

Climate Ready Forestry Learning Exchange: summary report

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Key points

On 6th October 2015 forest managers, policy makers and researchers met at Queen Elizabeth Forest Park in Scotland to share knowledge and experience about how we can manage forests to help our environment, economy and communities to cope with our changing climate; in particular with flooding, slope stability and wind risks. The main points arising at the meeting were:

General

To increase the ability of the forestry sector to respond to climate change it was felt that there was a need to:

- Improve the flexibility and coherence of forest policy and grants;
- Collate and develop coherent guidance across government agencies;
- Increase the use of monitoring and an adaptive forest management approach;
- Develop integrated decision support tools;
- Increase knowledge exchange between researchers, policy makers and forest managers.

Flooding

- To address flooding in Aberfoyle, Forestry Commission Scotland (FCS) and others have been developing a forest habitat network in the Duchray catchment. Building on this, the Strathard Ecosystem Services project intends to trial a number of additional natural flood management measures in the Duchray catchment.
- There was felt to be value in producing a summary of evidence about forestry's relationship to flooding, to demonstrate the positive impacts that forests may provide even if these cannot be quantified.
- There is a need for more research and joined up guidance on riparian woodland and woody debris dams.

Slope stability

- Trees can improve the stability of steep slopes but present challenges arising from the need to carry out management operations such as thinning and felling.
- FCS's Steep Ground Management Programme has been building knowledge and skills to undertake forest management operations on steep slopes and to understand how to make decisions about where to prioritise forest management for slope stability.

Wind risk

- FCS's Cowal and Trossach's Forest District are taking a strategic approach to reduce wind risk, identifying areas of high risk and felling them earlier than usual.
- The constraining of forest operations to small parcels of land by the land management grant scheme in Scotland makes it difficult for land managers to manage for wind risk.
- ForestGALES is a computer-based tool that can help with the management of wind risk to forests. It may have a role in helping forest managers to demonstrate to insurers that they have taken a robust approach to reducing wind risk.

What is the purpose of this report?

This report summarises information presented and discussions at the climate ready forestry learning exchange that took place at Queen Elizabeth Forest Park (QEFP) (near to Aberfoyle in Stirlingshire) on 6th October 2015. The event brought together land managers, policy makers and researchers to share knowledge and experience about the management of forests for resilience to our changing climate. In particular it explored the land management actions that can help our forests, communities and economy cope with the risk of flooding, landslides and damaging high winds. Site visits to demonstrate forest management actions at Forestry Commission Scotland's (FCS) QEFP were used as a stimulus for discussion about the actions the forestry sector is taking and could take to manage these risks. Successes and challenges were also explored and used to generate ideas about how policy, research and practice could better encourage and enable the forestry sector and others to cope with climate change.

During the day the group heard from a number of speakers:

- Jo Hagg, (Adaptation Scotland) on weather trends and Scotland's likely future climate;
- Maida Ballarini (FCS) who summarised policy progress towards climate resilience in the forestry sector;
- John Hair (FCS) who explained the impacts of weather and associated forest management actions in QEFP and Cowal and Trossachs Forest District;
- Louise Bond (SEPA) and Tom Nisbet (Forest Research) on the role forest management has to play in helping to reduce flooding;

- Ben Lennon (FCS) who explained the challenges around slope stability and forest management practices; and
- Bruce Nicoll (Forest Research) on approaches to the management of wind risks to forests and the role of the computer-based tool ForestGALES.

This report summarises the information on flooding, slope stability and wind risks that were discussed at the event, explaining the experiences in the management of these issues at Queen Elizabeth Forest Park (QEFP) and in Scotland more widely. It also summarises the challenges and solutions for forest management to these risks and the wider challenge of climate change, put forward by the event's participants.

How can we manage flooding?

What is the challenge?

As Scotland's climate changes it is predicted that winters will become milder and wetter; there will also be more extreme weather including intense rainfall. Weather records show that over the past few decades Scotland's weather has got wetter and there have been more heavy downpours. Since 1961, on average winter rainfall has increased by 20% across the country. This brings an increased risk of flooding and detrimental impacts to infrastructure, people and the environment.

What is being done to address the challenge?

A riparian forest habitat network in the Duchray catchment

The Duchray river basin catchment is over 11, 000 hectares and is located in the headwaters of the River Forth about 30km west of Stirling. The land is heavily forested and contains many steep slopes. Water flowing from the catchment has contributed to flooding in the nearby town of Aberfoyle, which has flooded regularly in recent years with significant negative impacts on local residents, businesses and schools. There is a need to reduce the future risk of flooding to the town.

About sixty percent of the Duchray catchment is managed as part of the National Forest Estate (NFE) by FCS's Cowal and Trossachs Forest District. NFE land next to the Duchray Water was planted with Sitka spruce in the mid-1950s with a focus on timber production. Since the mid-1990s FCS have been felling and restructuring the woodland in the floodplain along the length of the Duchray Water to create a 'riparian' habitat network. This is now 800 ha in extent and is managed to provide a range of benefits, including slowing down flood flows for flood alleviation downstream in Aberfoyle.

The width of the riparian zone ranges from some 100 metres in the upper part of the catchment to around 300 metres in its lower reaches. Planted with birch, alder, Scots pine and aspen, it has been considerably augmented by natural regeneration. In addition to the habitat network, action has been taken to reduce the speed of runoff from the forest road system. This has included installing more culverts (at 30 metre intervals) along a length of forest road near to the Duchray Water to disconnect drain flows and allow waters to flow more slowly through the riparian buffer zone. Around 40% of the catchment is in private ownership so collaboration between land owners has

been important in enabling a consistent approach to riparian management across the whole catchment.

An ecosystem services approach to land management in Strathard

The Strathard Ecosystem Services Project builds on these actions and will identify and trial a variety of land management measures in the Duchray catchment for multiple benefits. A primary objective is to enhance the contribution of the forest to flood alleviation in Aberfoyle, however other benefits e.g. to wildlife and to tourism, will also be delivered as part of the project's 'ecosystem services approach' to making land management decisions. The project started during 2015 and involves a range of partners including FCS, SEPA, SNH, Stirling Council and Loch Lomond and the Trossachs National Park; it also involves local stakeholders such as private land owners and the wider local community. The 'natural flood management' measures trialled may include the installation of woody debris dams and timber bunds to slow the flow of the water, and to create mini storage areas including wetland habitat. Peatland restoration, woodland creation and Continuous Cover Forestry (CCF) may also be used to reduce and slow water flows.

Natural flood management measures to slow flood flows in Pickering

The Slowing the Flow at Pickering project started in 2009 and has similar objectives to the Strathard project. The approach and actions taken in the Duchray catchment will draw from the learning developed at Pickering; including that:

- A partnership approach is important to bring people together to agree a way forward to manage flood risk;
- Catchment hydrology is complex and involves many interactions. Scientific modelling can be used to guide the placement of measures but it is also about learning by doing; monitoring change and applying lessons learned;
- Natural flood management can make a contribution to reducing flood risk but it is only part of the solution, it is important to use a combination of measures that work together effectively and are cost effective;
- The size of the contribution made by natural flood management measures depends on the specific circumstances in each catchment e.g. the type and scale of measures, and where they occur in the catchment. It also depends on the size of the catchment, on how the assets are located downstream and the interaction in the timing of flows of tributary watercourses;
- Quantifying the benefits delivered by natural flood management is difficult due to the challenge of measuring how many, relatively small-scale land use measures interact at the catchment scale, especially during large and infrequent flood events.

Managing flood risk: challenges and solutions

This section summarises participants' discussions about the on-going challenges and solutions to using forest management to reduce flooding.

Riparian woodland and woody debris dams

The role of riparian woodland in flood management is emerging as an increasingly complex topic; while some organisations encourage the planting of woodland near to water courses to provide a range of benefits, including helping to slow flood waters, others have concerns that the washout of woody debris could contribute to downstream flooding by blocking critical structures such as bridges and culverts. There was a suggestion of a need for more research and more joined up guidance on managing riparian woodland and woody debris dams. This would enable land management decisions to proceed with a fuller understanding of the pros and cons of their role in flood risk management.

UPM Tilhill, in partnership with Heriot Watt University (Edinburgh) are carrying out research to measure the impacts on flood flows of a large woodland creation scheme in the Ochil Hills; the catchment drains to the town of Menstrie which has suffered from flooding in recent years. The research will conduct a series of experiments on the Menstrie Burn to monitor run off of water and soil from parts of the woodland established using different cultivation practices on different slope angles. It will also monitor the hydrological impact and movement of woody debris within the burn.

Public and stakeholder understanding of the role of forestry in flooding

Amongst national and local stakeholders there are mixed views on the influence of forestry on flooding. Whilst some promote forestry as providing a potential contribution to flood reduction strategies, others see forestry operations (for example clear fell and cultivation practices) to be a significant contributory factor in flooding. It was suggested that we need to capture more evidence about the influence of forestry on catchment hydrology to create a more balanced understanding of the role of forestry in flood management across government agencies and stakeholder groups (including local communities). Trusting and understanding relationships between stakeholders and communities, and partnership projects which can facilitate such understanding, were seen as having an important role in achieving this objective. This may require the forestry sector to increasingly adjust forest operations to emerging issues such as flood risk.

Quantification of the benefits of natural flood management measures

There are many challenges which make it difficult to measure the contribution of forests to flood risk reduction; these include the complex mix of activities that influence flooding, particularly in large catchments and the relatively long time scales over which some measures develop –. Although hard scientific evidence of the impacts of natural flood management measures used in the Slowing the Flow at Pickering project remains to be collected, the local community view the measures very positively and feel they are already making a significant contribution to reducing flooding in the area. However, more data are needed to demonstrate to local authorities and others that natural flood management measures are effective and to improve confidence in funding their use. To help inform decisions, a collated body of work which draws together evidence and examples of the role of natural flood management in flood alleviation was proposed as being something which might be considered.

How can we manage slope stability?

What is the challenge?

As our climate changes, wetter winters and more heavy rainfall bring the risk of soil erosion and loss of stability in steep slopes leading to landslips. Forested land on steep slopes brings challenges which arise from the need to carry out operations such as thinning and felling. These operations carry the risk of causing destabilisation of soil on steep slopes, and associated liabilities and potentially negative publicity if landslips impact on third party infrastructure such as public roads, pathways and communities. At the same time, native and broadleaf forests, along with CCF, can have an important role to play in helping to stabilise soil on steep ground. There is a need to better understand how to maximise this potentially beneficial role of trees whilst also understanding how forest management practices can be conducted so as to minimise the risk of destabilising soil on steep slopes.

What is being done to address the challenge?

The Forest Enterprise Scotland Steep Ground Management Programme

Current estimates suggest there are about 88,000 ha of land on steep slopes in Scotland's NFE. In Forest Enterprise Scotland's (FES) Cowal and Trossachs Forest District and across the NFE more widely, a legacy of postponing the felling of trees on these sites due to the relatively high risks and costs, means there are now an increasing number of forests on steep ground which are over-mature and are prone to windthrow.

To address the challenge on the NFE, British Geological Survey were commissioned to carry out a desk based study to identify high risk landslide sites. They identified 104 sites on the NFE that posed threats to down slope public infrastructure and other assets. Building on this, a more detailed survey of the high risk sites was completed by geotechnical experts who produced recommendations for the future management of these sites.

There are 24 sites at high risk of landslide in Cowal and Trossachs Forest District. The main risks are forest harvesting operations dislodging boulders and disrupting slope stability. The recommendations for management are to maintain drainage and look after hydrology on steep slopes. The district has been working with this information to spread harvesting operations on steep sites over a number of years and to build the recommendations into risk assessments so as to ensure actions to minimise risks are taken from the outset of any forest operation. In future, they plan to explore ways to maintain slope stability after tree felling.

This work forms part of the FES Steep Ground Management Programme. This comprised four projects, with some work on-going:

- 1) *Slope Stability Project*: involved the identification and analysis of high risk land slide sites on the NFE and the development of generic management recommendations. This involved close working between geotechnical and forestry experts;

- 2) *A82 Project*: focussed on the management of timber harvesting operations along the A82 - an area which has large volumes of timber planted on steep slopes and where there have been a number of highly publicised land slips, sometimes involving trees falling on to the road;
- 3) *Steep Ground Harvesting Project*: identified tree harvesting techniques for steep slopes; in particular the use of skylines and cable cranes as an alternative to using machines on the ground. Skyline systems involve the harvesting being done on the slope by hand and the trees being brought down on a cable wire (skyline) to a central point where they are processed. They are thought to cause less disturbance to slope stability than conventional harvesting methods but are much lower in output with higher operational costs;
- 4) *Long-term Management of Steep Slopes Project*: developed guidance about how to promote slope stability on steep ground, e.g. by using mixed species and mixed rooting, ensuring good hydrology and uninterrupted drainage, and taking approaches which minimise wind damage to trees. The guidance encourages a holistic view to long term management including species choice, silvicultural systems and operational activities.

The long term management of steep slopes guidance encourages decisions to be made based on an evaluation of cost and risk against public benefit. As a general principle even-aged unthinned conifers are detrimental to slope stability and mixed age and species with a variety of rooting depths are beneficial. However, the range of options for any particular site will be determined by a variety of factors. Between these two extremes, forest management decisions need to be guided by local conditions that will influence costs and benefits e.g., cost of infrastructure, the location of timber mills, landscape value, etc..

Managing slope stability: challenges and solutions

This section summarises participant discussions about some of the on-going challenges and possible solutions to the management of forested land on steep slopes.

Training and skills of forestry contractors to work on steep slopes

Skyline technology used in forest harvesting operations on steep slopes is 50-60 years old and, in Scotland, the knowledge and skills used to operate it have dwindled. To address this problem FES has established a five year management agreement with a contractor for timber harvesting on steep slopes. The length of the contract has provided the contractor with the confidence and the ability to invest in the machinery and to develop the skills necessary to work on steep slopes. Following this example, other contractors have invested in skyline harvesting machinery. However, timber prices are currently low, and if they remain so, the relative costs of harvesting on steep slopes may outweigh the benefits, making it more difficult to engage contractors in this work.

The risks of carrying out forestry operations on steep slopes

To ensure operations on steep slopes are appropriately managed, planning and coordination with councils and contractors is required. While there are contractors who will undertake timber harvesting on steep slopes, some have concerns about being held responsible if things go wrong.

Establishing shared responsibilities between councils, contractors and other partners can therefore be important in securing contractors to carry out forestry operations on steep ground.

Tactical planning between land managers and managers of public infrastructure

There are examples of close working between government agencies responsible for land management and those responsible for maintaining infrastructure such as trunk roads. Collaboration has worked most effectively at a strategic level and the challenge is now to join up at a tactical level so that plans for tree harvesting and road maintenance are coordinated so as not to conflict with one another.

How can we manage wind damage to trees?

What is the challenge?

As Scotland's climate changes we will experience more extreme weather. Scotland is already experiencing more frequent winter storms and these are impacting on forests, damaging trees and timber and causing economic losses to land owners and, in some cases, damage to third party infrastructure such as roads and railways.

The risk of wind damage to trees is a concern throughout Cowal and Trossachs Forest District; with damage being sustained in most winters, and some summers. The last significant wind storm was in the winter of 2011/12; when 130, 000 cubic metres of timber were damaged. The immediate impact of this was the disruption to traffic and power supplies as roads were blocked and powerlines damaged. In the longer term it has required the district to adjust their harvesting plans so as to enable the salvage and tidy up the wind thrown trees. This has involved postponing planned harvesting in some areas.

What is being done to address the challenge?

Assessing the vulnerability of trees to wind damage in Cowal and Trossachs Forest District

To reduce the risk of wind damage occurring, the district have started to look at how they can restructure their forests. This has involved using ForestGALES and other tools to find out which parts of the forest are more vulnerable to wind damage and those areas that are more stable. The most vulnerable stands of trees can then be scheduled to be felled first, and the more stable trees kept longer. This approach involves the district taking some risks as they try to keep a proportion of the forest standing for longer than normal. As part of the effort to reduce wind risk, CCF is being used on the far side of Loch Ard (a lower wind risk area); whilst some wind damage has occurred, natural regeneration is being encouraged to allow trees to grow in areas where they have been lost.

The approach of the district addresses three key strategies for managing wind risk:

- 1) Reducing the risk e.g. by harvesting trees before they blow over, avoiding thinning operations on exposed sites; and using CCF on less exposed sites;
- 2) Spreading the risk e.g. by restructuring the age profile and diversifying tree species;
- 3) Accepting the risk – a proportion of the forest will be damaged in average winter storms, but this can be managed as part of the annual timber cut.

Development of ForestGALES wind risk management tool

ForestGALES is a computer based tool developed by Forest Research that can help with the management of wind risk to forests. It enables foresters to understand how wind risk to forest stands changes as they grow (as trees get taller the risk increases); it can also assist with decisions about when to fell trees based on understanding the return period for damaging wind and when the risk of losing trees would be too high. It is also able to inform decisions about where to thin a forest e.g. by showing how the risk of wind damage increases following thinning. As well as working at a stand level, ForestGALES can measure wind risk across a whole forest estate and inform strategic decisions about whether to and how to adjust the level of wind risk across a forest. In October 2015 ForestGALES was updated to include the latest knowledge about tree stability and the revised version of the tool was validated by comparing damage predicted by it with the actual damage which occurred at QEFP in winter 2011/12.

Managing wind risk: challenges and solutions

This section summaries the main challenges and possible solutions to the management of wind damage to forests raised by participants.

The scale of land management

The constraining of forest operations to small units of land by the current land management grant scheme (SRDP) creates logistic and economic difficulties for land managers who are required to operate within numerous small patches of forest across a much larger landscape. In terms of the management of wind, this slows the clearance of wind damaged trees and creates more forest edge which can increase the risk of wind thrown trees.

Insurance for wind damage

There have been a number of wind storms that have affected Scotland's forests in recent years. It was suggested that we may be approaching a situation where increasing premiums or an inability to get insurance will force forest owners to more proactively manage for wind risk in forests. ForestGALES was seen as having a role in helping forest managers to demonstrate to insurance companies that they have taken a robust approach to reducing wind damage.

ForestGALES – climate change and spatial elements

Forest managers and planners increasingly rely on GIS based tools to explore and map alternative options, and analyse spatially the impacts of their decisions. There were requests that ForestGALES should be integrated with GIS to allow better integration of wind risk into the planning process. The feasibility of this will be explored by Forest Research, but the current recommendation is to simply run data for multiple stands through ForestGALES in batch mode and then reformat the output data as needed and read it into GIS.

How can we enable the forestry sector and others better cope with our changing climate?

This section summarises participants' suggestions of the wider challenges and solutions to enabling Scotland's forests to be more able to cope with the changing climate, and more widely, to realise their wider potential to help people, the economy and the environment to cope with climate change.

Improving the flexibility and coherence of forest policy and grants

A critical issue when thinking about how we can enable forests to cope with climate change and realise their wider potential to address climate challenges facing Scotland, is how policy e.g. the UK Forest Standard (UKFS), is linked with land management grant schemes i.e. SRDP. Also important is how both policy and support respond to practical land management circumstances, especially at local and regional levels. Concerns were raised about a lack of cohesion between UKFS and SRDP in terms of the scale at which land management decisions should be taken (e.g. at the forest-catchment level, rather than the stand level) and about the flexibility of grants to respond to changing conditions brought about by climate change and site specific solutions to risks. In particular there was a suggestion of a need for more flexibility in land management grants and licences to a) allow the planting of climate matched tree provenances from further south where climate conditions are similar to those projected for Scotland; b) enable shortening rotations of Sitka spruce; and c) encourage a culture of forest management in which experimentation and learning play a key role (so called 'adaptive forest management'). It was also suggested that forest ecosystem services should be more strongly recognised within the grant system.

Collating evidence and developing coherent guidance across government agencies

Information which better draws together evidence from research and practice is needed; including on the role of forest management in flooding. In particular there was felt to be a need for information on the role of riparian woodland and woody debris dams in managing flood risk. The need for more joined up and consistent guidance to deliver sustainable land management was also stressed. In particular there was a call for joined up guidance on riparian woodland and woody debris dams.

There is a need for national, regional and local land use policies to be aligned. It was felt that while Scotland's Land Use Strategy focuses on integrated land management and the delivery of ecosystem services, regional and local land frameworks still work in silos and do not encourage an integrated use of land. The SRDP does not support integration of land uses either, as land owners need to apply to different options under different schemes. This results in national strategies that support landscape scale decision making and integration across different land uses that does not follow through to regional and local policy and ultimately in land management actions.

Increasing the use of monitoring and an adaptive forest management approach

Across the forestry sector it was felt there is a need for more monitoring and shared learning about the impacts of land management actions to address climate change. It was noted that most Met Office weather stations are in lowland areas and that there is the potential to install more weather

stations in upland forested areas including at QEFP. This would provide greater understanding of emerging weather trends in upland areas which could be used to inform land management.

Developing next generation decision support tools

There was felt to be value in developing a spatial function in ForestGALES, as well as developing it to work with broadleaf species and complex stands, such as those managed for continuous cover. Some participants asked that forest decision support tools could be made more compatible, and if possible integrated, to allow them to work together to help inform complex decisions related to managing forests to provide multiple ecosystem services. The importance of involving end user groups in the development of tools aimed at assisting land management decisions was stressed.

Increasing the exchange of knowledge between researchers, policy makers and forest managers

Participants emphasised the value of using events and other activities which bring together practitioners, policy makers and researchers to share knowledge about forest management practices that will help address the challenges and opportunities of climate change. Stakeholder engagement activities such as partnership projects, which share knowledge and generate shared understanding around land management to address climate change were also seen as being required. The following suggestions were put forward:

- Better and more frequent knowledge sharing between policy, practice and research;
- Use of site visits to demonstrate climate change issues as they are experienced and understand how they can be managed at particular locations (e.g. at the site level);
- More use of private forest sector sites for demonstration and a more proactive involvement of the private forest sector in knowledge exchange activities;
- Stakeholder engagement activities to share knowledge and understanding of the climate change challenges forestry is addressing, particularly to alleviate flooding;
- Regular updates from research and practice as projects progress; especially from partnership projects where researchers, policy makers, land managers and other stakeholders are working together to address climate change. There was particular interest in the community partnership approach of the Strathard Ecosystem Services Project;
- Workshops and formal training courses e.g. to demonstrate and provide hands-on experience of tools such as ForestGALES and Ecological Site Classification;
- Research evidence and land management guidance to be more accessible outside of the Forestry Commission e.g. internal guidance on slope stability should be made more widely available;
- Knowledge exchange topics were proposed:
 - species and silvicultural diversification;

- translation of the ecosystem service concept into local level management and illustrations of how to coordinate its delivery across different land use types and holdings;
- assessment of multiple climate change risks and opportunities, and their translation into forest management plans;
- integration of the three year business planning cycle into longer term land management planning;
- management of wildfire risk;
- engineering of forest roads given changing rainfall patterns;
- contingency planning to cope with risks.

Challenges requiring research

Topics requiring further research were put forward as being:

- Woody debris to understand whether it helps or hinders flooding and to enable the development of agreed guidance;
- Short rotation forestry and whether it can provide more flexibility and resilience to climate change;
- Species mixtures and how they perform under a changing climate, drawing out actual experiences e.g. the role of nurse crops;
- Small scale species trials using non-local provenances;
- Regional diversity and resilience.

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