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A Framework to design a GIS-based decision support tool for cyclone-induced marine flooding management at Reunion Island

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Coastal flooding by wave overtopping is quite regular at Reunion Island, in particular during cyclonic events. Given the limited geographic scale of this phenomenon, the municipalities are often in first line to assure the protection of the population. Current operational forecasts provide nearshore marine conditions of waves and water levels but this information is not directly usable to estimate the flood extension and anticipate operational measures. Thus, there is a crucial need for the municipalities to have flexible and practical tools at their disposal to interpret the marine forecasts in terms of flooding impact on their territory and enhance their capacity to anticipate and organize their operational response.

Here, we propose a framework to design a GIS-based decision support tool based on both feedback analysis, field observations and state-of-the-art coastal hydrodynamic modelling. The method notably relies on a pre-calculated database of 500 synthetic events simulated with a complete chain of models: (1) WW3 for waves (2) MARS-2DH for water levels and surge (2) SWASH for wave overtopping. The analysis of the relationship between marine conditions, overtopping discharge volumes and flooded areas led to the constitution of inundation maps, delimiting the extension of impacted areas given different levels of exposure. It is coupled with a graduated response plan, defining a list of operational actions associated to each level (water level monitoring, alert, roads closure, evacuation, etc.). The criteria of transition between the different levels connect marine forecasts with field observations and historical landmarks, thus enabling different levels of use and anticipation.

This tool was constructed in a collaborative manner with the municipal services of Sainte-Suzanne city (northern coast of Reunion Island) and tested during a crisis exercise on site. During the exercise, it allowed the municipal services to project into the future of the event, and thus to adapt to the situation and to anticipate the actions to be implemented. The appropriation of this GIS-based decision support tool must continue for the municipal services to gain in efficiency.