



Improving decision-making during high-impact hydrometeorological events: A series of serious games for flood crisis management exercises

Galateia Terzi¹, Isabelle Ruin¹, Benoit Gaudou², Delphine Grancher³, Déborah Bodini¹, Pierre Nicolle⁴, and Olivier Payrastre⁴

¹Université Grenoble Alpes, CNRS, IRD, Grenoble INP, IGE, F-38000, Grenoble, France

²IRIT, Université de Toulouse, CNRS, INP, UT3, UT1, Toulouse, France

³Laboratoire de Géographie Physique, UMR 8591, Université Paris 1 Panthéon Sorbonne, CNRS, UPEC, 92190 Meudon, France

⁴GERS-LEE, Univ. Gustave Eiffel, IFSTTAR, F-44344 Bouguenais, France

Effective decision-making during high-impact hydrometeorological events such as floods is crucial to mitigate adverse socio-economic impacts. Traditional approaches often fall short of providing adequate guidance under uncertain conditions. In this study, we explore the effectiveness of cooperative gaming in enhancing decision-making processes during such crises.

As part of the European ANYWHERE project, we developed ANYCaRE (Anywhere Crisis and Risk Experiment), a role-playing game simulating a crisis management unit responsible for ensuring the safety of populations during weather crises. Simulated high-impact events include floods/flash floods and wind storms. A more complex scenario simulated cross-border CBRN hazards. Players take on the roles of representatives of the various organizations in the crisis unit. They must collectively choose the best options for ensuring people's safety in the face of a damaging and rapidly evolving event. The chronology adapted to the pace of the hazard under consideration: three successive rounds of play simulate and anticipate the evolution of the risk, from detection to impact.

The primary aim of the game was to assess the benefits of new forecasts and impact-based products in decision-making under pressure. The S-ANYCaRE version tested how public information from social media is used in emergency centers to decide on protection and risk communication. Since 2017, over 300 participants engaged in real-time decision-making exercises testing probabilistic forecasts and impact-based information in various settings, including European workshops, training courses, and emergency operations centers. Post-game investigation suggests that these forecasts, including crowdsourcing data, increase decision-makers confidence during the crisis. In the debriefing phase, stakeholders highlighted challenges in managing data overload and prioritizing actions.

The serious games approach developed in this study proved valuable in fostering interdisciplinary cooperation and raising awareness about the complexities of managing weather-related emergencies. The playing scenarios require strategic thinking amidst uncertainty, facilitating a better understanding of flood crisis management. Therefore, we envisage using game sessions for multiple purposes, including the sensibilization of participants to the challenges of managing weather emergencies, facilitating cooperation between developers and end-users for the development of efficient pre-operational forecast products, and training civil protection authorities and stakeholders in new disaster management tools.

The evolution of PICSCaRE, a version of the game simulating a recent flood catastrophe in southern France, into a participative simulation tool marks a significant advancement. This tool, combining

the tabletop role-playing game with a digital agent-based behavior simulator currently under development, will enable players to test the effectiveness of their crisis management and communication measures on individual responses and the frequency of endangerment situations.

This study presents the stages of development of this hybrid version and its potential to raise awareness of the variety of behavioral responses to changing hydrometeorological circumstances and associated socio-economic impacts. We envisage that integrating serious games into routine flood crisis management exercises enhances decision-making skills and preparedness. In particular, combining impact models with serious games would foster better risk communication and adaptive strategies. As hydrometeorological events increase in frequency and severity, innovative approaches like simulation games are crucial for reducing socio-economic vulnerabilities in a changing climate.