Cairngorms NATIONAL PARK
Pàirc Nàiseanta a' Mhonaidh Ruaidh

STRATEGY

Cairngorm and Glenmore

Strategy

Strategic Environmental Assessment Environmental Report

December 2015

Appendix 2: Environmental Baseline

Topic 4: Soil

Topic 4: Soil

> *"Soil is a resource of common interest… and failure to protect it will undermine sustainability and long term competitiveness in Europe."*
>
> Commission of the European Communities (2006).

Soils cover most of the natural world, forming the foundation of all terrestrial ecosystems and services. They support key processes in biomass production and mass exchange with atmospheric and hydrological systems. Nearly all of the food, fuel and fibres used by humans are produced in soil. Soil is also essential for water and ecosystem health. It is second only to the oceans as a carbon sink, with an important role in the potential slowing of carbon change. Soil functions depend on a multitude of soil organisms, which makes soil an important part of our biodiversity (Joint Research Centre, 2012).

Although soils are a continually evolving, living and dynamic medium responding to external pressures and management, some activities such as development or pollution can mean their recovery or reformation cannot take place within human timescales. This means soils are a finite and essentially non-renewable resource (Scottish Government, 2009).

Land Capability for Agriculture

Although it is estimated that Agriculture contributed about £688 million to the Scottish economy in 2014 (Scottish Government, 2015), it is difficult to value the direct financial contribution that healthy soils make to our economy. But it is now widely acknowledged that the sustainable management of soils, and the protection of soils' ability to deliver a wide range of environmental and ecological services, is essential to achieving sustainable economic growth.

Land Capability Classification for Agriculture mapping provides detailed information on soil, climate and relief for those involved in the management of land use and resources. The classification ranks land from 1 to 7 on the basis of its potential productivity and cropping flexibility determined by the extent to which its physical characteristics (soil, climate and relief) impose long term restrictions on its agricultural use. Land classified from 1 to 3.1 is considered to be prime agricultural land, while land classified as 3.2 to 7 is considered to be non-prime (Soil Survey of Scotland Staff, 1981).

There are no areas of prime agricultural land within the Cairngorm and Glenmore area, nor indeed is there any in the Cairngorms National Park. Around half the land within the area is classified as 6 or 7, which denote areas of 'rough grazing only' and 'very limited agricultural value' respectively.

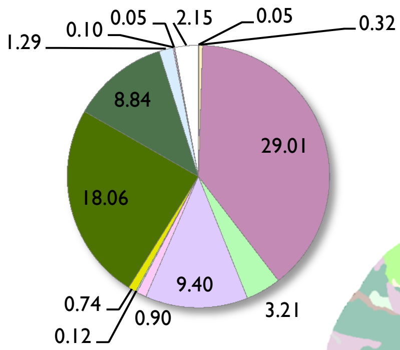


Figure 30 Landuse classification by km² (Soil Survey of Scotland Staff, 1981).

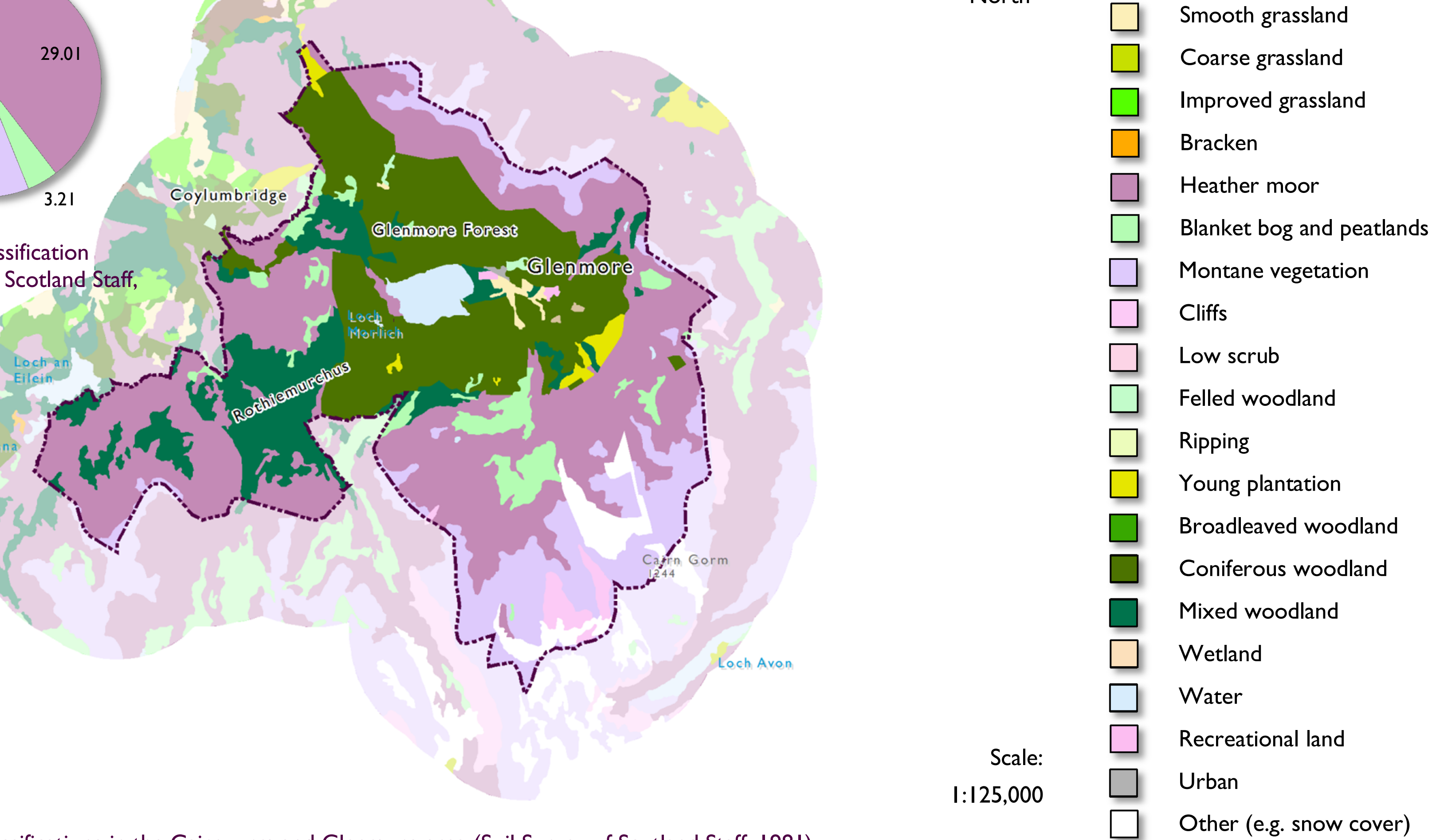
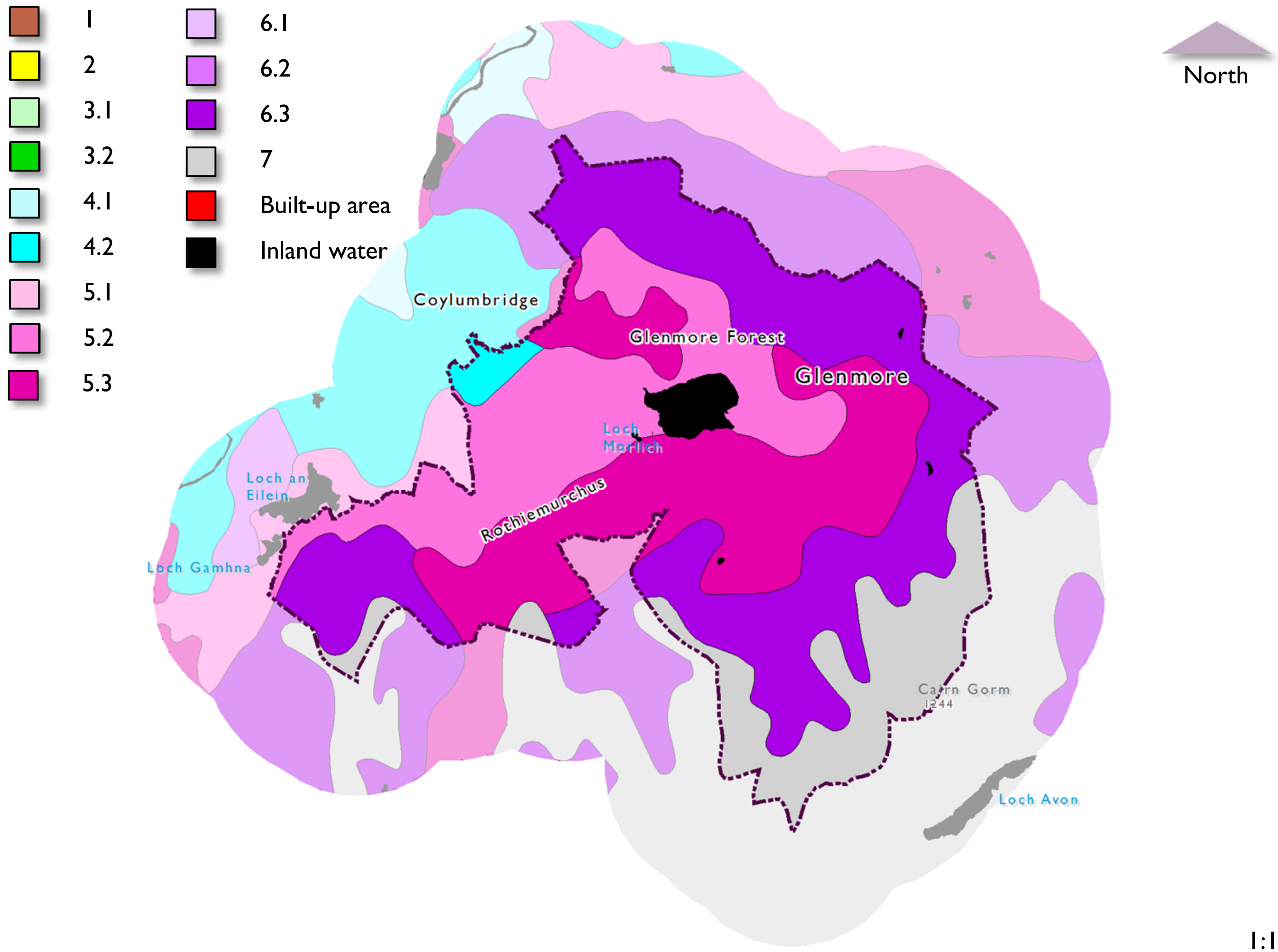


Figure 31 Landuse Classifications in the Cairngorm and Glenmore area (Soil Survey of Scotland Staff, 1981).



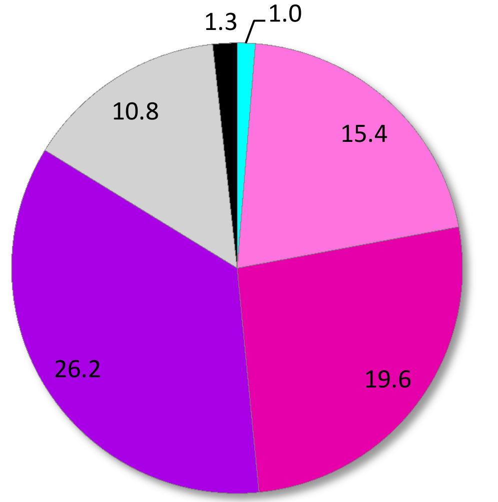


Figure 32 Agricultural land classification by area (km^2) (Soil Survey of Scotland Staff, 1981).

Scale:

1:125,000

Figure 33 Agricultural land classification in the Cairngorm and Glenmore area.

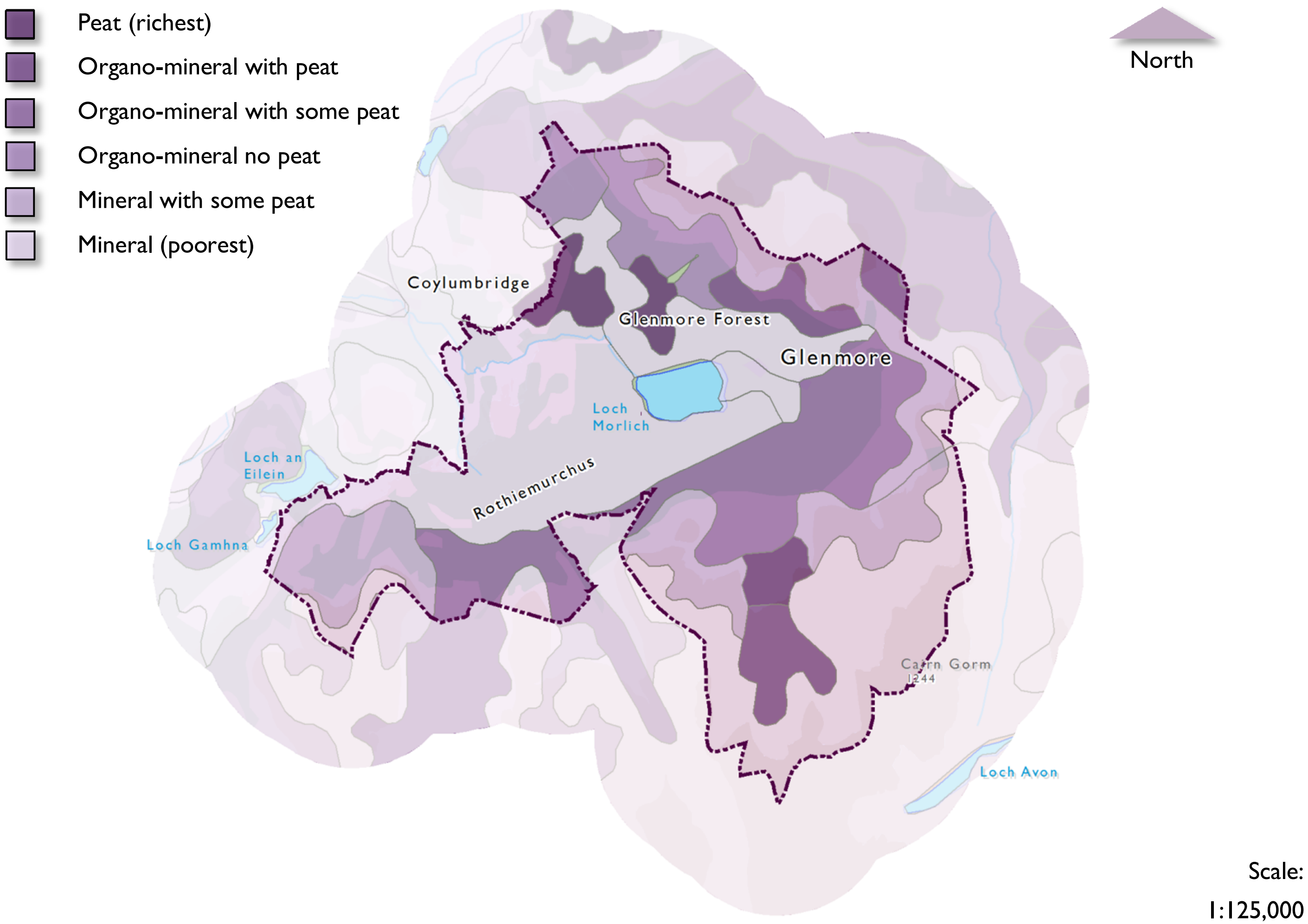
Organic Matter

Soil organic matter is a universal constituent of soils and plays a vital role in contributing to a range of soil functions. Organic carbon is the dominant component of soil organic matter (around 50%), so management of soil has important wider consequences in the context of greenhouse gas emissions and climate change. Soil organic matter also contains a wide range of nutrients (e.g. nitrogen, phosphorus) and trace elements that are essential for plant growth and health. The presence of soil organic matter is a critical indicator of soil quality and is required to deliver many of the vital functions of soil including its ability to provide nutrients, ameliorate the inputs of wastes and pollutants, contribute to the formation of good physical conditions, improve water storage and provide a habitat for microbial populations (Rees *et al.* 2011).

The Cairngorm and Glenmore areas are home to areas of soil that particularly rich in soil organic matter. These areas are a result of the Cairngorms' cool, moist climate encourages the retention of decomposed organic materials, with peatlands containing the largest quantities of soil organic matter (**Figure 34** and **Figure 35**). These soils are important global reserves of soil carbon.

The organic matter content of soils is at risk from a range of pressures, with land use change and climate change being of particular importance. The pressures affect the incorporation, cycling and breakdown of organic matter in the soil through alteration of soil conditions populations (Rees *et al.* 2011). The major pathway of loss of organic matter from soils is by carbon dioxide (CO_2) emission to the atmosphere via soil respiration, but other greenhouse gases can also be emitted as a result of soil organic matter decomposition, for example methane (CH_4) and nitrous oxide (N_2O) (Scottish Executive, 2007). In addition, carbon compounds can be released from soil into water, for example dissolved organic carbon and particulate organic carbon (Buckingham *et al.* 2008; Dinsmore *et al.* 2010). Other processes can also influence the amount of organic matter loss, such as soil erosion (Bilotta et al. 2007). Although most CO_2 is returned to soils as a consequence of the photosynthetic activity of plants, the net exchange (the difference between gains and losses) of carbon from land surfaces may still be large (*Rees et al.* 2011).

Climate is important in determining the equilibrium soil organic matter content. Temperature and rainfall influence both the input of organic matter via photosynthesis (e.g. litter and root inputs), and its subsequent decomposition through microbial activity, with resultant release of greenhouse gases and dissolved organic carbon, along with nutrients and trace elements. Thus any change in climate, for example increased rainfall and/ or increased temperature, is likely to change the rate at which organic matter is lost or accumulated in Scottish soils (Rees *et al.* 2011).



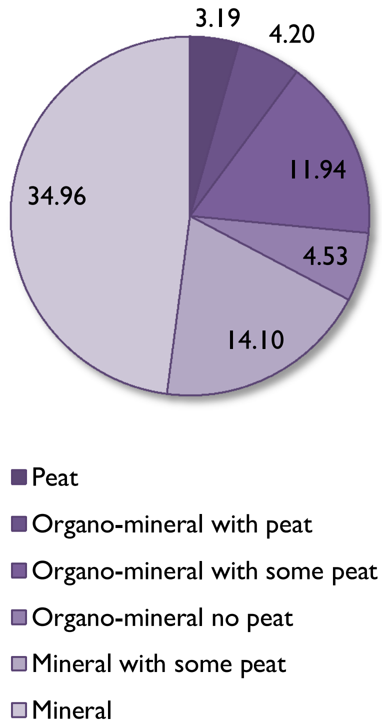


Figure 34 Carbon richness of soil by area (km^2) in the Cairngorm and Glenmore area (Scottish Natural Heritage, 2012).

Figure 35 Carbon Richness of Soil (Scottish Natural Heritage, 2012).

There is a particular concern regarding the sensitivity of soil organic matter to changes in climate. Projected climate change in the Cairngorms National Park, with warmer and drier summers and wetter winters, threatens to increase losses of soil organic matter (see **Topic 1: Climatic Factors**, p. 73). Another concern is that extreme weather events such as heavy rainfall could contribute to significant losses of organic matter through soil erosion (Rees *et al.* 2011).

Issues caused by climate change may be compounded by unsustainable land use activities such as those related to agriculture, forestry practices, recreation / game management, peat exploitation and development. Many of the Cairngorms National Park's most organic rich soils are located on its moorlands, large areas of which are managed for game. Deer can cause compaction and erosion and it is necessary to maintain the deer population at a sustainable level. Grouse shooting requires management of the moorland habitat such that a good balance of young heather is available for forage. This is normally done by burning (muirburn), typically in patches which are burnt every 10–20 years. Carefully managed heather moorland should aim to retain soil organic matter and the soil carbon balance over time but poorly managed burning can result in losses. There is evidence of soil organic matter loss following burning though the evidence base is scant (Rees *et al.* 2011).

The consequences of organic soil loss are potentially serious since it provides a number of important ecosystem services, such as:

- Providing the basis for food and biomass production
- Controlling and regulating environmental interactions
- Storing carbon and maintaining the balance of gases in the air
- Providing valued habitats and sustaining biodiversity
- Preserving cultural and archaeological heritage; and
- Providing raw materials.

Contamination

Soil contamination can come in many forms and from many sources. However, not all are of concern within the Cairngorm and Glenmore areas. While contamination from metals, organic chemicals, radioactive substances and pathogens may exist within area, they are not of an order that is likely to cause significant harm to the environment and can therefore be scoped out of the assessment.

Because of its potential effects on habitat and biodiversity, soil acidification is however of significance. Typically, this pollution originates from gaseous emissions of sulphur dioxide and oxides of nitrogen, which are dissolved in rainwater to form sulphuric and nitric acids which subsequently are deposited on soil, causing soil acidification. Excess nitrogen deposition can also lead to soil eutrophication.

Acidification and eutrophication impacts are often greatest in upland areas as a result of high rainfall and are exacerbated by predominantly poorly-buffered and nutrient-poor soils and the greater sensitivity of locally adapted biodiversity to a change in soil conditions. However, lowland soils, especially those associated with ecosystems of high conservation value, may also be affected by acidification and eutrophication. In addition, fertiliser application in excess of crop nutrient requirements can result in acidification and eutrophication of agricultural and forestry soils (Cundill *et al.* 2011).

Acidification can impact on soil nutrient cycling, causing critical load exceedance and a reduction in the ability of soils to filter contaminants. Further nitrogen additions are also less readily retained in ecosystems where the critical load for nitrogen is exceeded, resulting in 'nitrogen' saturation' (Aber *et al.* 1989; Agren & Bosatta, 1988).

Contaminates may therefore more readily enter water bodies, the acidification of which has been linked with soil acidification in Scotland (Helliwell *et al.* 2001). The impacts of soil acidification on both the biological and chemical quality of water has been observed in the Cairngorms (Soulsby *et al.* 1997). See **Topic 3: Water** (p. 85) for further details.

Soil Erosion

Soil erosion by water or wind is a natural process where soil particles become detached and are transported within the landscape. Features of soil erosion may be found throughout the Cairngorms National Park (**Figure 36**). For example, landslides and debris flows are a relatively common occurrence on many of the National Park's hill slopes, which have been over-steepened by glaciation (Ballantyne, 1986, 2004). The rate of soil loss via erosion and the incidence of landslides can be increased by removing the vegetation cover that protects the soil (e.g. ploughing to grow crops, deforestation) or by engineering works. Tillage erosion also leads to the redistribution of soil downslope (Lilly *et al.* 2011).

The erosion of upland organic (peat) soils is also prevalent in some parts of the National Park, and in particular the Monadhliath Mountains, the southern part of which fall within its boundary. The mechanisms that lead to erosion in these soils are not fully understood although historic overgrazing by sheep and deer may be a contributory factor. There is also evidence that changes in climate over many years may be partly responsible for the development of gully systems in these areas (Lilly *et al.* 2009).

Landslides (in the form of debris flows) have occurred in clusters over the last 7,000 years which may be related to climatic factors such as the frequency of extreme rainfall events, for example, although deforestation is also likely to be an important factor. Debris flows in the Lairig Ghru appear to occur with a return period of around 20 years, with each episode of debris flow activity thought to be linked to intense rain storms (Baird & Lewis, 1957; Innes, 1982; Luckman, 1992). Landslide and debris flow activity is reported to have increased over the last 200–500 years (Innes, 1985; Ballantyne, 2004) and it is thought that localised extreme rainfall was the major contributing factor to the

Scottish landslides in 2004 (Winter *et al.* 2005). Triggering of peat slides is also commonly attributed to intense rainfall events (Dykes & Warburton, 2008).

Climate change (see **Topic 1: Climatic Factors**, p. 73) is therefore likely to lead to an increase in the frequency of landslides and in the intensity of soil erosion (Ballantyne, 2004; Winter *et al.* 2005).

One of the most important factors in the protection of soils from erosion is vegetation cover, as roots bind soil particles together and plants protect soil from direct raindrop impact, as well as disrupting overland flow. Where vegetation cover is sparse, or soils are bare, the incidence of landslides and soil erosion (by wind and water) is greater.

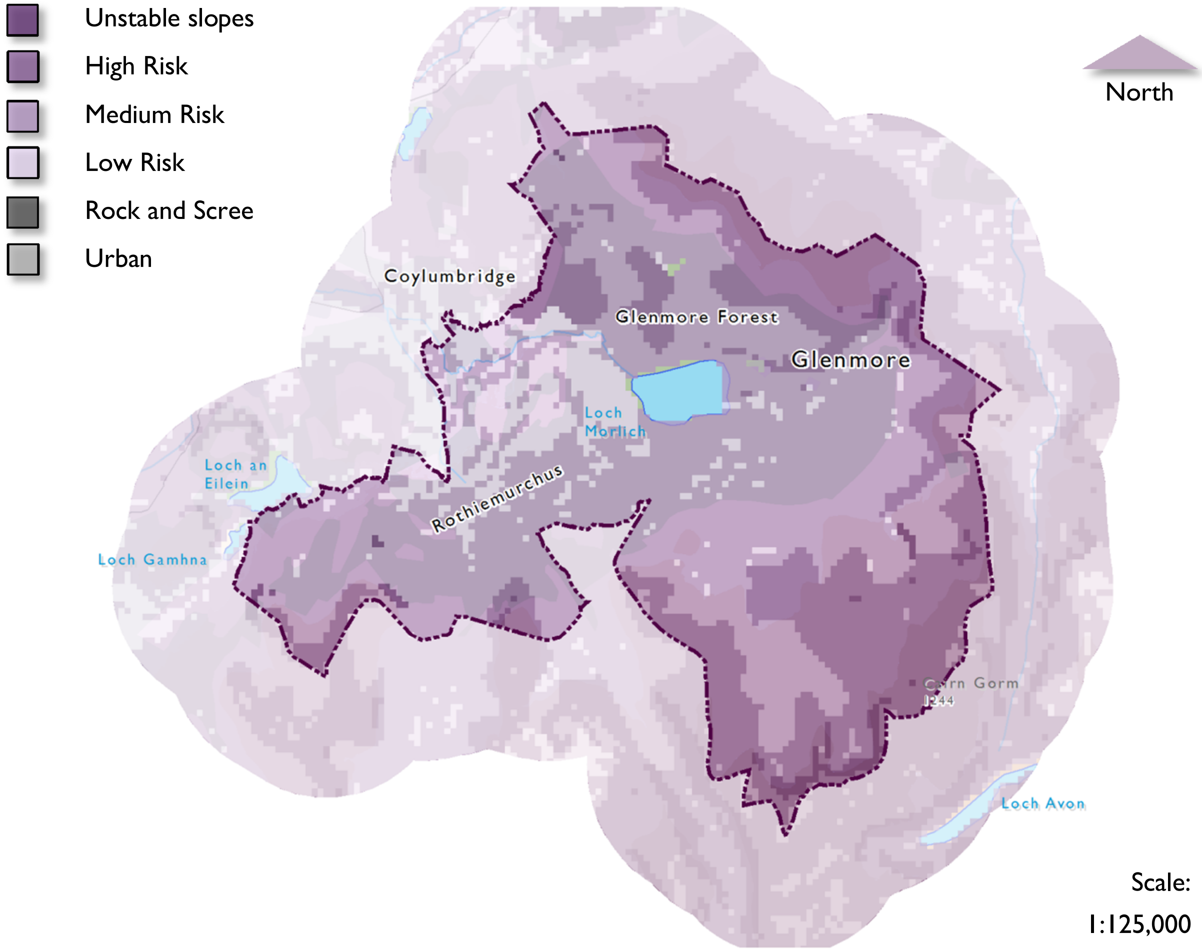


Figure 36 Soil erosion risk within the Cairngorm and Glenmore Area.

In some upland areas of the Cairngorms National Park, heavy grazing by sheep and deer has caused a decline in heather cover which has then been replaced by tussock forming grasses with poorer soil binding abilities. However, one difficulty in establishing links between soil erosion (in particular, the erosion of peat) and grazing is that historic stocking densities, which are generally unknown, may have had more influence on the risk of erosion than current stocking densities. Also, both sheep and deer will preferentially graze specific areas, resulting in localised areas experiencing greater grazing pressures and an increased risk of erosion (Lilly *et al.* 2011).

Estates and upland farms have commonly used burning as a means of controlling vegetation structure and improved heathland productivity. This can cause issues when too much vegetation is removed. Severe burning may even make the surface organic layer of the soil water resistant, resulting in greater run-off and greater potential for soil erosion and landslides (Lilly *et al.* 2011).

Given its heavily wooded nature, soil erosion originating from forestry activities is also a significant consideration for the Glenmore area. While in most instances, tree cover has a positive effect on soil erosion, providing vegetation cover and binding soils, certain activities may cause issues. For example, the bed of new drainage ditches can be scoured and run-off during harvesting can remove the loosened soil (Lilly *et al.* 2011).

Due to the area's popularity as a visitor and tourist destination, the effects of recreation must also be given consideration. Hill walking and mountain biking on some hill and upland areas can cause erosion and lead to the extension of paths across sensitive environments where natural regeneration of the vegetation is slow. These areas then become vulnerable to continued erosion (Lilly *et al.* 2011).

Key Messages

The Cairngorm and Glenmore area does not contain any mapped areas of Prime Agricultural Land; it does however have large areas of Carbon Rich soils, which perform important ecosystem services, particularly as a carbon sink. Soil erosion, both natural and through inappropriate land management techniques place many of these soils at risk.

There is little evidence of soil contamination within the area, however inappropriate development may lead to instances, which in turn may have a negative effect on water quality.

The Strategy may have an effect on soil quality, particularly through its influence on the distribution of development within the area.

Inter-relationships with other topics

- Topic 1: Climatic Factors 73
- Topic 3: Water 85
- Topic 5: Material Assets 104
- Topic 6: Biodiversity, Fauna and Flora 113
- Topic 7: Landscape and Cultural Heritage 159
- Topic 8: Population and Human Health 176