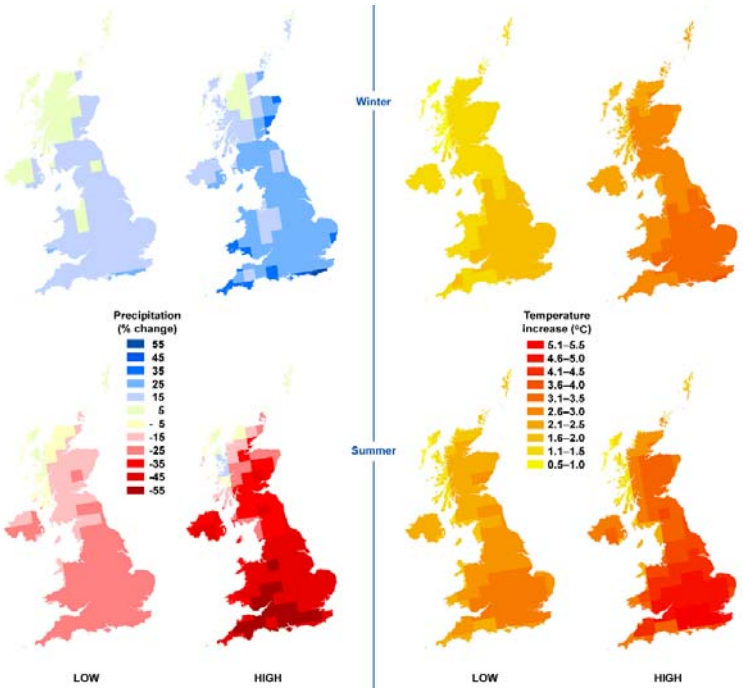
Climate change, provenance selection and the consequences for timber production of ash and beech



Climate change predictions

There is convincing evidence that the global climate is changing, largely as a result of anthropogenic emissions of greenhouse gases. Predictions are for temperatures in the UK to rise by between 3 and 5ºC during the course of this century. Rainfall in winter is predicted to increase significantly, by up to 30%, while summer rainfall will be significantly lower across most of the UK. Future changes in wind speed are uncertain, although the storm track is predicted to move further south with an increased frequency of deep depressions crossing the southern UK during the winter months. Cloud cover will fall during summer, accompanied by a reduction in relative humidity and a large increase in potential evapo-transpiration. Summer drought is thus likely to become the greatest constraint to species selection and timber production.

Figure 1. Climate change scenarios for Low and High emissions scenarios for the 2080s. UKCIP02 scenarios prepared by the Tyndall and Hadley Centres for Defra.

Climate matching analysis

Matching the future predicted climate of the UK to current climates in Europe can provide insight into the identity of tree provenances that may provide suitable material for planting in anticipation of climate change. This analysis indicates that many of the 'traditional' continental provenances from central Europe are poorly matched to both the current and future climates of the UK. Western France and, under the more extreme climate change scenarios, parts of the Mediterranean at high elevation have current climates best matched to that predicted for the southern UK.

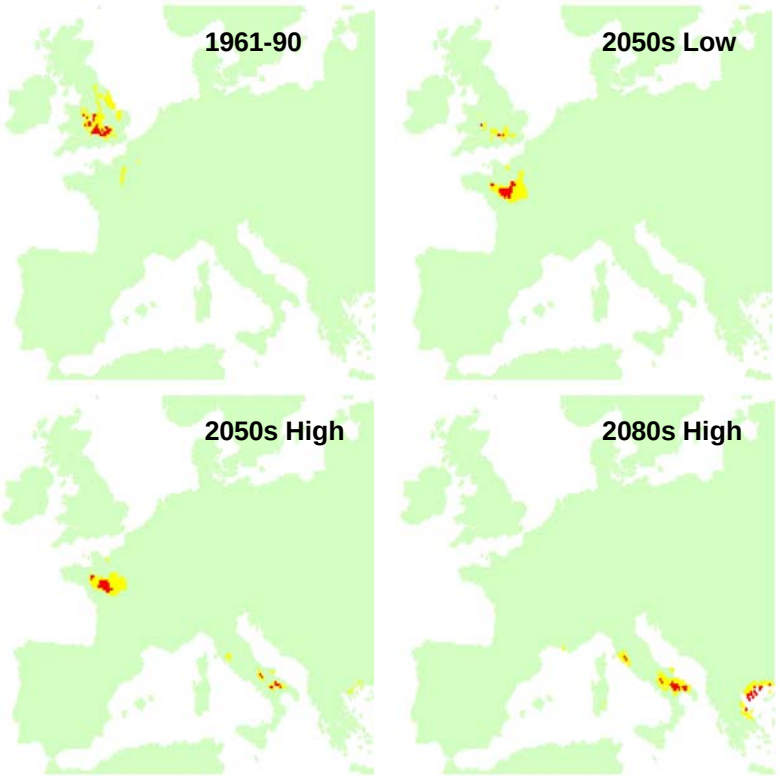


Figure 2. Climate matching analysis for Little Wittenham. The red and yellow areas represent the 0.2% and 1% of grid-squares in Europe best matched to each scenario. Climate matching was performed on the basis of monthly mean temperature, diurnal temperature range and precipitation, weighted according to the annual range for each variable. Baseline data are from a global data-set of 10 minute resolution provided by the Climatic Research Unit of the University of East Anglia, and the future scenarios are based on the UKCIP02 50 km gridded data-set.

Climate change adaptation

A number of options are available for adaptation to predicted climate change. Practising 'conservative' forestry, in which species well matched to the current climate, but also capable of adapting to a degree of change, are planted is a simple, 'no-regrets', option. Tree species that are currently at the drier end of their range at a given site should therefore not be planted. Other adaptation measures include the selection of non-local or non-native provenances and the planting of both mixed species and mixed provenances. As climate change progresses, establishment and management practice may also need to adapt. It must also be appreciated that predictions of future species suitability given here only cover the coming half century - beyond this timeframe, the consequences of climate change are likely to be more serious and further adaptation measures will be necessary.

Interpreting French productivity data

In the absence of UK productivity data appropriate to our future predicted climate, data from France can provide an indication of the likely future productivity of those species in the UK.

For both ash and beech, productivity would be classed as 'suitable' in commercial terms, in the regions of west and north west France that correspond to the future predicted climate for the UK. However, certainly in the case of ash, productivity is reduced south of the Loire, suggesting, as ESC predicts, that ash may suffer in the UK beyond the middle of this century.

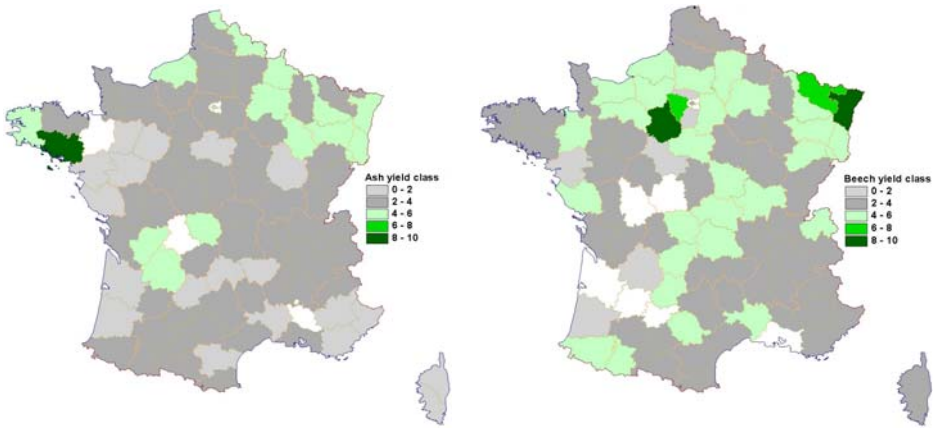
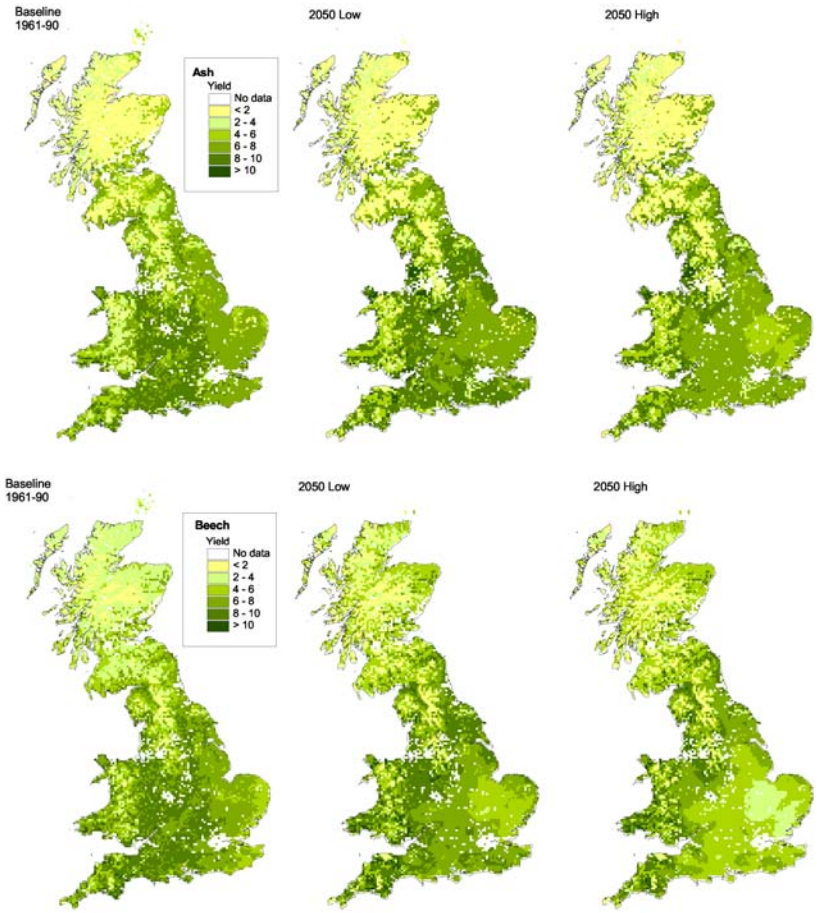


Figure 3. Productivity of ash and beech in France. Data are shown as 'Department' averages. For comparison, average yield class of both ash and beech in south east England (ESC estimates) is 7.4 m^3 ha^{-1} yr^{-1}.



The Ecological Site Classification Decision Support System (ESC)

ESC has been developed to support the UK forestry industry in commercial species selection and the restoration of native woodland. It is a knowledge based model in which suitability or yield class is predicted on the basis of four climatic (accumulated temperature, exposure, moisture deficit and continentality) and two edaphic (soil moisture and soil nutrient regime) factors.

A number of assumptions have been made, that should be considered when interpreting the suitability maps and climate change. In particular, the following have not been considered.

- *the direct effects of rising atmospheric CO_2 concentrations on growth and evapo-transpiration;*
- *the effects of a possible change in the frequency of severe pathogen or insect pest outbreaks;*
- *changes to the frequency of extreme climatic events;*
- *the predicted increase in winter windspeed rather than mean annual windspeed;*
- *changing soil moisture quality index as well as the moisture deficit.*

Figure 4. ESC predictions of yield (m^3 ha^{-1} yr^{-1}) under baseline (1961-90), 2050s Low and 2050s High climate scenarios for ash (top) and beech (bottom). For ash, productivity increases across much of the southern UK under the 2050s Low scenario but this increase is reversed under the 2050s High scenario. Under both Low and High emissions scenarios, the productivity of beech is predicted to fall by the 2050s.

Provenance selection

The planting of provenances adapted to the predicted climate of the future may represent an adaptation response in anticipation of climate change. However, it must first be ascertained that they are well adapted to both current and future climates at a given location; there is concern that more southerly provenances may be susceptible to frost damage. However, evidence suggests that, at least in young trees, vigour is maximised in provenances best suited to the climate in which they are growing. Local provenances are thus unlikely to perform well in the climate predicted for the future.

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