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Developing resilience to hydrologic extremes in irrigated agriculture through risk transfer mechanisms in the context of southeastern Brazil

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In the last decades, we have witnessed increasing losses on crop yield due to an increase in magnitude and frequency of hydrological extremes such as droughts and floods. These hazards promote systematic and regressive impacts on the economy and human behavior. Risk transfer mechanisms are key to cope with the economic impacts of these events, therefore safeguarding income to farmers and building resilience to the overall sector. The index-based insurance establishes an index that can be monitored in real or near-real-time, which is associated with losses to a specific agent. While the manifestation of the causality hazard to exposure and exposure to damage and its mathematical representation in cash flow equations is a hard task, incorporating an objective and transparent index adds up a new challenge to this modeling framework. Moreover, past events that have been used as the main guide to evaluating expected losses given risk can no longer offer an accurate risk estimation due to environmental changes. This work aims to tackle the hydrologic extremes risk transfer modeling in irrigated agriculture to obtain optimized premium values and parameters of an insurance fund for irrigated agriculture in Southeastern Brazil. This study will be developed in the Piracicaba, Jundiaí, and Capivari river basin, also known as PCJ catchment in the states of São Paulo and Minas Gerais, Brazil. The region, with approximately 5 million inhabitants, is considered one of the most important in Brazil due to its economic development, which represents about 7% of the National Gross Domestic Product (GDP). The Hydrologic Risk Transfer Model of the Hydraulic and Sanitation department of the University of São Paulo (MTRH-SHS) will be used to obtain optimized premium values. The main index variable is streamflow fitted to extreme value theory distribution for low and high flows. To evaluate climate change and land-use change scenarios, Regional Climate Models (RCMs) and land use projections will be related to streamflow in a hierarchical Bayesian framework. Synthetic data will be then simulated according to scenarios previously defined in a Monte Carlo approach. The hazard-damage function will be obtained by total crop yield and revenue per municipality, then the relationship between the index and expected losses is determined in an empirical equation. Finally, a cash flow computation is run with synthetic data obtaining optimized premiums in a way to minimize fund storage values. We expect to provide further evidence of the feasibility of

actuarially fair premium values for the agents in the sector considering global phenomena of climate change and land-use change. Results will support climate change adaptation plans and policy as well as contribute to methods for estimating risk in a changing environment.