



Flash floods along the Italian coastal areas: examples from Pozzuoli city, Campania, Italy

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The Italian western coastal areas are the most exposed in the country to low-pressure systems coming from the central-western Mediterranean Sea and Atlantic Ocean. In the last years, many Italian coastal villages were struck by floods and flow processes triggered by high-intensity and short-duration rainfall, typical of flash flood events. In the Campania region (SW Italy) a series of events has caused several fatalities and heavy damages in the last decades, i.e. the flash floods of Casamicciola - Ischia Island (10/11/2009 - 1 fatality) and Atrani (9/9/2010 - 1 fatality). In this work we describe the rainfall properties and the ground effects of the 2009, 2010 and 2011 flash floods which involved the city of Pozzuoli, along the Campi Flegrei coast, where a catastrophic flood event (13 fatalities) is reported in 1918 in the AVI Project database. Rainfall data were measured at a sampling rate of 10 minutes by a regional Civil Protection rain gauge located in the city of Pozzuoli near the areas struck by the flash flood effects. In order to analyze the extreme features of the rainstorms and compare them, we have considered the 1-hour maximum rainfall amount and the 10-min peak storm intensity value for each event. The first rainstorm occurred on 14 September 2009; it was characterized by a 1-hour maximum rainfall amount of 34.4 mm and a 10-min peak storm intensity of 57.6 mm/h. The second rainstorm occurred on 30 July 2010; it was characterized by a 1-hour maximum rainfall amount of 40.6 mm and a 10-min peak storm intensity of 126 mm/h. The third rainstorm occurred on 06 November 2011; it was characterized by a 1-hour maximum rainfall amount of 44.2 mm and a 10-min peak storm intensity of 67.2 mm/h. The three described rainstorms all triggered erosional processes and shallow landslides in the upper part of the Pozzuoli drainage basin that supplied sheet flows and hyperconcentrated flows downstream, with severe damage to the human structures built near or inside the main drainage channels. In this area, in fact, one of the most serious problems for the Civil Protection authorities is the intense urbanization that dramatically increases not only the volcanic and seismic risks but also the level of geo-hydrological risk. The high degree of damage within the basin was also caused by incautious man-made modification of sectors of the drainage network and the use of culverts and even concrete-walled channel segments that in some cases were used as paved roads for local transportation. In all the three cases no warnings were issued to citizens because of the lack of early-warning systems but, fortunately, no fatalities or injuries were reported after the events. The analysis of these flash flood episodes showed an interesting case of interaction between hydrological processes and the geologic setting of a highly urbanized area such as the Campi Flegrei district, where the occurrence of heavy rain coupled with abundance of loose pyroclastic material on the steep volcanic hillslopes is likely to produce high levels of geo-hydrological hazard and risk.