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Andic soil features and debris flows in Italy. New perspective towards prediction

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Debris flows are dangerous hazards causing fatalities and damage. Previous works have demonstrated that the materials involved by debris flows in Campania (southern Italy) are soils classified as Andosols. These soils have peculiar chemical and physical properties which make them fertile but also vulnerable to landslide. In Italy, andic soil properties are found both in volcanic and non-volcanic mountain ecosystems (VME and NVME). Here, we focused on the assessment of the main chemical and physical properties of the soils in the detachment areas of eight debris flows occurred in NVME of Italy in the last 70 years.

Such landslides were selected by consulting the official Italian geodatabase (IFFI Project). Andic properties (by means of ammonium oxalate extractable Fe, Si and Al forms for the calculation of Al_o+1/2Fe_o) were also evaluated and a comparison with soils of VME was performed to assess possible common features.

Landslide source areas were characterised by slope gradient ranging from 25° to 50° and lithological heterogeneity of the bedrock. The soils showed similar, i.e. all were very deep, had a moderately thick topsoil with a high organic carbon (OC) content decreasing regularly with depth. The cation exchange capacity trend was generally consistent with the OC and the pH varied from extremely to slightly acid, but increased with depth. Furthermore, the soils had high water retention values both at saturation (0.63 to 0.78 cm^3 cm^{-3}) and in the dryer part of the water retention curve, and displayed a prevalent loamy texture. Such properties denote the chemical and physical fertility of the investigated ecosystems. The values of Al_o+1/2Fe_oindicated that the soils had vitric or andic features and can be classified as Andosols. The comparison between NVME soils and those of VME showed similar depth, thickness of soil horizons, and family texture, whereas soil pH, degree of development of andic properties and allophane content were higher for VME soils. Such results are consistent with the different soil environments; indeed, in VME a continuous soil enrichment of weatherable volcanic glass affects both soil pH and formation of short range order clay minerals. In conclusion, the direct relationship between debris flows and Andosols, previously found in the Campania VME, is confirmed in some NVME. These findings highlight the similarity of the materials involved by debris flows both in VME and NVME and suggest the existence of a pedological control on debris flow initiation. Furthermore, these results encourage a further extension of soil studies to other European mountain ecosystems.

The evidence that andic soils may play a crucial role in debris flows initiation in Italy enables to develop a new strategy for debris flows forecasting. For the case of Sarno 1998 landslides, we provide an example of innovative approach exploring the results obtained by combining the spatial distribution of these andic soils with “on the fly” simulation modelling of the soil water balance, using real time weather forecasting data. The obtained results enable to develop promising Geospatial Decision Support Systems to improve our ability to predict debris flows on soil-covered slopes.