British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Creating a Debris Flow Susceptibility Model for Great Britain – A GIS Based Approach

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What is a debris flow?

The term debris flow refers to the rapid downslope flow of poorly-sorted debris mixed with water (Ballantyne, 2004). Debris flows are described by (Hungr et al., 2014) as: "*very rapid to extremely rapid surging flow of saturated debris in a steep channel. Strong entrainment of material and water from the flow path*". They are a widespread phenomenon in mountainous terrain and are distinct from other types of landslides as they can occur periodically on established paths, usually gullies and first- or second-order drainage channels. Debris flows in Great Britain are most commonly found in upland Scotland but also in parts of Wales and the Lake District.

Types of Debris-flow in the UK

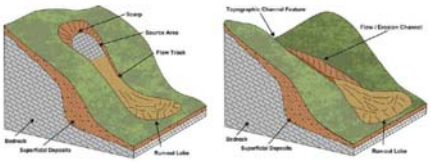
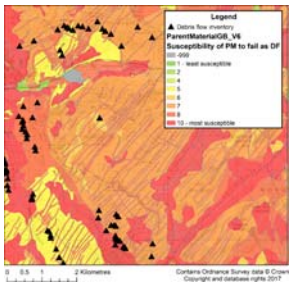


Figure from NETTLETON, I. M., MARTIN, S., HENCHER, S. and MOORE, R. 2005. Debris flow types and mechanisms in Winter, M. G., Macgregor, F. and Shackman, L. (Eds.) Scottish Road Network Landslides Study, The Scottish Executive. © Crown Copyright 2005. Contains public sector information licensed under the Open Government Licence v3.0.

Example impacts of debris flows in Great Britain

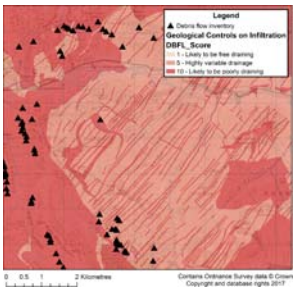
In recent years, the Scottish road and rail networks have been affected particularly by debris flows. In 2004, the A85 in Glen Ogle, north of Lochearnhead, Stirlingshire, was blocked by two debris flows trapping 57 people (Milne *et al*., 2009). Both debris flows totalled around 15 000 m^3 of deposit (Winter et al, 2014).The A85, which normally carries up to 5600 vehicles per day was closed for four days (Winter et al., 2006).

Geological factors that influence the likelihood (or not) of debris flows



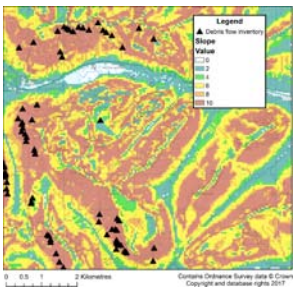
Availability of material

Using the BGS Soil Parent Material dataset, characteristics of the regolith were analysed and classified to determine the likelihood of failing as a debris flow.



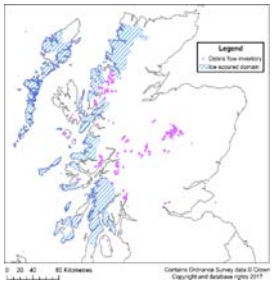
Hydrogeological conditions

Debris flows are usually triggered by intense rainfall events. If a potentially mobile deposit is permeable but the underlying deposit is of a more impermeable nature, infiltration of water will be impeded and this can lead to an increase in pore water pressure, subsequent lowering of shear strength and potentially a debris flow under the right conditions.



Slope and gullies

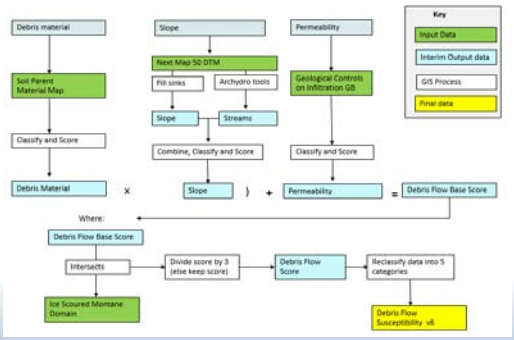
A key control on debris flow initiation is slope angle. Debris flows generally have a minimum limiting angle of around 30° but can be initiated on gully floors on slopes as low as 15-20° (Innes, 1983). Slope angle and channels (on slopes) were modelled using a 50 m DTM. Scores were assigned based on literature review and expert judgement.



Glacial scouring

Ballantyne (2004) highlighted that debris flows are scarce in areas of extensive glacial scouring that removed regolith material. Areas of glacial scouring were delimited for Great Britain using expert knowledge in conjunction with the BGS Quaternary Domains Map.

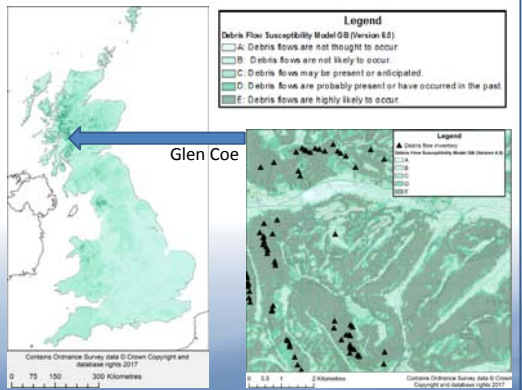
Model compilation



Each aforementioned geological and geomorphological factor that influences debris flow susceptibility were combined and reclassified into five categories reflecting the potential for a debris flow to be initiated.

Results

74% of known debris-flows within the inventory occur within category E. (16% in D, 4% C, 6% B and 0% A).



Model limitations

- The model is limited to areas where debris flows are initiated, as well as parts of the debris flow track. It does not indicate where the material involved in the failure will flow (run out).
- DTM used (NEXTMap™ 5m) has been resampled to 50m cell size for use at national scale. It does not always accurately represent the ground surface such as edges of woodland areas.
- The model does not include any influence of land cover or vegetation on the stability of a slope due to the data availability at a national scale that does not reflect vegetation type updated on a regular basis – this is better incorporated at the local scale.
- Only considers natural geological slope conditions.
- Intended purpose is 1:50 000 scale and the data is limited to the quality of geological surveying.

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