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Modeling heterogeneous farmers' response to climate change via agent-based simulation

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Farmers' risk preferences significantly shape their decision-making processes, influencing key strategies like crop selection and irrigation practices. Concurrently, climate change poses significant threats to agricultural activities, necessitating an in-depth examination of coupled human-nature systems. Farmers perceive changes in climate patterns, such as severe and more frequent droughts, but their reactions to these changes may be highly heterogeneous, influenced by factors such as individual risk aversion, satisfaction, uncertainty, interaction and comparison with other farmers. Agent-based modeling (ABM) has emerged as a powerful tool to capture the complexities of agricultural systems and simulate the interactions between farmers, their environment, and climate change. However, despite increasing calls to incorporate realistic human behavior, the prevailing paradigm remains the use of representative rational agents.

This study presents an ABM application in the Adda River basin, Italy, where agents represent farmers who make decisions on crop type and irrigation method. The main goal is to understand how the system reacts and withstands the impact of emerging climate-change-driven scenarios. The study attempts to find a more realistic approach to agents' decision-making by implementing different behavioral models. The first model assumes profit maximization under perfect foresight, a traditional approach commonly used in ABM literature. The second model introduces uncertainty about future climate conditions and heterogeneity in farmers' risk aversion preferences on the basis of past performances. The third model embraces a more comprehensive approach to behavioral modeling, incorporating behavioral concepts such as reference points and loss aversion. This model acknowledges that farmers' decision-making is not solely guided by profit maximization, but also influenced by their prior experiences, perceptions of losses, and the potential for regret. This more comprehensive approach aims to offer a more comprehensive representation of farmers' decisions on crop selection and irrigation practices, under conditions of uncertainty and risk. Agents' individual preferences have been calibrated using survey data from the domain's field.

Implementing these different decision modules, we tested the agents' response to various climate change scenarios, including historical conditions and future projections for representative storylines. Preliminary results reveal notable differences in system dynamics and resilience across the behavioral models and risk aversion levels. These findings provide insights into the

appropriateness of behavioral modeling tools for understanding agricultural decision-making under evolving climatic conditions.