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Development of synthetic velocity - depth damage curves using a Weighted Monte Carlo method and Logistic Regression analysis

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Damage curves are the most significant component of the flood loss estimation models. Their development is quite complex. Two types of damage curves exist, historical and synthetic curves. Historical curves are developed from historical loss data from actual flood events. However, due to the scarcity of historical data, synthetic damage curves can be alternatively developed. Synthetic curves rely on the analysis of expected damage under certain hypothetical flooding conditions.
A synthetic approach was developed and presented in this work for the development of damage curves, which are subsequently used as the basic input to a flood loss estimation model. A questionnaire-based survey took place among practicing and research agronomists, in order to generate rural loss data based on the responders' loss estimates, for several flood condition scenarios. In addition, a similar questionnaire-based survey took place among building experts, i.e. civil engineers and architects, in order to generate loss data for the urban sector. By answering the questionnaire, the experts were in essence expressing their opinion on how damage to various crop types or building types is related to a range of values of flood inundation parameters, such as floodwater depth and velocity.
However, the loss data compiled from the completed questionnaires were not sufficient for the construction of workable damage curves; to overcome this problem, a Weighted Monte Carlo method was implemented, in order to generate extra synthetic datasets with statistical properties identical to those of the questionnaire-based data. The data generated by the Weighted Monte Carlo method were processed via Logistic Regression techniques in order to develop accurate logistic damage curves for the rural and the urban sectors. A Python-based code was developed, which combines the Weighted Monte Carlo method and the Logistic Regression analysis into a single code (WMCLR Python code). Each WMCLR code execution provided a flow velocity-depth damage curve for a specific land use. More specifically, each WMCLR code execution for the agricultural sector generated a damage curve for a specific crop and for every month of the year, thus relating the damage to any crop with floodwater depth, flow velocity and the growth phase of the crop at the time of flooding. Respectively, each WMCLR code execution for the urban sector developed a damage curve for a specific building type, relating structural damage with floodwater depth and velocity.
Furthermore, two techno-economic models were developed in Python programming language, in order to estimate monetary values of flood damages to the rural and the urban sector, respectively. A new Monte Carlo simulation was performed, consisting of multiple executions of the techno-economic code, which generated multiple damage cost estimates. Each execution used the proper WMCLR simulated damage curve. The uncertainty analysis of the damage estimates established the accuracy and reliability of the proposed methodology for the synthetic damage curves' development.