbacks from the governmental to the household levels, and is suitable for assessing timely scientific themes such as the safe-development paradox, the irrigation efficiency paradox, supply-demand cycles, and the reservoir paradox.

The model is fully open source (<https://github.com/GEB-model/GEB>) and can be set up anywhere globally with reasonable default parameterization with little effort, while allowing for improved parameterization using local data. Current implementations include the Krishna basin (India), the Meuse (Western Europe), the Murray-Darling basin (Australia), and the Hetao irrigation area (China). We encourage other researchers and practitioners to test, use, and contribute to the model.

