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Rainfall thresholds for the triggering of landslides in Slovenia

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Both at the worldwide level and in Slovenia, precipitation and related phenomena represent one of the most important triggering factors for the occurrence of slope mass movements. In the past decade, extreme rainfall events with a very high amount of precipitation occurs in a relatively short rainfall period have become increasingly important and more frequent, that causing numerous undesirable consequences. Intense rainstorms cause flash floods and mostly trigger shallow landslides and soil slips. On the other hand, the damage of long lasting rainstorms depends on the region's adaptation and its capacity to store or infiltrate excessive water from the rain. The amount and, consequently, the intensity of daily precipitation that can cause floods in the eastern part of Slovenia is a rather common event for the north-western part of the country. Likewise, the effect of rainfall is very dependent on the prior soil moisture, periods of full soil saturation and the creation of drifts in groundwater levels due to the slow melting of snow, growing period, etc.
Landslides could be identified and to some extent also prevent with better knowledge of the relation between landslides and rainfall. In this paper the definition of rainfall thresholds for rainfall-induced landslides in Slovenia is presented. The thresholds have been calculated by collecting approximately 900 landslide data and the relative rainfall amounts, which have been collected from 41 rain gauges all over the country. The thresholds have been defined by the (1) use of an existing procedure, characterized by a high degree of objectiveness and (2) software that was developed for a test site with very different geological and climatic characteristics (Tuscany, central Italy). Firstly, a single national threshold has been defined, later the country was divided into four zones, on the basis of major the river basins and a single threshold has been calculated for each of them. Validation of the calculated thresholds has been verified by the use of several statistical parameters. Equations of thresholds of each specific zone are quite different mainly due to different climate regime and the density of the rain gauge network. In general, all thresholds have good capacity of avoiding false alarms, but at the same time, some missed alarm can be expected from local threshold, while the national threshold will lead to less missed alarm. Beside the setting of a threshold system, directly usable for civil protection purposes at national scale, an additional outcome of this work is possibility of applying methodology to another region, therefore testing its degree of exportability in different geological and climatological settings.