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Multi-hazards consequences in coastal context at different scale analyses (Normandy, France)

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Coastal environment with high interaction between nature and societies (land-sea interface) are subject to multi-hazards interaction such as landslides, flood or cliff retreat. These territories are characterized by numerous Element at Risk (EaR) located in valley bottoms, front sea, at the outlets of small dry-watershed or on landslide areas. The aim is to quantify the potential consequences of EaR by integrating multiple hazards interaction at various scale analyses. The experimental study site is located in the margin of the Parisian Basin. It is characterized by alternating sequences of plateaus and valleys between Houlgate and Honfleur (Normandy—France).

To identify and quantify these EaR, three scales analyses have been used from medium scale (1:50,000 – 1:25,000), to local scale (1:10,000 – 1:2,000) by using multi-criteria approach. To quantify the EaR, we adopted three steps approach:

1) Definition of an initial index value of EaR according to the rank order weighting without considering the hazards (proximity, location, etc.). This initial value is attributed at three different scales. (a) At medium scale, a global value of EaR is defined by integrating all components of the study site (such as built-up areas, agricultural areas, etc.). (b) At medium scale, the infrastructure value (buildings, roads and lifelines) is defined from physical injuries and both functional and structural components. (c) At local scale, the index value is defined according to the variations of intrinsic structural component of building.

2) Considering environment constraint (hazard location) to define a second index value to EaR. It means that we consider the location of EaR in relation to flood, landslide area or both areas. This new value is computed to the initial index value (step 1) to take into consideration these different hazards. Consequently, it is necessary to firstly define boundaries of the hazard (flood envelope, landslide limits) by GIS-approach. These boundaries are defined according to multiple criteria such as distance to the river, low-lying areas or morphology (alluvial plain) for flood area. Potential landslide areas are defined according to parameters as slope degree, curvature, aspect and historical density of landslides. Multi-hazards areas are the conjunction of both flood and landslide areas (including cliff retreat).

3) The initial value of EaRs is combined with hazards and multi-hazards index value by fuzzy logic system. A series of conditions defined by different operators (such as Max, Min, And, Or, etc.) take into consideration the evolution initial value (step 1) of EaR according to the type of hazard (step 2).

Two main results emerged from this study. In first, we have quantified potential consequences at three different spatial scale analyses (from medium to local scale analysis) without considering hazards. This provides a first information of sensitive EaRs on the territory even in case of alteration of hazard areas (climate change). However, this first information should be completed with multi-hazards integration in order to highlighted potential consequences to different hazards. Consequently, this multiple scale analysis by integrating consequences to multiple hazard provide a better assessment of EaRs for the purpose of improve the disaster risk reduction.