EGU24-2433, updated on 08 Mar 2024
https://doi.org/10.5194/egusphere-egu24-2433
EGU General Assembly 2024

Merging social learning and behavior modelling to reinforce farmers adaptation to climate change

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Agriculture is one of the most sensitive and vulnerable activities to climate variations, motivating farmers' actions to face climate change-induced stressors and shocks. Traditional management approaches based on linear growth optimization strategies, overseen by command-and-control policies, have proven inadequate for effective water management and climate change adaptation because they partially failed to account for the inherent unpredictability and irreducible uncertain risk conditions. Furthermore, this approach overlooks the necessity of addressing changes in human behavior, knowledge sharing, and motivations as part of climate change adaptation pathways. Conversely, accurate bottom-up approaches focusing on social learning input, enhance system transformation by building collaborative problem solving. Surveys and interviews, both forms of associative processing, have proven effective in delving into knowledge-based information and tracking the impact of personal experiences on water management and climate change action. Additionally, Agent-Based Models (ABM) have been utilized to enhance the interplay between social and physical surroundings, depicting individuals' and stakeholders' narratives, and charting the hydrosocial landscape.

Assuming water has different physical, social, political, and symbolic value(s) for individuals and communities, it is crucial to strengthen the involvement of stakeholders in order to gain a deeper understanding of their preferences, potential solutions and persistent constraints that are conditioning decision-making processes in coupled human-nature systems. This underscores the need for holistic and systemic approaches that can integrate the domains of water and climate in specific arrangements, fostering direct engagement among users, stakeholders, and decision-makers through social learning. In this context, the insights and observations of farmers and irrigation districts managers are highly valuable in gauging climate change awareness, perceived impacts, and adaptive capacity. Their understanding is imperative to provide informed decisions to policy-makers, and the first step to minimizing misconceptions or maladaptation practices that could affect the water management and governance processes.

This work presents a transdisciplinary approach that combines farmers' clustering with behavior and agrohydrological modelling to support water management and address climate change risks. We consider a case study in northern Italy 1) to identify farmers' and managers' perspectives regarding climate change, 2) to anticipate farmers' decisions by testing different rationality and

risk preferences in an ABM, and 3) to assess how farmers' and managers' feedback loops can be incorporated into regional adaptation strategies. Results indicate that farmers and managers are aware of climate change, perceive climate variability and impacts, and combine preventive and reactive measures to reduce climate vulnerability. After first running simulations, the ABM effectively represents the heterogeneity of farmers, creating a more diverse representation of their behavior, while identifying how risk aversion influences how farmers adopt cropping patterns and irrigation methods. A better understanding of the farmers' behavior in terms of risk assessment and adaptability can facilitate the transferability of bottom-up findings and the customization of targeted and flexible adaptation instruments to avoid maladaptation or inefficient transformation when facing water management and climate change in coupled human-nature systems.