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A physically based criterion for hydraulic hazard mapping

Luca Milanesi (1), Marco Pilotti (2), and Olga Petrucci (3)

(1) Università degli Studi di Brescia, DICATAM, Brescia, Italy (luca.milanesi@ing.unibs.it), (2) Università degli Studi di Brescia, DICATAM, Brescia, Italy (marco.pilotti@ing.unibs.it), (3) CNR-IRPI (National Research Council-Research Institute for Geo-Hydrological Protection), U.O.S.of Cosenza, Rende (CS), Italy (o.petrucci@irpi.cnr.it)

Hydraulic hazard maps are widely used for land use and emergency planning. Due to their practical consequences, it is important that their meaning is effectively transferred and shared by the stakeholders; to this purpose maps should communicate hazard levels moving from the potential consequences on specified targets. For these reasons flood maps showing only the extension of the inundated areas or flow features as depth and/or velocity may reveal themselves as ineffective instruments. The selection of the specific target to analyse must, in our opinion, be site-specific and reflect land use and/or the hydraulics features of the phenomenon. In case of sudden processes, such as torrential floods or debris flows, hazard levels should be referred to human life, because emergency plans may not mitigate risk; on the contrary, when the time scale of the flood wave propagation is sufficiently larger than the warning system one, the focus might move to the economic value of properties, since human-focused criteria may result in too severe land planning restrictions. This contribution starts exploring, from a theoretical point of view, human hazard levels as drowning, toppling and friction stability limits, which are the main failure mechanisms of human stability in flows. The proposed approach considers the human body, set on a slope and hit by a current of known density, as a combination of cylinders with different dimensions. The drowning threshold is identified through a limiting water depth, while toppling and translation are studied respectively through a moment and momentum balance. The involved forces are the friction at the bottom, the destabilizing drag force exerted by the current, the human weight and buoyancy. Several threshold curves on the velocity-depth plane can be identified as a function of different masses and heights for children and adults. Because of its dependence from the fluid density, this methodology may be applied also to define hazard thresholds for debris flows if the simplification of considering the presence of debris through an augmented density of the fluid continuum is accepted.
This methodology, which fits with most literature experimental dataset for both adults and children impacted by a flood, is then tested with historical data concerning flood events truly occurred in the past. Data have been mined from a historical database containing approximately 11000 records concerning the effects of hydro-meteorological events occurred in Calabria (southern Italy) since 19th century, selecting only the events where people were directly involved. These data come from different sources as newspapers, archives of national and regional agencies, scientific and technical reports, on-site surveys reports and information collected by interviewing both involved people and local administrators. Dealing with descriptive information of events occurred in different historical periods and morpho-climatic sectors of the region, the quantities required to implement the model can be found in a limited number of recent cases. In order to widen the data set that can be used to validate the proposed methodology, we explore some approaches to indirectly assess the parameters required to implement the model.