



## **Origin and evolution of sinkholes in an alluvial setting: the case study of Piano dell'Acqua (San Basile, Northern Calabria, Italia)**

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Five sinkholes have recently been identified at “Piano dell’Acqua”, in the territory of San Basile (Northern Calabria, Southern Italy). They are located in a hilly setting, where the main landform is represented by a slight valley draining toward the east. The sinkholes are limited in size, with maximum diameter of 10 m, and maximum depth of 2.5 m. Two of them present elongated shapes, whilst the remaining three are circular. The area where the sinkholes developed is characterized by Pliocene conglomerate and sand, dislocated by tectonic lines.

Sinkhole phenomena were initially investigated in the whole territory by means of multi-temporal aerial photos; the outcomes from this analysis were checked in the field through geological, structural and geomorphological surveys. Historical analysis was started in order to collect and critically evaluate the existing information and testimonies about the age of occurrence of the surveyed phenomena; several interviews with local inhabitants were performed, and a number of archives scrutinized.

As a result, it may be assumed that two out of the five identified sinkholes developed during the winter 2000-2001 (period “a”), with likely rapid formation; two of the other cases probably originated during the 70’s (period “b”), as also suggested by the age of the vegetation hosted within the sinkholes; c) the last sinkhole opened sometime between February 2001 and November 2007 (period “c”). According to the collected testimonies, a further phase of sinkhole development might have occurred in the first half of the past Century, but no field evidence of this older phase has been found.

Analysis of the seismic catalogues showed that no earthquake can be identified as possible trigger of any of the sinkholes at Piano dell’Acqua. Therefore, the origin of the studied phenomena may be related to sub-cutaneous erosion, within an area that is rich in groundwater. Local changes in the water table, both related to climate and man-induced activities, may have triggered the development of the sinkholes that, according to the sinkholes’ classification by Waltham and co-workers (2005), belong to the “suffusion” or “dropout” types.

The local stratigraphic and tectonic conditions at Piano dell’Acqua have been investigated through Electrical Resistivity Tomography, aiming at also identifying unknown underground cavities which may be hydraulically connected with the superficial features. Moreover, hydrologic investigations have been carried out in order to analyse in detail the climatic conditions of the three periods (a-c) mentioned above. Recorded rainfalls and drought periods have been analysed by means of the Standardized Precipitation Index, by computing the deficit of precipitation for different temporal scales. By applying the method of the runs, the return periods of the drought periods have also been evaluated.

Thanks to the performed analyses, the geological characteristics of the study area and the climatic characteristics of the assumed periods (a-c) of origin of the sinkholes have been investigated in detail, and a progressive shortening of the return periods of origin of the sinkholes could be pointed out.