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Impulse waves modeling for coastal area risk analysis

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The increase demand for hydrogeological risk assessment in coastal area motivate the research for sustainable flood risk management all over the world. This task has to account that coastal area is complex environment and pose particularly challenging problems due to the simultaneous operation of several processes (atmospheric, oceanographic, biological and geological).

The authors have developed a methodology for the hydrogeological evaluation of risk in coastal area based on a combined damage *ex-post* and *ex-ante* analysis. The proposed approach develops quantitative procedures that evaluate the *total* risk of flooding, reflecting possible contributions of various operational, hydrologic, hydraulic, and geotechnical factors and how they might act individually and jointly.

In the ex-post analysis (actual damage) historical and geological data are combined in order to reconstruct flood recurrence and associated geological effects. The ex ante analysis is indeed a potential damage investigation in which different scenarios in terms of time recurrence and extent of flood events are considered.

The study of impulse water waves that may be highly destructive both in terms of property damage and loss of lives is of prime importance in the analysis of potential damage in coastal areas. Despite impulse water waves have been modelled with a variety of numerical methods, only detailed numerical approaches are accurate enough to correctly predict the mechanism of impulse wave generation, thus allowing to evaluate the associated risk. Therefore, as a significant part of the ex-ante analysis, we developed a 3D transient numerical model to simulate impulse water waves that may be generated during catastrophic floods by the sudden fall of alluvial or landslide material into the sea. The model is based on coupling a full Navier Stokes mathematical model to a Volume Of Fluid (VOF) method, in the FLUENT 6.2 environment.

Since our simulation approximates the landslide material as a liquid, the problem is schematised in a multi-component (water, air and landslide) two-phase flow. The model has been updated and validated with literature experimental data on impulse waves generated by subaerial landslides impacting onto a water body. The comparison between numerical and experimental demonstrates the accuracy of the method and its ability to reproduce the complex flow phenomena that occur during the initiation of an impulse wave associated with an extremely unsteady process: impulse flux transfer, flow separation and reattachement, water cavity formation and collapse.

The effectiveness of this approach is also demonstrated by simulating the case study of the mega-tsunami wave produced in 1958 by an earthquake generated landslide impacting onto the water of the Lituya Bay, Alaska.