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# An example of landslides regional warning system based on rainfall thresholds: the first step in Piemonte region (North-western Italy)

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The Arpa Piemonte Regional Warning System Service manages an advanced meteo-hydrological automatic monitoring and prediction system to oversee related natural hazard (meteorological and flood events) to reduce their impacts on anthropic environment. The Regional Warning System needs an integration about prediction of phenomena induced by rainfall as the landslides, characterized by more difficult evaluation. To fill this gap, we tried to integrate the Regional Warning System through an empirical method, applicable to regional scale, based on the correlation between rainfall levels and landslide movements historical information. The research focused on establishing rainfall thresholds for landslides trigger, differentiating the critical rainfall values (expressed as hourly mean intensity) through geological setting of landslide sites. We considered the rainfall events responsible for widespread landslide movements that involved the Piemonte region in a period between 1990 and 2004, for a total number of 20 rainfall events end 419 landslides having hourly trigger-time information. As a result, three threshold-type zones have been identified: a) Type 1 includes zones that require very high values of critical rainfall (5.2-8.3 mm/h) and are principally characterized by coarse-grained massive metamorphic or igneous bedrock and by dolomitic-calcareous or calcareous-schistic bedrock in alpine or pre-alpine environment; b) Type 2 includes zones that require high values of critical rainfall (3-5.5 mm/h) and are principally characterized by thin-grained massive or schistic metamorphic bedrock in alpine or pre-alpine environment; c) Type 3 includes zones that require lower values of critical rainfall (1.5-3.6 mm/h) and are principally characterized by sedimentary bedrock in hill environment. Moreover, for each Type-zone are available three threshold-levels corresponding respectively to the trigger of early shallow

landslides (few and localized phenomena - first warning level), to the trigger of most shallow landslides (widespread phenomena - second warning level) and to the trigger of other deeper landslide typologies too (widespread phenomena - third warning level). This empiric model has been calibrated by back analysis on historical events; since no significative event has happened after the implementation, this thresholds system still needs to be tested and verified on new future events. Further investigation can be addressed to thresholds variability depending on elapsed time between subsequent critical rainfall events. This aspect is probably linked to time interval necessary to reavailability of unstable slope situations after the previous mobilizations.