

The Climate Change Challenge for British Woodland

How will trees in Britain adapt to the changes in climate expected over the next 100 years? Stephen Isaac explores the key issues and looks at potential responses.

Our climate is changing. Everyone is aware of the threat to the polar ice sheets, many people are aware of the threats to coral reefs and Siberian permafrost, but how much is known about the threats to biodiversity in the UK?

By 2040 the UK's annual average temperature is expected to rise by between 0.5°C and 1°C, depending on region and worldwide levels of greenhouse gas emissions. By 2100 the rise is expected to be between 1 and 5°C. The UK's climate has already warmed by 0.4°C and 0.9°C over the last century and has experienced eight of the ten warmest years on record since 1990.

This year the UK Climate Impacts Programme (UKCIP) updated its climate change scenarios from 2002 as part of UKCP09, in order to predict the climate change effects from low, medium and high greenhouse gas emission forecasts produced by the Intergovernmental Panel on Climate Change. The 2009 scenarios predict that all areas of the UK will get warmer, and the warming will be greater in summer than in winter. There will be little change in the amount of precipitation (rain, hail, snow) that falls annually, but it is likely that more of it will fall in the winter, with drier summers, for much of the UK. Sea levels are also expected to continue to rise, and will be greater in the south of the UK than the north.

In 2009 UKCIP also published an updated report on recent climate trends in the UK. The report shows that all of these climate changes have occurred in the last two decades, albeit with regional variation. It also shows that;

- severe windstorms have become more frequent in the UK in recent decades.
- average annual and seasonal relative humidity has decreased in all regions of the UK, except Northern Ireland, between 1961 and 2006, by up to 5%.
- the annual number of days with air frost has reduced in all UK regions between 1961 and 2006. There are now typically between 20 and 30 fewer days of air frost annually compared to the 1960s, with the largest reductions in northern England and Scotland.

The impact on woodlands

Woodlands and forests, like most flora and fauna, are susceptible to climate variability, for example through increased forest fire risk, pest and disease infestations and wind damage. These changes are already happening in many parts of the world; most people have seen the devastating effects of forest fire in countries like Australia, the US and the drier countries of Europe. We may now be seeing the first signs of them in Britain, with recorded changes in earlier spring bud growth on British trees and the increasing incidence of pest and disease attack on many tree species. Many of the predicted impacts on woodland will be direct, others will be indirect and as a consequence may be more difficult to predict.

Direct impacts on trees

Increasing concentrations of atmospheric carbon dioxide (CO₂) are known to affect the productivity of flora through photosynthesis. Controlled experiments on sessile, pedunculate and red oak saplings have shown that tree size increases by 30-50% when the CO₂ concentration is doubled. Although evidence suggests that mature trees are unlikely to respond as much in a forest environment, some increase in productivity is likely and the forestry sector may benefit from this. Large leaved species such as the non-native sycamore may also out-compete native species that have a higher biodiversity value. Other effects of increasing CO₂ concentrations are likely to include reduced leaf area water use, an increase in leaf area, possible changes in timber quality and changes to the nutritional quality of foliage for insect herbivores.

As discussed previously, increased temperatures are likely to lead to earlier bud growth in the year. This has already been shown to affect some species. For example, oaks in Britain are now experiencing budburst up to two weeks earlier than in the 1950s. Sycamore, hawthorn and hornbeam are also budding earlier in the year. Although the growing season is therefore expected to extend for many species, this earlier budburst could also increase the risk of frost damage early in the year. Warmer temperatures later in the year may also cause delayed or incomplete winter hardening and therefore increased susceptibility to frost damage. Additionally, warmer winters may not fulfil the winter chilling requirements for flower and seed germination, thereby affecting natural regeneration. Long-lived woodland species may be less able to adapt to such changing conditions as those with a shorter life cycle. Woodland flora are also expected to respond to earlier springs, with temperature sensitive species like garlic mustard and cow parsley leafing earlier and dominating over snowdrops and bluebells.

As a result of higher peak temperatures the top-dying of Norway spruce is likely to increase in England and eastern Scotland and Norway spruce could cease to be a productive species over much of England. Increasing heat and drought in the south and east are also likely to increase tree loss, particularly among newly established trees and mature trees in hedgerows and urban environments. Coniferous species may also experience increased drought crack in central and southern England.

Changing rainfall patterns are likely to cause direct impacts on trees. In south-east England, reduced summer rainfall and an increased evaporative demand are likely to lead to longer periods of drought stress on trees. This is already known to affect beech trees in south-east England. Conversely, increased winter rainfall could increase the risk of waterlogging, thereby reducing tree stability. Waterlogging could also cause fine root death and thus indirectly affect the ability of trees to take up water, which in turn could affect their ability to withstand summer droughts.

The final direct impact is likely to come from changing wind speeds. The UKCP09 report on recent climate trends shows that storms have become more intense in recent decades. If this trend continues woodland will likely become more vulnerable to wind damage.

Indirect impacts on trees

Experts have predicted that the majority of insect pests that currently affect UK forestry are likely to benefit from climate change as a result of increased activity and reduced winter mortality. Pests that are currently found in low or medium levels, such as defoliating moths, the horse chestnut leaf miner and bark beetles may become more prevalent. The range of certain pest species may also expand, with a northward movement of species that currently have a southern distribution and the probable appearance of new species from continental Europe and beyond. Outbreaks of bleeding cankers, green spruce aphid and pine weevils are also likely to increase as the climate warms. Fungal pathogens such as *Phytophthora ramorum*, responsible for the condition known as 'sudden oak death' may also thrive. Up to early December 2006 a range of tree species in Cornwall including beech, southern beech, horse chestnut, sweet chestnut, sessile oak, Turkey oak and sycamore have all been found with potentially lethal infections of this fungus. Red band needle blight is another fungal disease that could become more widespread in the UK. It was first spotted in the UK in the 1950s but has only become a serious problem recently. The disease, recognisable by a distinctive red band around each needle, can kill trees, affect their rate of growth and reduce the quality of their timber. It thrives on Corsican pine, but has also attacked indigenous species such as Scots pine. Mammalian tree pests such as the grey squirrel and various deer species may also be more likely to survive the winter under warmer conditions, with deer additionally benefiting from earlier spring growth of ground vegetation.

Forest fires pose a considerable threat to woodland worldwide. Although the risk may be higher in warmer and drier countries, parts of the UK are certainly vulnerable. Although the earlier growth of ground vegetation could reduce the risk of forest fires in spring and early summer, extended summer droughts, such as those of 1976 and 1995, result in a build up of dry, dead and highly flammable vegetation. Flooding associated with sea level rise or fluvial inundation may also pose a significant threat to trees in coastal areas or river floodplains, either directly or gradually and indirectly through habitat change. In some cases wet woodland species may benefit from increased fluvial inundation.

Mitigation and adaptation

Woods and forests of the world have an important role to play as carbon 'sinks', essentially absorbing atmospheric carbon dioxide that would otherwise contribute to climate change. Woodland is also important in that it provides biomass, an alternative to burning fossil fuels and the use of short rotation forestry can provide timber that often provides a practical alternative to using fossil fuel intensive materials.

In order to manage the response to climate change there are several ways in which the forestry sector and landscape managers can adapt to the changing circumstances. For example, climate change predictions should be taken into account when choosing stock. Species already at the edge of their range or with poor capacity to reproduce may need to be discounted. The introduction of more southerly or drought resistant species could help revitalise existing woodlands and establish more robust new woodland. Increasing the species mix of the woodland can also enhance its adaptive capacity and help to alleviate the threat from pests and diseases that target specific species. Areas of land

vulnerable to sea level rise or changed hydrological conditions may also need to be discounted from new planting schemes.

On a landscape level, larger, better connected woodland will enhance the ability of woodland and individual tree species to adapt to a changing climate, for example through migration within the woodland area. This may include managing, protecting and connecting woodlands to increase resilience and reduce the impacts from other external pressures that might have a cumulative or synergistic impact with climate change. The risk of fire can also be reduced through management of fuel loads, managing for appropriate age and species structures of woodlands, and the use of fire breaks.

The forestry sector could potentially come into conflict with nature conservation bodies over the choice of species and the way in which woodlands are managed but the two sectors are not mutually exclusive. There is potential to increase the biodiversity value and climate change resilience of commercial forestry and non-commercial woodland by utilising the latest climate change research and promoting effective co-ordination between planners and the wider public. Research into the effects of environmental and climate change on forestry and how the forestry sector can adapt to and mitigate climate change is now being actively progressed through bodies such as Forest Research, an agency of the Forestry Commission which has recently developed a 'Centre for Climate Change.'

The outputs from the UKCP09 climate change scenarios can be used as a vital tool for predicting and responding to the likely impacts on woodlands and trees in Britain. As well as providing useful data for landscape managers they could also provide a vital baseline input to policymakers and environmental professionals assessing climate impacts on biodiversity using tools such as Environmental Impact Assessment, Strategic Environmental Assessment and Habitats Regulations Assessment. By understanding the climate challenges ahead we can better inform our responses to it and give wildlife-rich British woodland a fighting chance of survival.

Stephen Isaac AIEMA

Halcrow Group Ltd

IsaacS@halcrow.com

Article published in the Institute of Environmental Management's 'Environmentalist' magazine, November 2009.

References:

1. European Forest Institute. 2008. Impacts of Climate Change on European Forests and Options for Adaptation.
2. Forestry Commission. 2005. Climate Change and British Woodland. Information Note.

3. Forestry Commission. 2009. Red Band Needle Blight. <http://www.forestry.gov.uk/> accessed on 19/5/09.
4. Parmesan, C. 2005. Biotic Response: Range and Abundance Changes. Chapter 4 *in* Lovejoy, T.E & Hannah, T (eds) Climate Change and Biodiversity. Yale University Press, New Haven and London.
5. Woodland Trust. UK Phenology Network. <http://www.naturescalendar.org.uk/> accessed on 19/5/09
6. UK Climate Impacts Programme. <http://www.ukcip.org.uk/> accessed on 2/7/09.