



A Strategic Approach to Debris Flow Risk Reduction on the Road Network

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Abstract

Rainfall-induced debris flows frequently cause disruption to the Scottish road network. A regional assessment of debris flow hazard and risk allows risk reduction actions to be targeted effectively. To this end a strategic approach to landslide risk reduction, which incorporates a classification scheme for landslide management and mitigation has been developed, in order to provide a common lexicon (or group of words) that can be used to describe goals, outcomes, approaches and processes related to risk reduction, and to allow a clear focus on those goals, outcomes and approaches. The focus is thus first on the desired outcome from risk reduction: whether the exposure, or vulnerability, of the at-risk infrastructure and people (and their associated socio-economic activities, which may be impacted over significant areas) is to be targeted for reduction or whether the hazard itself is to be reduced (either directly or by affecting the physical elements at risk). This paper describes the strategic approach in the context of perhaps Scotland's most active debris flow site, the Rest and be Thankful on the A83 strategic road.

Keywords: Landslides, debris flow, risk, management, mitigation, road

1 Introduction

Rainfall-induced debris flow events often affect the Scottish strategic road network. After a particularly severe series of events (Winter et al., 2006; Milne et al., 2009) the Scottish Road Network Landslides Study (SRNLS) was commissioned with the overall purpose of ensuring that the hazards posed by debris flows were systematically assessed and ranked allowing sites to be effectively prioritized within available budgets (Winter et al., 2005). The hazard and risk assessment comprised three phases:

- A pan-Scotland, GIS-based, assessment of debris flow susceptibility;

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- A desk-/computer-based interpretation of the susceptibility and ground-truthing to determine hazard;
- A desk-based exposure analysis, primarily focusing on life and limb risks, but also accounting for socio-economic impacts (traffic levels, and the existence and complexity of the detour were used to estimate these impacts).

These phases were used to determine the locations of sites of highest hazard ranking (risk) (Winter et al., 2009; 2013a). As part of the SRNLS Winter et al., 2009) an approach to the management and mitigation of landslides was developed. This allowed for both:

- Relatively low-cost exposure reduction (management) measures that can be applied extensively;
- Relatively high-cost hazard reduction (mitigation) that are targeted at specific sites.

In order to facilitate a strategic approach to landslide management and mitigation a structured classification scheme has been developed (Winter, 2014). This focusses on the overall goal of landslide risk reduction before homing in on the desired outcomes and the generic approach to achieving those outcomes. Only then are the processes that may be used to achieve those outcomes (i.e. the specific management and mitigation measures and remedial options) addressed. A top-down, rather than a bottom-up, approach is thus targeted. This scheme provides the main focus of this paper, drawing on the example of the A83 Rest and be Thankful site (Winter et al., 2009) to illustrate how this approach may be applied strategically. The Rest and be Thankful is perhaps the most active debris flow site in Scotland and has a significant effect on the operation of this part of the strategic road network. The site is located in the eastern part of Argyll, in the west of Scotland, and to the north-west of Glasgow and to the west of Loch Lomond.

While other forms of landslide are extant in Scotland most, with the exception of rock fall, rarely impinge on infrastructure. However, it is important to note that the principles put forward in this paper, if not the detailed examples, can be equally applied to other forms of landslide and, indeed, to other forms of geohazards, as well as other elements at risk.

2 Management and Mitigation

A regional landslide hazard and risk assessment enables the prioritization of sites potentially subject to risk reduction, in the light of defined budgets. However, it is important to note that it is only in cases for which the risk is deemed to be greater than that which is tolerable, or greater than the level at which the risk holder is willing to accept (Winter & Bromhead, 2012), that risk reduction is required. There are many forms of landslide mitigation (VanDine, 1996). However, to reduce landslide risk to acceptable levels, either the potential exposure (or vulnerability) or losses that are likely to arise as a result of an event, and/or the magnitude of the hazard, must be addressed. Thus management strategies involve exposure reduction outcomes and mitigation strategies involve hazard reduction outcomes (Figure 1). Further, it is important that those funding such works, including infrastructure owners and local governments, are able to focus clearly on goals of, the outcomes from, and the approaches to such activities rather than the details of individual processes and techniques.

To this end a strategic approach to landslide risk reduction (Figure 1), which incorporates a classification scheme for landslide management and mitigation was developed, to provide a common lexicon (or group of words) that can be used to describe goals, outcomes, approaches and processes related to risk reduction, and to allow a clear focus on those goals, outcomes and approaches.

It is designed to encourage a strategic approach to the selection of landslide management and mitigation processes (specific measures and remedial options). It is intended to aid a focus on the

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