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Temporal reliability of a landslide inventory map. A case study in the Northern Apennines (Emilia-Romagna Region, Italy)

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Landslides are multidimensional processes that relate to spatial, temporal, and thematic components. By describing landslide location, characteristics, and pattern distribution, landslide inventory maps are essential tools for landslide specialists as well as for planners and decision-makers. Nevertheless, the lack of suitable information about their quality represents a significant limitation to their use and raises serious questions about possible misuses. In fact, due to the active nature of landslides and of anthropogenic processes, the time variable is an essential aspect of landslide inventories and a fundamental component of their quality assessment. This work aimed to define the temporal reliability of a landslide inventory map and to evaluate potential temporal trends.
We investigated the spatial and temporal evolution of slope failures in the Dorgola Valley (16 km2), a landslide-prone catchment located in the Northern Apennines and characterised by a man-made landscape. To this end, we prepared a multi-temporal landslide inventory on the base of 18 sets of aerial and satellite images spanning over a 60-year time interval (from 1954 to 2014). In particular, to investigate potential short-term trends, three sets of very high resolution GeoEYE images were purposely acquired from 2012 to 2014. The results of this study demonstrated that the total number of landslides in each image set is affected by three main factors: detection issues, anthropogenic processes, and slope failure activity and evolution. Basically, it turned out that landslide distribution is the result of two antagonistic forces: landslide activity sensu stricto, which contributes to increase the total number of mass movements, and man efforts to overcome landslides, which become more relevant and intense after slope instability climaxes. As a consequence, in order to understand how much a landslide inventory is affected by time, we analysed new detected landslides as well as those that disappear from the records. Notably, it emerged that most new detected landslides present quite small areas and concentrate in particular zones and within existing landslides. Furthermore, this study showed that, while the cumulative number of mass movements increased, the total area covered by landslides decreased with time. Ultimately, the cartographic matching between each pair of single inventories revealed that data quality undergoes a progressive deterioration both in the short- and in the long-term probably due to natural and man-induced revegetation. More generally, this work proved that landslide inventory maps need periodic updates especially as far as small landslides are concerned. For the Dorgola catchment, in particular, in order to record all slope failures and realise a landslide inventory as complete as possible, a desirable acquisition frequency is once a year or maximum every two years.