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A contribution for predicting Tsunami inundation induced by rock fall along the Gaeta cliff (Central Italy)

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Many sectors of Italian coasts are characterized by tall scarps, close to large or pocket beaches that display ramp shape with moderate to low acclivity profile. During the summer, all these beaches are densely populated by sunbathers. Moreover, Italian coastal areas are often intensely urbanized even at a short distance from the sea and very close to sea level. Being cliffs often affected by gravity processes, the impact on the water of a falling volume of rock, depending on size and height of fall, may represent a potential source of tsunami-type hazard for adjacent beaches and boats.

In this work we present an attempt to evaluate the run-up and ingression values in the Serapo beach (Gaeta, Tyrrhenian Sea coast of Central Italy) of an anomalous wave induced by a potential rock fall along the contiguous more than 100 meters high limestone cliff (the so-called Montagna Spaccata, "cleft mountain").

Detailed geological and geomorphological field analyses are being carried out, including geomechanical analyses and geodetic monitoring, in order to recognize the sectors with the most critical stability conditions. Preliminarily, the major potential volume of instable block and its most likely kinematics have been estimated with the purpose of characterizing the rock fall process.

The first water rise produced by the impact of the rock on the sea surface has been estimated according to two approaches: a) the Murty (2003) equation, that gives the relation between water elevation and volume of fallen material; b) the Glasstone and Dolan method (Hills & Mader, 1997), comparing the carbonate rock fall to a meteoritic impact on the sea surface. The rockfall kinematics suggests that the Glasstone and Dolan equation, despite it was developed for a different environment, is better applicable than Murty's (valid for slides) to the case under discussion. On the basis of the Green's law (1837) we defined the shoaling component of the run-up values. Our results show that the impact on the water of the hypothesized carbonate block will produce off-shore of the Serapo beach a maximum first water elevation of about 0.45 m. The resulting run-up value would reach 4.25 m $\pm$ 0.30 at the Serapo beach.

Combining the expected run-up data with the available Digital Elevation Model we defined the inundation map for this coastal sector. The map shows that the studied area is interested by a high level of risk: the whole Serapo beach would be inundated because of a rock block fall of the assumed size (2,500 cubic meters), which is very large, but not impossible.

We are well aware that the many uncertainties in the here applied methodology can provide only a rough estimate of run-up distribution; the method was originally developed for a meteorite impact in the ocean, with much greater energies and water depths, and the input data are not detailed enough for a modeling at the needed scale. Yet, we believe our results not at all unrealistic and therefore calling for a more precise investigation. Together with the studies now in progress, we will realize a more precise DEM of sea floor and beach. In the meanwhile, we are investigating new analogical/numerical models specifically focused on this hazard.