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Modeling past and future landslide occurrences after extreme weather events in the Styrian basin, Austria

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In the ongoing EASICLIM Project (Eastern Alpine Slope Instabilities under Climate Change), funded by the Austrian Climate Research Program (ACRP), research focuses on possible changes in patterns of landslide occurrence due to climate change. However, the interplay between meteorological variables, land cover/land use and landslides is still not fully understood. In June 2009 an extreme event of heavy thunderstorms happened in the Styrian basin, Austria, triggering thousands of landslides. Detailed field mapping of the landslides executed by the Geological Survey of Austria, focused on the 730 km^2 region of Feldbach where more than 3000 landslides could be recorded. In September 2014 after a similar but less severe event, again a high number of landslides occurred in the Styrian basin.

The objective of this study was to assess the impact of the extreme weather events on the probability of landslide occurrences in the Styrian basin. For the analysis we developed a statistical model linking meteorological variables (e.g. weekly aggregated precipitation) to slope failure based on available data recorded during the 2009 and 2014 events. As basis for modeling we created an event-based inventory using mainly the datasets from the Geological Survey of Austria and from the Styrian Provincial Government, allowing the assignment of the meteorological triggering event to each landslide event separately. For the assessment of landslide occurrence probabilities a generalized additive model (GAM) was developed including local geomorphological, geological, soil, land cover/land use, and meteorological predictors. The model performance was assessed using spatio-temporal cross-validation, and the area under the receiver operating characteristic curve (AUROC). The spatial k-fold cross-validation was performed by calibrating the model to k sub-regions, and by predicting for each fold landslide occurrence for the remaining regions. For the temporal cross-validation the model was calibrated to the 2009 events and used for the prediction of the 2014 events, and vice versa. Under the assumption that landslide-conditioning processes remain unchanged, the new model has the potential to be used for future storylines of slope instabilities based on climate and land cover/land use scenarios.