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Quantitative analysis of "calanchi" slopes in northern Sicily: erosion rates and their relationships with rainfalls and physico-chemical properties of terrains

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Three years (2006 – 2009) of monitoring data from two calanchi sites located in the western Sicilian Appennines are analyzed and discussed: the data comes from two networks of erosion pins and a rainfall gauge station.
The aim of the present research is to quantitatively analyze the effects of erosion by water and to investigate their relationships with rainfall trends and specific properties of the two calanchi fronts.
Each of the sites was equipped with a grid of randomly distributed erosion pins, made of 41 nodes for the "Catalfimo" site, and 13 nodes for the "Ottosalme" site (in light of the general homogeneity of its geomorphologic conditions); the erosion pins consist in 2 cm graded iron stakes, 100 cm long, with a section having a diameter of 1.6 cm. Repeated readings at the erosion pins allowed to estimate point topographic height variations; a total number of 21 surveys have been made remotely by acquiring high resolution photographs from a fixed view point. Since the two calanchi sites are very close each other (some hundred meters), a single rainfall gauge station was installed, assuming a strict climatic homogeneity of the investigated area. Rainfall data have been processed to derive the rain erosivity index signal, detecting a total number of 27 erosive events.
Despite the close distance between the two sites, because of a different geologic setting, the calanchi fronts are characterized by the outcropping of different levels of the same formation (Terravecchia fm., Middle-Late Miocene); as a consequence, both mineralogical, textural and geotechnical (index) properties, as well as the topographic and geomorphologic characteristics, change. Therefore, in order to define the "framework" in which the two erosion pin grids have been installed, 40 samples of rock have been analyzed, and a geomorphologic detailed survey has been carried out; in particular, plasticity index, liquid limit, carbonate, pH, granulometric fractions and their mineralogic properties, electrical conductivity and sodium adsorption ratio (SAR), have been characterized.
The analysis of the data allows to define relationships between the response of each erosion pin and the erosive rainfall events, the micro-hydrologic of its position and lithotechnical properties of the outcropping rocks. The estimations of the mean annual erosion rate and of the erosivity index, as well as results of the terrain analysis, largely agree with available data from literature observed in similar sites affected by calanchi development. Moreover, the gained results well reflect the differences of the morphologic features and their distribution on the two calanchi fronts; of particular interest is the spatial distribution and variability of piping landforms that markedly influence the development of gullies, specially on "Catalfimo" site, where a high frequency of pipes of different typologies can be detected.