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## **Trees and Climate Change**

A Practical Guide for  
Woodland Owners & Managers

*by*

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Commissioned by Nicholsons



# Introduction

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Concern about the impacts of climate change on our trees and woodlands has led to increasing interest from owners and managers. The science of climate change and tree-related research is developing fast but advice for landowners can be difficult to access or remains unclear. This publication sets out to summarise the science and provide advice for future-proof woodland management.

What do we want from our woodlands in the 21st Century?

Trees, woods and forests are important for society, the economy and the environment. They are the single largest natural land-type supporting biodiversity in Europe. As climate change increasingly affects our lives, our woodlands are likely to be ever more important in providing ecoservices (such as landscape connectivity, soil and water conservation, habitat for wildlife) and as a carbon-lean resource (such as wood for construction, material for bioenergy).

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Long-term forecasts in world timber trends suggest a continuing decrease in hardwood exports from tropical forests and increasing consumption of timber in industrialising countries such as China and India. There are therefore good opportunities for increasing our domestic timber supply, particularly for valuable hardwood timbers. This would bring many benefits, such as using timber for use in material substitution, thereby reducing our carbon footprint.

In recent decades UK forest policy has concentrated on environment and social objectives. Sustainable forest management (SFM) must include economic factors, and naturally, economics often drives the ambitions and interest for woodland owners. Quality timber production can fulfil roles in increasing domestic timber supply, contributing by-products to bioenergy demand, and by providing materials for product substitution. True SFM should deliver wood products whilst protecting/enhancing the environment and providing benefits to society.

We should aim for the best quality and health in our woodlands. This will provide resources for the widest range of future opportunities, including timber. In summary – remember the mantra “quality sells”.

# Climate Change – Evidence and Projections

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## Evidence

Climate change is widely accepted as a fact. The science of climate change is conducted and summarised at a global level by the Intergovernmental Panel on Climate Change (IPCC). The IPCC includes hundreds of leading experts and therefore it seems irrational to dismiss lightly any of their conclusions (Table 1).

Effects of temperature increases have been documented (with ‘medium confidence’) on agricultural and forestry management at Northern Hemisphere higher latitudes. These include earlier spring planting of crops, and alterations in natural disturbance regimes of forests (*i.e.* fires and pests). Climate change is already affecting living systems globally, and affecting the range and abundance of animals and plants (Parmesan, 2006). Wide ranging evidence exists for climate change affecting biomes, forests and tree species across Europe

TABLE 1

### Some conclusions from the 2007 Fourth Assessment Report of the IPCC

- Global greenhouse gas (GHG) emissions have grown since pre-industrial times, with an increase of 70% between 1970 and 2004.
- The understanding of anthropogenic warming and cooling influences on climate has improved since the Third Assessment Report (TAR), leading to “very high confidence” that the globally averaged net effect of human activities since 1750 has been one of warming
- Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level
- At continental, regional, and ocean basin scales, numerous long-term changes in climate have been observed. These include changes in Arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones.
- Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases.
- With current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades.

## Projections

Woodland growth will be impacted by climate change to different degrees across Europe, the UK generally less impacted than boreal and Mediterranean regions. The most widely recognised impact will arise from temperature change (warming), which will profoundly affect trees and woodlands by altering photosynthesis and respiration, and other factors such as phenology (*e.g.* leafing dates) and evolution.

A warming of up to 2°C may be beneficial for trees but the response will vary between different species (Saxe *et al.*, 2001). Increases in CO<sub>2</sub> (a greenhouse gas) may also increase growth rates in the short term (*i.e.* before other negative effects impact). The greatest impact may come from extreme and unpredictable events; so called ‘stochastic’ events, such as drought, extreme wind and precipitation, frost, fire, insects and pathogens. Of course, impacts are likely to come from more than one direction and may be related. For instance, trees stressed by drought will become more susceptible to disease and pests.

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In the UK, we lead the world in climate science and have a wealth of information on likely impacts of climate change on our woodlands (*e.g.* Broadmeadow, 2002). Generally, native broadleaved species may become unsuitable for timber production on some soils and aspects. Species projections have been developed by Forest Research following likely scenarios for 2050 and 2080 (Broadmeadow *et al.*, 2005). The strongest projection is that beech will become less viable on southern slopes in southern England. General risks and responses are summarised in Table 2.

# As a forest owner, what should I do?

## UK policy

Before deciding what you would like to do, it is important to review the policies relating to forestry in the UK and how they affect woodland owners and managers.

Beyond the woodland grant schemes the key policy to highlight here is that which relates to what tree material you may include in a new planting scheme. The Forestry Commission has advocated local planting material through the definition of seed zones (Herbert *et al.*, 1999). However, a recent publication by Forestry Research (Hubert and Cottrell, 2007) states that *"this relatively fine-scale system of zonation, if*

*rigorously imposed to control the use of planting material, may be overly restrictive in the face of predicted climate change."* This has yet to be reflected in any change in planting grant schemes.

We live and operate in fast-changing times, and forestry is already moving up the agenda



The recent revision of the forestry strategy for England (Department for Environment Food and Rural Affairs, 2007) recognises the value of timber production but perhaps falls short of recognising the reality for individual woodland owner's needs. We live and operate in fast-changing times, and clearly forestry is already moving up the rural agenda, and may benefit in the future from increased interest and support from Government.

TABLE 2

### General Predictions of Climate Change on Trees and Woodlands

RISKS	IMPACTS	RESPONSES
Temperature CO <sub>2</sub>	<ul style="list-style-type: none"> <li>● Increased growth but less with drought</li> <li>● Increased growth rates until other risks impact</li> <li>● Species will respond differently, forest dynamics will be affected</li> </ul>	<p>Select species according to new growth potential</p> <p>Adjust yield estimates and develop flexible stand management to account for altering competition, interaction and regeneration.</p>
Fire	<ul style="list-style-type: none"> <li>● Mortality</li> <li>● Few species fire resilient</li> <li>● Most European forests not natural wildfire ecosystems</li> </ul>	<p>Incorporate firebreaks, resilient species (non-natives?).</p> <p>Improve management (<i>e.g.</i> thinning, forest floor maintenance).</p>
Drought	<ul style="list-style-type: none"> <li>● Mortality or stress.</li> <li>● Increased susceptibility to pests and pathogens</li> </ul>	<p>Consider altitude and aspect, and select species carefully.</p> <p>Utilise small-scale site features to suit species.</p>
Wind	<ul style="list-style-type: none"> <li>● Damage to tree form</li> <li>● Reduction in growth</li> <li>● Mortality</li> </ul>	<p>Use shelterbelts around woods to protect valuable crops and increase growth</p>
Extreme Precipitation	<ul style="list-style-type: none"> <li>● Reduction in growth</li> <li>● Waterlogging</li> </ul>	<p>No specific response. Potential role for forestry in reducing runoff and minimising flood risk.</p>
Frost	<ul style="list-style-type: none"> <li>● Damage to tree form.</li> <li>● Timber quality reduced</li> </ul>	<p>Avoid frost sensitive species or use selected genotypes.</p> <p>Account for small-scale site variability.</p>
Pests & Pathogens	<ul style="list-style-type: none"> <li>● Health reduction.</li> <li>● Mortality</li> </ul>	<p>Genetic variability (provenance) and species mixtures for robustness. Pest control where feasible.</p>

## What to plant

A common phrase of leading climate change researchers in recent times is 'robustness', or in other words creating a resource that can resist or adapt to change.

An important recommendation is to avoid single species plantations and the planting of material of narrow genetic origin. You would be well advised not only to plant native trees that are of local origin but also include some sourced from further afield, ideally from further south where our climate may be matched in the future.

Furthermore if appropriate to the site, it may also mean that you could include some non-native trees that are predicted to grow well with climate change (see Table 3 below). Trees closely related to native species (e.g. *Fraxinus angustifolia*.) or those native to Europe (e.g. *Juglans regia*) may be more politically acceptable in the short-term. *Nothofagus* spp. may have potential but provenance choice will be critically important.

Another important consideration may be to use mixtures in designing new woodlands, including different species for specific purposes such as soil moisture retention, nitrogen fertilising effects, wind protection and microclimate provision. A high shrub content as part of the mixture can be highly effective in many of these criteria.

Finally, plant with an eye to the future. What is the purpose of the planting or what might its value be in the future? A poorly designed plantation with poor quality planting stock is unlikely to deliver much value.

TABLE 3

### Non-native tree species worthy of consideration

Sycamore	<i>Acer pseudoplatanus</i>
Sweet chestnut	<i>Castanea sativa</i>
Oriental beech	<i>Fagus orientalis</i>
Ashes	<i>Fraxinus angustifolia</i> , <i>F. ornus</i>
Walnuts	<i>Juglans regia</i> , <i>J. nigra</i> , hybrids
Southern beeches	<i>Nothofagus</i> spp.
Hop hornbeam	<i>Ostrya carpinifolia</i>
True service tree	<i>Sorbus domestica</i>
Oaks	<i>Quercus pubescens</i> , <i>Q. rubra</i>
Monterey pine	<i>Pinus radiata</i>
Locust tree	<i>Robinia pseudoacacia</i>



## Where to plant

We expect that stressed trees will be more susceptible to pests and diseases, and of course will not grow or yield well. It may be more important now than ever to match a species carefully to the site, particularly at the small scale. In other words, avoid planting beech on southern facing slopes and hill tops. Best growth for productive species such as ash and walnut will be where there is good soil moisture and microclimate, such as near the valley bottom or lower slopes.

At the large scale, you might want to avoid planting beech in the southern counties, except on the very best sites. Conversely the suitable range of walnut and sweet chestnut may extend north in the UK, and new species (as suggested within Table 3) may be viable in the southern counties and south west.



## How to manage

Variation in woodland age and structure will also be beneficial in the future. Silvicultural systems can be applied where the canopy is maintained at varied levels without clear-felling, using varied tree species and using natural regeneration where possible. The concept of 'close to nature forestry' was advocated in the 1880s but has increasing resonance today.

In the UK, woodland managers should be aware of a potential increased risk of fire, particularly in southern England, and plan and manage forests accordingly. Pests and diseases are difficult to manage (and predict) but risks can be diminished through good design, such as planting trees of different genetic origin.

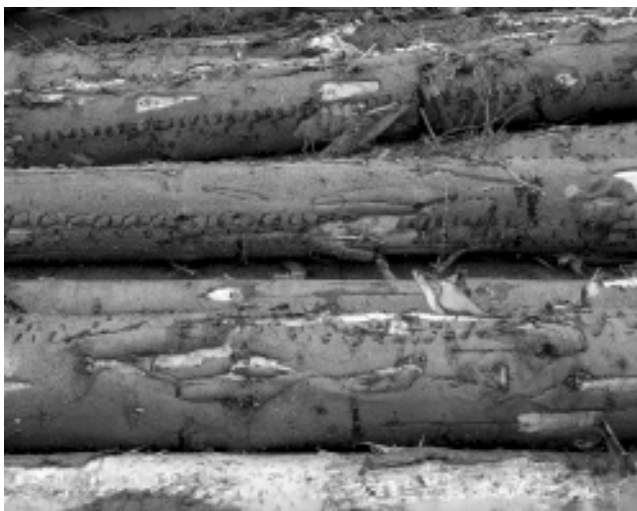
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Most crucially, operate with sustainable forest management objectives. Aim for the best timber quality, and there will be plenty of trees of lower quality and management (pruning and thinning) by-products for woodfuel provision. Retention of misshaped trees and standing deadwood, together with sensitive understorey and ride management, will assist biodiversity to adapt to climate change.

Finally, a well-managed wood will provide society with landscape value and environmental protection, and if you choose, a wonderful place for people to enjoy for pleasure or sport.



## Summary

Our woodlands will play a crucial role in the 21st Century. The global trend in timber may reflect an increasing demand for wood products. Woodlands will be important in supporting a carbon-lean society: where material substitution (timber replacing brick, concrete or steel), bioenergy and management of woodlands as carbon sinks will be high priority. The provision of ecosystem services will become higher priority, such as helping nature adapt to change, linking the landscape, and soil and water protection and management.

Woodland management must rise to meet these challenges, whilst owners should be able to capitalise on the values from their forests. Assisting woodlands, tree species and wildlife to adapt to change will be challenging. There may be a greater role for mixed-woodlands and close to nature forestry practice, and these may provide a more flexible and robust forest resource. The roles of genetics and silvicultural best practice are very important and must be considered hand-in-hand.

There is so much uncertainty in the science of climate change projections, and in how the environment will respond, it is difficult and perhaps foolhardy to make firm recommendations. However, woodland owners and managers quite rightly want to plan for the future and need good information and guidance where possible. It is hoped that this publication provides some useful pointers and encourages the reader to find out more.

# Further Information



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Tree and forest functioning in response to global warming.  
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## Web Resources

British & Irish Hardwoods Improvement Programme: [www.bihip.org](http://www.bihip.org)

Forest Research - The Research Agency of the Forestry Commission:  
[www.forestresearch.gov.uk](http://www.forestresearch.gov.uk)

Forestry Horizons - A UK-based forestry think-tank: [www.forestryhorizons.eu](http://www.forestryhorizons.eu)

IPCC - The intergovernmental panel on climate change: [www.ipcc.ch](http://www.ipcc.ch)

Nicholson Nurseries - Quality trees and advice: [www.nicholson-nurseries.co.uk](http://www.nicholson-nurseries.co.uk)

Valbro - Growing valuable broadleaved trees: [www.valbro.uni-freiburg.de](http://www.valbro.uni-freiburg.de)



## About the Author

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