A Bayesian network approach for multi-sectoral flood damage assessment and multi-scenario analysis

Remi Harris¹,², Elisa Furlan¹,², Hung Vuong Pham¹,², Silvia Torresan¹,², Jaroslav Mysiak¹,², and Andrea Critto¹,²
¹Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici, Environmental Sciences, Informatics and Statistics, Lecce, Italy
²Department of Environmental Sciences, Informatics and Statistics, University Ca’ Foscari Venice, Venice, Italy

Extreme weather and climate related events, from river flooding to droughts and tropical cyclones, are likely to become both more severe and more frequent in the coming decades, and the damages caused by these events will be felt across all sectors of society. In the face of this threat, policy- and decision-makers are increasingly calling for new approaches and tools to support risk management and climate adaptation pathways that can capture the full extent of the impacts. In the frame of the LODE DG ECHO project (https://www.lodeproject.polimi.it/), a GIS-based Bayesian Network (BN) approach is presented for the capturing and modelling of multi-sectoral flooding damages against future ‘what-if’ scenarios. Building on a risk-based conceptual framework, the BN model was trained and validated by exploiting data collected from the 2014 Secchia River flooding event, as well as other contextual variables. Moreover, a novel approach to defining the structure of the BN was performed, reconfiguring the model according to expert judgment and data-based validation. The model showed a good predictive capacity for damages in the agricultural, industrial and residential sectors, predicting the severity of damages with a classification accuracy of about 60% for each of these assessment endpoints. ‘What-if’ scenario analysis was performed to understand the potential impacts of future changes in i) land use patterns and ii) increasing flood depths resulting from more severe flood events. The output of the model showed a rising probability of experiencing high monetary damages under both scenarios. In spite of constraints within the case study dataset, the results of the appraisal show good promise, and together with the designed BN model itself represent a valuable support for disaster risk management and reduction actions against extreme river flooding events, enabling better informed decision making.