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Analysis of uncertainties in the entire process of tsunami vulnerability assessment

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In the framework of European SCHEMA project (www.schemaproject.org), whose aim is the development of a methodology for the vulnerability assessment for tsunami hazards in the Atlantic and Mediterranean area, we carried out an analysis of the uncertainties that intervene at different stages and several levels of the entire process, from post disaster field measures to hazard and damages assessment.
Errors are for instance introduced when collecting post disaster observations during field survey, owing to the different measuring methods: type of instruments used, type of water marks taken into account, referential (sea level or ground), type of correction applied for tides. In some extreme cases (Banda Aceh, Indonesia), differences of several meters have been found between measures of inundation heights taken by different teams at the same locations.
Other uncertainties are due to limitations of the numerical codes employed for reproducing the tsunami generation, propagation and run up. A very critical point is the accuracy of the input parameters for numerical modelling, especially the resolution of the employed DTM or DEM, which can noticeably affect the extension of the predicted inundated area. Concerning the duration of the modelled phenomenon, the comparison of five different numerical tools against a common test site led us to verify that the consistency of the computations on the long term varies sensitively depending on the code. This is particularly visible when observing the synthetic tide gauges, some of them showing maximum waves even 10 hours after the first one. This rises the problem of reliability of results for instance for emergency management in dangerous coastal strips exposed to repeated waves, where rescue teams may have to work during several hours or days.
The damage assessment is carried out by means of fragility functions or matrices, which in our case have been empirically developed from data acquired where a very strong earthquake occurred before the tsunami attack and thus exhibit cumulated effects of both phenomena. They also integrate secondary factors of damaging such as effects of erosion or impact of floating objects. Moreover, the damage functions are built linking the mean damage level on buildings with the maximum water elevation measured on the field, thus they do not take into consideration tsunami parameters such as the stream velocity or the hydrodynamic force.
A last crucial point we considered concerns the uncertainties introduced in hazard mapping due to cartographic processing. We could check that an offset in the inundation maps can be due to a distortion of output raster maps or to resampling of the input DTM automatically operated by the numerical codes used for the tsunami simulation. Often this offset is less than 1 pixel, which can be acceptable for hazard mapping at regional level, but is more difficult to manage at local scale for detailed vulnerability studies.