Effects of flood-induced individual businesses' financial distress over complex cooperative productive systems.

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Today, flood risk management practices incorporate non-structural measures that take into account the potential of ecosystems to prevent, regulate and reduce water-related hazards. However, the implementation of non-structural measures, such as floodplains and water retention areas, increases the exposure of agricultural areas for better protection of urban and industrial areas. Since agricultural enterprises are closely linked to land productivity, this exposure trade-off directly affects farm incomes, and thus the long-term sustainability of agricultural activities in floodplain and water retention areas.

Additionally, local businesses are increasingly interconnected in production/supply networks. We consider these networks as complex systems. In our work, we focus on a cooperative wine-making system (CWS). A CWS is conceptualized as a supply chain in which a cooperative winery and a set of vinegrowers interact. The basic product of the system (the grape) is supplied by the vinegrowers, which the cooperative finishes processing (carrying out the wine-making, bottling and marketing stages).

We propose to analyze the extent to which individual winegrowers in financial difficulty may pose a threat to the sustainability of the system in the event of flooding. To carry out this analysis, we build an agent-based model (the COOPER model) to simulate the production dynamics of the CWS. We utilize the model as a virtual laboratory to explore the behavior of the system under several flood scenarios. We test the influence of 4 parameters on financial viability at both the individual and system levels: the rigidity of the cost structure of the winery, the location of the winery, the individual business cessation criteria and the individual initial treasury.

Our results show that winery-related parameters influence the capacity of both system and individuals to absorb flood impacts more than individual parameters. The analysis of financial flows shows that the return to pre-disaster states might not be possible. Furthermore, without financial support, some businesses may never recover and business dismissal due to financial pressures and harvest variations threats the survival of the CWS. In addition, we unveil a mechanism to graduate the degree of damage spreading in case of productions losses within the CWS hidden in the revenue-cost sharing rules and the structure of costs. From a managerial point of view, this type of result has strong implications: managers can influence the capacity of the CWS to absorb shocks and prevent damage propagation by keeping cost structures from becoming too rigid.