Minimising Debris Flows with Native Aspen at the Rest and Be Thankful

A Proposal by Eadha Enterprises Feb 2012

Introduction

A number of recent landslide events have occurred across Scotland over the last few years which have been given a high media profile. These have caused sever disruption to transport systems and risked human life. Various studies have been commissioned by Transport Scotland to look at the causes of these slope failures and to assess the potential effects of climate change on the frequency and severity of events. Clearly, this is a major issue affecting upland areas of Scotland and is set to increase in severity in the future.

Landslides

Most events have been typical of flow-type landslides. The influence of substantial flows of water, the stripping of superficial deposits, and the speed with which debris has both flowed and been deposited have all been apparent. In many cases the initial trigger appears to have been the displacement of relatively small amounts of material, often into a stream channel. This has added a substantial debris charge to already high and potentially damaging water flows. The combination of water with high sediment loadings then has substantial erosive power. In other cases highly saturated materials have slumped rapidly downslope. Such events are typically described as 'debris flows' and are distinguished from most other types of landslides involving shear by the dynamic, as opposed to broadly static, nature of the failure mechanisms. Flows are generally characterised by rapid erosion and movement with high proportions of either water or air acting as a lubricant for the solid material.

Case Study A83 Glen Kinglas/Cairndow – 9 August 2004

The A83 in Argyll & Bute was blocked at two locations in Glen Kinglas, 0.5km and 2.5km from the junction with the A815, and at a point approximately 1km north of Cairndow. In addition to causing the road to be closed for slightly over a day, the debris flow at Cairndow also had a substantial effect on a residential property immediately upslope from the road. Numerous smaller debris flows were also observed on the hill slopes either side of Glen Kinglas. The A83 is a single-carriageway route and in Glen Kinglas lies at approximately 100m AOD, at the toe of the steep undulating slopes of Binnein an Fhidhleir and Stob Coire Creagach, which extend some 700m to 800m above the road. The slopes are generally vegetated with grass, bracken and occasional heather cover with a few forested areas on the lower slopes adjacent to the road. Rock outcrops locally on the slopes, but mainly on the higher ground. The slope is frequently incised with watercourses. These are culverted below the road and into Kinglas Water, located a short distance to the south of the A83. In early August 2004 the hillsides were in a saturated condition following a relatively wet spell during the preceding weeks. This was followed by a relatively short period of exceptionally heavy rainfall. Typically the flows commenced in the steep upper reaches of the slopes at around

500m AOD. At the head of each a shallow scarp, less than 1.5m, was observed. The waterlogged material is assumed to have flowed into existing water courses providing a more erosive sediment charge, resulting in erosion up to between 10m and 15m either side of the channels. Deposition occurred at the toe of the slope where the gradient slackens. Several hundred tonnes of material are estimated to have blocked the road at the two locations in Glen Kinglas. The debris blocking the road comprised very silty sand and gravel with frequent cobbles and boulders, the largest of which was estimated to weigh nine tonnes. Smaller boulders remained within the watercourses, although none was considered to be a further threat to the road.

Hazard Reduction Measures

The conclusion of various studies on landslides has led Transport Scotland to adopt a largely risk based approach given the scale of the problem and the impracticality and expense of installing hard engineering solutions. The focus has been on categorising each location and establishing an early warning system. However Eadha Enterprises believes that the use of bioengineering and more precisely eco-engineering solutions to address the problem has been neglected to have been considered in sufficient detail. The nature of land management can be one of the major factors determining slope instability. Overgrazed hill land is particularly prone to slope instability and the extent of this type of land throughout Scotland illustrates the scale of the problem. Conversely, the sensitive management of land, with appropriate grazing control and expanding areas of certain deep-rooted native tree species could have significant positive effects.

Vegetation and Land Cover

Vegetation may have three beneficial effects in maintaining slope stability:

1. Intercepting rainfall to reduce infiltration into the ground
2. Removing soil moisture
3. Reinforcement of the ground by a root network.

The amount by which particular vegetation improves the stability of a slope will vary with the type of vegetation. Trees are likely to be more beneficial than shrubs, which would be better than grass.

Plant roots play a critical role in stabilising colluvium against failure on hillsides. Furthermore, vegetation cover provides interception of rainfall and encourages evapotranspiration, thus reducing both direct and indirect infiltration into the soil which can de-stabilise colluvium. Removal of vegetation by deforestation and heather burning increases the possibility of debris flow by increasing water ingress into the soil. The effects of deforestation are known to endure for up to 10 years, with an associated elevated likelihood of instability during that time.

The most effective defensive measures against debris flows should target source, transportation and deposition areas. In source areas these include reforestation and ‘controlled harvest’ schemes to reduce debris production resulting from deforestation or natural loss of vegetation. Different types and densities of vegetation may be more or less retardant to debris flows depending upon how they affect soil infiltration rates and upon how their root system serve to hold the soil in place. Forestry can reduce the probability of

debris flows and the management of commercial forests can be designed to maximise stabilisation. In British Columbia, policy has concentrated on controlling timber harvesting and encouraging reforestation in the 'source zone'.

The surface conditions in the run-out zone may permit or impede the run-out of the flow. Afforestation may be particularly important in retarding flows as seen at Cairndow, but other conditions, such as hard surfacing or pasture land may be much more permissive to flows. However, a degree of caution should be exercised in extolling the benefits of commercial forestry incorporating shallow-rooted coniferous species. These species may be prone to uprooting particularly on steeper slopes with shallow soils. Uprooted trees can contribute to the power of the debris flow. This was seen at the A9 Dunkeld, where trees formed part of the debris that reached the road and trapped vehicles and at Glen Ogle, where trees were swept into the culverts and formed part of the blockage.

Attention should therefore be focussed on the potential benefits of native deciduous species. Research in New Zealand has found that vegetation-based treatments, centred particularly on use of fast-growing poplars and willows, have successfully controlled a range of gully erosion and earthflow mass movement problems. Treatments were found to be successful at 63% of earthflow sites, and 42% of gully erosion sites examined, using an evaluation technique known to be conservative.

Using the Poplar Pole Pinning method, poplar roots create cohesion in the soil and mechanically reinforce a soil by transferring shear stress in the soil to tensile resistance in the roots. The depth of the pole also helps in the short term to hold the slope whilst the root mass develops. An established poplar pole can draw between 70 to 100 litres of water per day, which means that if the water is available they have a high uptake across a site and help with a significantly amount of dewatering of the slope. Ideally the poplars need to be coppiced every 5 years to stop them growing too high and loading the slope.

Aspen

Aspen is a Scotland's only native poplar. It is a pioneer species and can tolerate a range of physical conditions and can be grown on exposed sites with thin soils. It has the widest attitudinal range of any tree species in Scotland, growing comfortably at 600m AOD. Aspen rarely sets seeds and spreads vegetatively by root suckering. This process can lead to laterally extensive root systems. The largest living organism on earth is an aspen clone in North America which extends some 30km. Aspen as with all poplars is also a deep-rooted species with roots potentially penetrating up to 2.5m below the surface given suitable conditions.

However there has been little or no research on the stabilisation benefits of native aspen, reflecting its generally undervalued and under-utilised nature. Only recently has there been an upsurge in interest in the potential commercial as well as biodiversity benefits of aspen which has stimulated research by the Forestry Commission and other academic institutions. Its potential for river bank stabilisation is now widely accepted, and it is increasingly planted as a major component of riparian woodlands. However, its role in slope stabilisation has still to be considered fully.

Eadha Enterprises
Eadha Enterprises is a newly established social enterprise with social, economic and environmental objectives. Eadha Enterprises work with local communities to provide environmental education and training and to deliver long term economic opportunities based on restoring degraded lands to productive systems in ecological balance.

Eadha Enterprises are core funded by Oxfam who are working with remote rural communities. For example Oxfam are supporting the community on South Uist, funding a tree planting programme to provide shelter and soil stabilisation in the face of climate change. Eadha Enterprises supplied some native aspen and willow for this project. The particular issues surrounding the Rest and Be Thankful are very much within Oxfam's remit given the social and economic impacts of road closures.

Eadha Enterprises have become one of the foremost experts in native aspen in Scotland, establishing a national collection of aspen clones for use in various applications including land remediation and decontamination, slope stabilisation, ecological restoration and biomass energy. A number of clones in the collection are of Argyll provenance which would be appropriate in any engineering applications at the Rest and Be Thankful. In addition, Eadha Enterprises are also diversifying into other rare upland native tree species including juniper and montane/dwarf willows. None of these tree species are grown in any number by commercial nurseries in Scotland. However taken together these pioneer tree species represent a unique assemblage of plants, many of which are UKBAP or LBAP species, that would be grown to create a valuable upland succession woodland to provide long term soil stabilisation of the slopes along the A83.

Eadha Enterprises are currently involved in a number of projects across Scotland. In East Ayrshire the Central Scotland Green Network is funding a project to explore the use of aspen and these other tree species to colonise poorly restored former opencast mine sites to deliver landscape scale ecological restoration and to provide a catalyst for regeneration of the neighbouring coalfield communities.

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