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Towards a better integration of the human and biophysical dimensions in global change modelling

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Global change encompasses on the environmental side components such as climate change, land degradation and pollution; and in the societal domain socioeconomic changes such as demography, economic development, and equality. This nexus is primarily driven by human activities and affects outcomes relevant for peoples' well-being and viability through a network of interactions and feedbacks. Due to its strong influence on land surface and land-atmosphere processes and as a basis for food security and income, agriculture and rural livelihoods are at the heart of global change.

Despite the close entanglement of rural populations, livelihoods, and agricultural production, their integrated assessment is so far hardly considered in large-scale and global foresight studies. Instead, most large-scale research on consequences of global change and potential solutions is still monothematic or combines few of the above elements.

Integration across disciplines is taking place only to a limited extent, typically with static combinations of model outcomes. E.g., integrated land use models typically combine yield projections for changing climate with a priori projections of economic and population change. Other examples are the combination of independent projections of crop productivity and water availability to analyze adaptation potentials within the biophysical domain or across scientific domains the estimation of migration driven by changes in crop productivity and water availability. Importantly, both mono- and interdisciplinary studies are most often confined to business-as-usual scenarios or trajectories along shared socioeconomic pathways. Consequently, they do not capture feedbacks involving the human dimension and potentials for adaptation, and therefore lack outcomes that can inform on options for local and regional decision-making covering the water-food-population nexus.

The state-of-the-art highlights a concerning lack of integrated approaches to model global change impacts and feedbacks across environmental and socioeconomic domains. Based on own research and literature that characterizes interactions in the water-food-population nexus under global change pressures and existing model types and approaches, we propose herein a platform

for the quantitative integrated modelling and assessment of global change impacts and adaptation covering food and water security, land use, demography, migration, and adaptive capacity.

Applications of such a modelling platform may address a wide range of pressing questions including shocks, their cascading effects and ultimate feedbacks (e.g. food security through output and input trade during and after Ukraine war; other historic shocks such as financial crisis; etc.); slow-onset global change impacts and adaptation; or transversal achievement of SDGs; and eventually serve as a first step towards the modelling of societal catastrophic change scenarios.