

Forest Research: Climate Change projects

Forest Research is part of the Forestry Commission and is the leading UK organisation engaged in forestry and tree-related research. Forest Research's programme of climate change-related research is wide-ranging, covering impact assessment and monitoring, adaptation and mitigation. The scope of the research includes forest management, biosecurity, the management of woodland for biodiversity and the services that trees and woodlands provide to society. The Forestry Commission spends around a quarter of its research budget with Forest Research on climate change and related programmes.



The flux tower at Alice Holt Research Forest monitors the exchange of carbon dioxide between the atmosphere and forest.

Climate change research

1. Climate change impacts on forest function

Long-term monitoring of climate information and the response of trees is fundamental to our understanding of forests and climate change. This programme builds on previous Forest Research work on assessing and quantifying the impacts of climate change on forests. It draws together information from long-term monitoring and experimental work at Alice Holt Research Forest and elsewhere in the UK. The research will:

- a) add to the comprehensive 13 year-long dataset for the Environmental Change Network site at Alice Holt;
- b) assess the impact of climatic variations and management on forest CO₂ and water exchange so that models can be used to predict the likely impacts of climate change;
- c) analyse long-term datasets on environment and forest function (e.g. growth, leafing and leaf fall data) to understand and characterise the impacts of change.

2. Ecological Site Classification (ESC) for climate change

ESC has been developed both as a stand-based and spatial tool (on a geographic information system (GIS) platform) for matching tree species and native woodland communities to site types. It has been successfully used to inform forest policy, particularly in relation to the impact of future climate scenarios on tree species. The programme is also developing stand-based and spatial climate change impact and adaptation tools, including new ways to assess the risk of biotic and abiotic impacts of climate change scenarios.



Forest Research's work includes modelling the effects of climate change on the suitability of tree species. This case shows expected changes to the suitability of Sitka spruce in Scotland by 2080.

3. Forestry as an instrument for mitigating climate change

This focuses on evaluating mitigation options based on the management of forest carbon and greenhouse gas (GHG) dynamics for input to national GHG projections. The research includes an economic analysis of mitigation options. Mitigation options covered include sequestering carbon in woodland, lower and more efficient energy use in forestry operations, substituting woodfuel and wood products for more energy-intensive materials and developing 'best practice' forest management guidelines.

Research also focuses on national and international reporting of carbon stocks and GHG balances, setting standards for assessment methods, indicators and interactions between different greenhouse gases. This project will provide information that can be applied consistently to address emerging policy issues. The programme will also continue a comprehensive GHG budget for a raised bog restoration project from a conifer plantation.



Research into peatland restoration is establishing how it affects emissions of key greenhouse gases and carbon storage.

4. Silvicultural impacts on carbon

This work will provide scientific evidence to underpin appropriate silvicultural regimes that promote 'low carbon' land management practices. This will be achieved through field assessments, modelling approaches and the synthesis of existing knowledge. It will initially concentrate on determining the effects of conventional management practices on soil carbon stocks, which will enable an evaluation of the resource available to supply the expanding woodfuel market.

5. Biosecurity in a changing climate

Climate change has the potential to alter the future distribution, abundance and impact of forest pests and pathogens. The impact will depend on the characteristics of their life cycles and factors that have a key influence on their biology and population dynamics. By improving our understanding of how climate change affects the interactions of pests, pathogens and host trees, Forest Research can establish current and future risk profiles to inform tree species choice, and predict and reduce the effects of biotic damaging agents by suitable management. Interdisciplinary research will initially focus on insect life cycles as a predictor of risk and the interaction between drought stress of trees and pathogen attack.

6. Tree stability and climate

A forest wind risk decision support system that works within a GIS is being developed further. ForestGALES was developed to provide risk assessments for uniform conifer stands; it requires field measurements to give current risk, or yield models to provide an assessment of how risk changes over time. It will now be used to aid the design planning process, to provide risk assessments at a regional or country scale, and to provide assessments of wind risk from climate change and extreme event scenarios. Extending the model to work with uneven age and mixed species stands will allow risk assessments for stands being managed by continuous cover forestry, a measure that has been proposed to increase resilience to climate change.

7. Process modelling

Physiological or process-based models of tree growth and function have benefits over conventional empirical growth and yield models since they can accommodate the likely impacts of rising CO_2 levels and enable future combinations of climatic conditions to be explored. This research programme will continue to develop process-based models, working closely with the 'Climate change impacts on forest function' programme.

8. Woodfuel research

The woodfuel research programme aims to:

- a) support the characterisation and quantification of the available resource;
- b) develop best practice for feedstock processing, drying and storage, together with disseminating improved information on fuel quality and energy values;
- c) research operational issues including the methods, logistics, economics, energetics and safety of the whole supply chain, from harvesting produce in the forest to recycling ash.



Woodfuel is a key component of Forestry Commission policy and research.

There is also close integration between the woodfuel research programme and the Biomass Energy Centre (BEC). The BEC provides a 'one-stop-shop' information service for all aspects of renewable energy production from biomass and is based at Alice Holt.

Selected climate change elements in other research programmes

9. Hydrology

An important component of this programme is the role of floodplain woodland in flood alleviation, comprising modelling studies, GIS opportunity mapping and practical demonstration. Also covered by the programme are risk mapping for landslip and the hydrological consequences of growing short-rotation forestry crops for bioenergy. The research will also provide a review of the potential contribution of woodland creation and management to meeting the objectives of the Water Framework Directive and the value of woodland shade for protecting fish populations from thermal stress.

10. Seed biology

A number of native tree species need to be chilled for successful germination. There is some concern that, based on published climate change scenarios, this chilling requirement may not be met and natural regeneration in seminatural woodlands may suffer. Research is currently focusing on interactions between seed origin/provenance, the chilling requirement and germination success.



Preliminary research has shown that ash seeds from southern France need less prechill than those from Scotland in order to stimulate germination.

11. Economic research

The economic research programme considers a range of projects relating to climate change, including:

- a) an analysis of silvicultural options for climate change mitigation;
- b) study of woodfuel supply, focusing on prices offered to woodland owners and prices charged to consumers for woodfuel products;
- c) payments for ecosystem services: review of approaches to valuation and risk management for forest-based carbon schemes.

12. Genetic conservation

This research will increase understanding of genetic diversity and gene flow in native tree populations and the consequences for adaptability to climate change. Trials with existing and new provenances will underpin the development of climate change adaptation measures.

13. Landscape ecology and spatial planning

The programme will improve understanding of the impact of woodland spatial planning and management on biodiversity by developing tools and decision support systems that help to translate science into action. Within the programme, Defra is funding projects to develop indicators for landscape connectivity and strengthen the evidence base of the benefits of habitat connectivity for climate change adaptation.

14. Long-term experiments

Data from FC arboreta, collections and long-term experiments are being collated to identify tree species that grow well under current conditions and would be expected to perform well under future climate conditions. This information will help to identify species for future production by the forest nursery and horticultural sectors.

15. National Inventory of Woodland and Trees

A revised digital woodland map for Great Britain is currently in preparation (to be completed in 2009). The map will be regularly updated through information from the Forestry Commission and combined with remote sensing data to provide robust and spatially explicit measures of changes in woodland area.

16. Land regeneration, urban greening and social research

The programme considers the provision of ecosystem services by street trees and urban woodland. The main topics include:

- a) the development of a model to determine the efficacy of trees, woods and associated greenspace at improving air quality and its direct impacts on human health;
- b) the ecosystem services afforded by urban trees and woods through review of existing models, datasets and systems;
- c) the development of a framework to demonstrate the value and benefits of urban greenspace.



Research into land regeneration shows that establishing greenspace can lead to a wide range of socio-economic, health and environmental benefits.

Key Forestry Commission publications arising from this work

- Benham, S. (2008). *The environmental change network at Alice Holt Research Forest*. Forestry Commission Research Note 001, Forestry Commission, Edinburgh.
- Brown, A. and Webber, J. (2008). *Red band needle blight of conifers in Britain*. Forestry Commission Research Note 002, Forestry Commission, Edinburgh.
- Ray, D. (2008). Impacts of climate change on forestry in Scotland – a synopsis of spatial modelling research. Forestry Commission Research Note 101, Forestry Commission Scotland, Edinburgh.
- Ray, D. (2008). Impacts of climate change on forestry in Wales. Forestry Commission Research Note 301. Forestry Commission Wales, Aberystwyth.
- Freer-Smith, P.H., Broadmeadow, M.S.J. and Lynch, J.M. (editors) (2007). *Forestry and Climate Change.* CABI, Wallingford, 253 pp.
- Hubert, J. and Cottrell, J. (2007). *The role of forest genetic resources in helping British forests respond to climate change.* Forestry Commission Information Note 86. Forestry Commission, Edinburgh.
- Vanguelova, E. et al., (2007). Ten years of intensive environmental monitoring in British forests. Forestry Commission Information Note 88. Forestry Commission, Edinburgh.
- Broadmeadow, M. and Ray, D. (2005). *Climate change and British woodland.* Forestry Commission Information Note 69. Forestry Commission, Edinburgh.
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The Environmental Change Network at Alice Holt Research Forest

















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