Rainfall thresholds and susceptibility mapping for shallow landslides and debris flows in Scotland [poster]

This item was submitted to Loughborough University's Institutional Repository by the/an author.


Additional Information:

• This is a poster presented at the European Geosciences Union General Assembly 2017.

Metadata Record: [https://dspace.lboro.ac.uk/2134/25049](https://dspace.lboro.ac.uk/2134/25049)

Version: Accepted for publication

Publisher: Loughborough University and British Geological Survey

Rights: This work is made available according to the conditions of the Creative Commons Attribution 4.0 International (CC BY 4.0) licence. Full details of this licence are available at: [http://creativecommons.org/licenses/by/4.0/](http://creativecommons.org/licenses/by/4.0/)

Please cite the published version.
1. Introduction

The spatio-temporal occurrence of landslides is determined by: (i) factors related to slope susceptibility or ‘where’ landslides can occur, such as geomorphology or lithology; and (ii) factors related to ‘when’ landslides can occur including by the exceedance of antecedent and initiation rainfall thresholds. In this study, an inventory of 75 landslides in mainland Scotland (70,100 km²) for the period 2004 to 2016 is used to construct a landslide susceptibility map using a logistic regression model and rainfall thresholds are determined using a binary classification and receiver operating characteristic (ROC) analysis [1]. Susceptibility is calculated for individual hillslope sections and thresholds are derived from 5 km² resolution precipitation radar. These assessments are combined to produce a hazard map and to identify the strategic road network segments that are likely to be affected by landslides.

2. Method

A. Terrain Susceptibility

Logistic regression model trained and tested (70 - 30 split) using 30-fold cross validation. The mean coefficients are then used to model the susceptibility of all hillslopes in Scotland. The model factors include:

- Hillslopes: hydrodynamic slope units with mean area of 0.21 km²; susceptibility is modelled for each hillslope unit.
- Slope Max & Elevation Range: continuous variables.
- Slope: classes for median slope angle (0 - 10o, 10 - 20o etc)
- Aspect: classes for mean slope aspect (NW - NE etc).
- Soil Parent Material: soil material and particle size (mm) classes.
- MR: classes for topographic roughness index.
- Rainfall: classes for mean rainfall (mm).

B. Trigger Thresholds

Determined using binary classification and ‘optimal point’ selection in ROC analysis (left); optimal point maximises landslide detection. Rain radar and monthly Rainy-Day-Normal (RDN) provides spatio-temporally normalised rain. The combination of 1-day rain duration and 12-day rain accumulation provides the most robust threshold detecting 68 % of landslides (right).

C. Landslide Hazard

Approximated by the product of terrain susceptibility and the greatest annual triggering frequency for each hillslope unit (results B).

For road network segments, hazard is the product of the sum of the susceptibilities and the greatest triggering frequency from the intersecting hillslopes. These are then converted to normalised probabilities to ensure consistency with the mean recurrence interval of the landslide inventory (6 Yr-1).

3. Results

A. Terrain Susceptibility

Odds ratio shows the change in the probability that a slope is susceptible for each different factor class or unit increase. Odds of 1 indicate no change. Positive and negative odds show increasing and decreasing probability, respectively. Grey shaded areas are not included as they have factors not associated to any landslides (clay soils < 0.002 mm).

B. Annual Trigger Frequency

Trigger frequency is highest in the North and West of Scotland. Grey shading shows the terrain elevation (max 1350 m asl). Lower frequencies in the east, including the Cairngorm mountains, are likely due to the rain-shadow effect of the west highlands.

C. Landslide Hazard

Landslide hazard is greatest for roads in central west Scotland. There is higher landslide hazard in the north west Scotland but with fewer adjacent roads. However, not all landslides will disrupt road segments and therefore hazard is likely to be overestimated.

Contact / Acknowledgements

Ben Postance: b.postance@lboro.ac.uk @benpostance

References: