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# Contribution of coupling hydraulic and economic models at the building scale for assessing flood adaptation

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In France, adaptation to floods has been the subject of a clearly identified public policy, at least since the first versions of the action programs for flood prevention launched in 2002. Axis 5 of these action programs aims to reduce the vulnerability of people and property by implementing flood adaptation measures at the "individual" level, i.e. dwellings, economic or agricultural activities.

In the specific case of dwellings, flood adaptation can have two objectives: to increase human safety and to reduce material damage. Neither of these objectives has an established method for measuring the effectiveness of the recommended measures. In fact, although it has been identified as a priority, the evaluation of the effectiveness of proposed measures remains underdeveloped and, as a consequence, professionals, especially those performing vulnerability assessments, lack the tools to assess the validity of their recommendations.

Furthermore, a number of studies show that effectiveness assessment can call into question the very validity of programs that are designed on the basis of broad principles but applied to specific areas.

This work presents an original spatially explicit, process-based (synthetic) 3D model at the building level, combining hydraulic and economic modules, and we show how it can respond to this need for assessing the effectiveness of flood adaptation measures. This model relies on the characterization of the vulnerability of spatially explicit (xyz) elementary building components based on expert knowledge and on the classical weir law to determine the water flow exchange between the exterior and interior of a building and between rooms. The combination of these elements allows us to i) simulate the hydraulic behavior of the building using flood duration and exterior flood depth as the main flood parameters; ii) estimate the flood damage caused by a

flood event; and iii) dynamically evaluate the danger of the path(s) to safety inside the building based on pedestrian stability studies.

Real case buildings are used to test the model. The selected buildings benefited from a French vulnerability reduction program called "Alabri". This program offers vulnerability diagnostics of buildings to voluntary owners and, based on the diagnostics, recommendations for vulnerability reduction. Field work and interviews show that the most frequently proposed measures are aimed at preventing water infiltration inside buildings (with temporary barrier systems) and creating refuge areas for people. The hypothesis is that the combination of both measures is sufficient to reduce flood damage and ensure the safety of the occupants of a dwelling. We also use specific hydraulic conditions to test these measures and their combination.

This approach allows us to perform contextual analyses and provide insights into the effectiveness of the recommended measures and their combination. This approach also allows us to analyze the extent to which the methodology we propose is consistent with the approach chosen by the professionals who carried out the diagnoses. Finally, it allows us to explore the potential of synthetic models for the ex ante analysis of mitigation policies.