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Comparison of TRMM satellite rainfall estimates with rain gauge data and landslide empirical rainfall thresholds under different morphological and climatological conditions in Italy

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Quantitative information on rainfall is necessary to predict the possible occurrence of rainfall-induced landslides. Landslide early warning systems attempt to predict rainfall-induced landslides through the comparison of quantitative rainfall information with empirical rainfall thresholds for the possible occurrence of landslides. Most of the systems exploit rainfall measurements obtained from networks of gauges, and only a few systems use satellite rainfall estimates. All the systems exploit empirical rainfall thresholds defined using rainfall measurements obtained from networks of rain gauges. Despite the availability of quantitative satellite rainfall estimates, and their experimental use in existing warning systems, surprisingly limited research has been done to compare satellite rainfall estimates and rain gauge rainfall measurements, for the forecasting of possible landslide occurrence. In this work, we analyse the relationships between rainfall measurements obtained from a network of > 1950 rain gauges in Italy and rainfall satellite estimates for the same area obtained by the NASA Tropical Rainfall Measuring Mission (TRMM-RT and TRMM-v6), for the period 2009-2010. Coupling point rain gauge measurements and TRMM rainfall estimates at individual grid cells (0.25° latitude × 0.25° longitude), we evaluate the correlation between the gauge rainfall measurements and the satellite rainfall estimates in different morphological and climatological conditions, using linear and power-law fitting models. We use cumulative rainfall measurements/estimates for different periods, from 3 to 72 hours. We analyse and compare the distributions of the ground-based rainfall measurements and the satellite rainfall estimates using standard non-parametric and parametric statistical methods. We observe significant differences in the obtained distributions for different morphological and climatological areas in Italy. Differences are larger in mountainous areas, and collectively reveal a complex relationship between the ground-based rainfall measurements and the satellite rainfall estimates. Power law correlation models have the best fitting performance, at the expenses of large prediction intervals, particularly for large values of cumulated rainfall. An exponential distribution provides a better fit for satellite rainfall estimates, compared to rain gauge measurements. The preliminary results indicate that specific empirical rainfall thresholds have to be defined to fully exploit satellite rainfall estimates in existing early warning system.