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# The influence of lithology, land cover, road network and slope gradient in the landslides triggered during the period November 2008 – February 2009 in northern Tuscany (Italy)

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In the provinces of Lucca and Pistoia (Tuscany, Central Italy) 650 landslides (mainly shallow rapid slides and debris flows) were registered by Civil Protection during the period spanning from November 2008 to February 2009.
During that period both provinces were struck by widespread precipitations: in November three distinct brief but very intense events brought the monthly precipitation well above the mean value, while the month of December was conversely characterized by heavy and prolonged precipitations whose cumulative amount doubled the monthly mean value. During January and February brief and intense precipitations struck again diffusively the whole studied area.
As a consequence of such a prolonged period of abundant rainfall, hundreds of landslides occurred in the provinces of Lucca and Pistoia damaging private and public buildings, assets and infrastructures. The state of emergency was declared by the National Civil Protection from December to February.
Rainfall has been without doubt the triggering factor of the landslides, but can some predisposing feature be identified? The answer is decisive for improving risk assessments and for developing effective emergency plans for civil protection purposes.
For example, rainfall thresholds can be easily used to set up warning systems that can forecast the time of occurrence of landslides but such methods have a very coarse spatial resolution: the identification of predisposing elements could be helpful to identify the most risky locations in order to reduce the spatial uncertainty.
From the Provincial and Regional Civil Protection archives many information about the occurred landslides were gathered and organized into a geographic database making use of a GIS system. Data include the exact location and day of occurrence of the landslides and their type.
By means of a GIS analysis, the landslides database was superimposed to various thematic maps (geology, land cover, road network, slope gradient) in order to estimate which value or class had been more often associated to landsliding during the studied event.
Results highlights that road cuts seem to be one of the most predisposing features, together with the presence of layered or schistous geologic formations. Many landslides concentrated in agricultural areas or in artificially modified slopes and, quite surprisingly, slope gradient seems to have played a secondary role.
Landslides are very recurrent phenomena in the studied area and on behalf of the local civil protection agencies the Earth Science Department of the Florence University is at present defining an alert system based on spatially variable rainfall thresholds. The alert system is still in a test phase and it is not yet operative, but some of the thresholds it is based upon have been validated making use of the data concerning the reported event. A comparison with other classic literature thresholds has been performed as well. The errors committed by each model have been then characterized in light of the afore discussed predisposing factors.