# Landslides: New early warning systems reduce false alarms

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Many slopes in the Campania region of Italy are covered with layers of volcanic soil, the result of repeated eruptions over the course of millennia. As the impacts of climate change worsen, including the occurrence of very intense and short rainfall in localized areas, there is a growing need, especially in this and other Italian regions that are vulnerable to landslides, to understand the dynamics that induce such events more precisely and develop models that can predict them. When employed through adequate early warning systems, these tools can support decision-makers in adopting effective and efficient measures to protect people and the areas themselves from landslides.

To this end, the study "Exploring ERA5 reanalysis potentialities for supporting landslide investigations: a test case from Campania Region" (Southern Italy) by the CMCC Foundation identifies the potential of the fifth generation of atmospheric models (known as reanalysis dataset ERA5) developed by the European Centre for Medium-Range Weather Forecasts for improving the performance of early warning systems used, for example, by the Civil Protection (Protezione Civile).

On a slope covered by pyroclastic soil landslides are usually caused by a combination of two factors: the antecedent slope wetness conditions and the triggering condition represented by an intense precipitation event. The early warning system currently used by the Campania region uses the latter as the only indicator, ignoring the antecedent conditions of the soil. As a result, every time a precipitation event of a certain intensity is forecasted, whatever the state of the ground at that specific moment, the system returns a state of alert, pre-alarm or alarm. This increases the likelihood of false alarms and therefore of decisions—such as road closures—which may cause interruptions to services that in some cases could be avoided.

"Reanalyses are atmospheric models, the same ones that are used for forecasting. But they are usually used in back-analysis to reconstruct past weather conditions," explains Guido Rianna, CMCC researcher and co-author of the study. "Because of this characteristic, the purpose of reanalyses is not to forecast, but to homogenize, from a spatial and temporal point of view, data from different in situ monitoring systems—such as weather stations—or from remote sensing, such as satellites."

The fifth generation of reanalysis (ERA5) has a much better spatial resolution than the previous ones, providing atmospheric variables on grid cells of about 30 km side. In addition, it is possible to access free daily updated data through the Climate Data Store of the Copernicus

Climate Change Service. This data ranges from 1979 up to 5 days before the consultation. Such a short time of data release allowed the authors of the study to assume—and then verify—a good performance of the tool not only for back-analysis studies but also for operational purposes such as the development of early warning systems.

"We first verified the reliability of the ERA5 reanalysis in reproducing rainfall histories leading to landslide events that actually occurred in the studied area," says Alfredo Reder, CMCC researcher and first author of the publication. "Next, we analyzed the specific landslide event that occurred in Nocera Inferiore (Campania) on 4 March 2005. We verified that, at that event, the soil moisture estimations offered by ERA5, although not free of constraints and limitations, would have been able to observe a very high value in terms of water content along the entire cover. Thus, we have been able to take the final step of evaluating the possibility of using these reanalyses operationally for an early warning system. In the last phase of our research, we verified that the ERA5 datasets, if used as a proxy to support a decision, could improve the reliability of the forecasting model currently used in Campania, because they can provide information on antecedent slope wetness conditions, which are a predisposing factor for a landslide event."

The results of the study suggest the potential of this tool especially for minimizing false alarms, while avoiding missed alarms.

"Any expert on landslides in pyroclastic soils would say that the occurrence of an intense precipitation event in September in Campania, happening on a soil in dry condition, can rarely trigger a landslide," concludes Rianna. "But to date there is a lack of quantitative observational support to affirm this. Today, a Civil Protection decision-maker, on the basis of existing studies in the literature, could not fail to sound the alarm in the event of a forecast of a precipitation event with certain characteristics: he could not support this choice with data on the

state of the soil in the prior period (except for a few limited slopes). Our research shows that ERA5 could fill this gap and therefore minimize the number of false alarms."

The results of this research apply to the case of pyroclastic landslides, which are characteristic of the studied area. The next step will be to verify the suitability of ERA5 reanalyses for the same purpose but in the case of other soil types, such as clay soils leading to slow landslides, which are characteristic of various areas of Italy, such as the southern Apennines and some areas of Basilicata and Campania.

**More information:** Alfredo Reder et al, Exploring ERA5 reanalysis potentialities for supporting landslide investigations: a test case from Campania Region (Southern Italy), *Landslides* (2021). DOI: 10.1007/s10346-020-01610-4

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