Department for Environment Food & Rural Affairs
Department for Business, Energy & Industrial Strategy
Met Office Hadley Centre
Environment Agency
Working together on UK Climate Projections

Forests for the future

Creating future tree growth and species suitability maps for foresters

Published May 2018

Forest Research

Michal Petr, Stephen Bathgate

- We have a web-based tool to assist public and private foresters to make informed decisions about which tree species to grow.
- We can use daily, monthly and annual data from multiple model sources and we will look at how we would update our tool using the UKCP18 data products.
- As with UKCP09, we will need bespoke advice and tools to translate UKCP18 products to the planning scale at 250m.

Forestry in the UK

The British forestry sector delivers a range of objectives ranging from habitats, timber production to recreation. Many of the mature forests in the landscape today were planted in the mid-20th century prior to concerns that climate change might affect their long term ability to deliver ecosystem services.

Today, the forest planning and management community across the private and public sector are aware that tree species choice should account for site conditions in current and future climates. Their informed decisions should sustain tree species in the landscape and also the ecosystem services they provide, such as timber and recreation.

Traditionally, foresters use land or forest management plans to decide which species they want to grow and when they will harvest them – driven by the different growth rates for coniferous and broadleaves species. As forest plantations are continuously felled and replanted forest planners need to update plans and use tools that can help them quickly assess which tree species can be the most tolerant to prevailing average and extreme climate conditions such as warmer temperatures or increased precipitation. The typical planning horizon is around 50 years for conifers managed via clearfell systems but can be as much as 150 years for broadleaved species such as oak.

Ecological Site Classification (ESC) To support foresters' decisions, Forest Research developed ESC in the 1990s. ESC is delivered as a computer-based tool for appraising tree species' potential by soil, accumulated temperature and other climatic variables. This tool is now widely used in forest planning at multiple spatial scales, ranging from individual sites (less than 10 hectares), forest block (10-1000 hectares) through to national scales.

Exploiting UKCP18

To understand tree growth and species suitability, we require daily temperatures (mean, maximum, minimum), accumulated days over 5°C (growing degree days) and other information to ascertain exposure (wind zone maps) and moisture availability (surface evaporation). We intend to use daily data to look for extreme values (e.g. late frost or drought) and monthly values to look at long term changes. Although we used the Regional Climate Models (RCMs) previously for the species suitability maps, we now consider spatial coherence to be less significant in this application area. The potential for the UKCP18 datasets are to be used to inform the development of ESC:

Observations We would use these to re-evaluate our ESC model (see site suitability study overleaf). We would explore tree responses to past extreme events, such as droughts. Daily and monthly data would be required.

Probabilistic projections In the drought risk study (see overleaf), we used the weather generator (WG) but this will not be available. However, we would be able to update our methods using monthly and annual data. (continued overleaf)

Figure 1. Consequences of poor species choice on unsuitable site. Sitka spruce planted on a windy site with poor rooting conditions has led to windthrow.

Find out more

This project is part of a portfolio of demonstration projects that have worked with the UKCP18 team to understand the implications of the next set of UK Climate Projections for their sector.

To find out more about the UKCP18 project and other demonstration projects, please visit https://www.metoffice.gov.uk/research/collaboration/ukcp

60km (from global) and 12 km (from regional) climate model daily data This model ensemble will provide us with the daily and monthly data (including variables to calculate potential evapotranspiration) for the suitability maps (see site suitability study). We will most likely use the whole model ensemble in our impact models, and report the mean (or median) and variability (e.g. standard deviation). Key for our users is how variability changes over time and space. We would also need to "bias-correct" the raw model data .

2.2km climate model data This offers information close to the scale of a forest block but we realise that additional effort is required to understand how to use the product at this scale in a robust manner. This would potentially be used to update the site suitability study.

What to be aware of with UKCP18

- The high resolution 2.2km model will only be available for three time periods (1981-2000, 2041-2060 and 2061-2080) and for RCP8.5. The probabilistic or 60km data may be required for uncertainty estimates across the Representative Concentration Pathways (RCPs) or continuously through the 21st century.
- The data will be available only as text (comma-separated value) and netcdf files. The underlying shapefiles for countries, administrative and river basin regions will be available and will be subject to the Open Government Licence.
- Forest site level planning requires information at 250m resolution due to the influence of topography. Further advice and tools will be required to downscale the climate data, particularly in mountainous regions.

Previous studies using UKCP09

Two previous studies have been used to inform our work: the first estimates tree growth using the UKCP09 probabilistic projections and the second quantifies tree species suitability using spatially-coherent regional climate models RCMs.

Drought risk The UKCP09 WG was used to estimate drought risk of growth potential and other ecosystem services for the major tree species across Great Britain (Petr et al., 2014). The approach provides changes in tree growth (stand yield class), which mostly decrease in the future depending on the location (see Figure 2). The WG is not being updated for UKCP18, hence we will use daily data from the 2.2km, 12km and 60km climate model datasets.

Species suitability (ESC) We used a similar approach to the drought risk study but included additional variables such as wind speed. Figure 3 illustrates a national scale ESC assessment for pedunculate oak, one of the main broadleaved species. In this case we can see suitability declining in East Anglia but improving in Wales and eastern Scotland. Both ESC and these maps have been used in several forestry publications (Ray, 2008; Ray and Broadmeadow, 2010), and widely used to inform forest managers.

The main outputs from the ESC model are information about tree species suitability and tree growth sensitive to climate (www.forestdss.org.uk/geoforestdss). We make this data freely available in different formats, such as GIS spatial datasets and tables within the ESC Decision Support System web application. The available information have been used to assist both public and private foresters make informed decisions about which tree to grow and where.

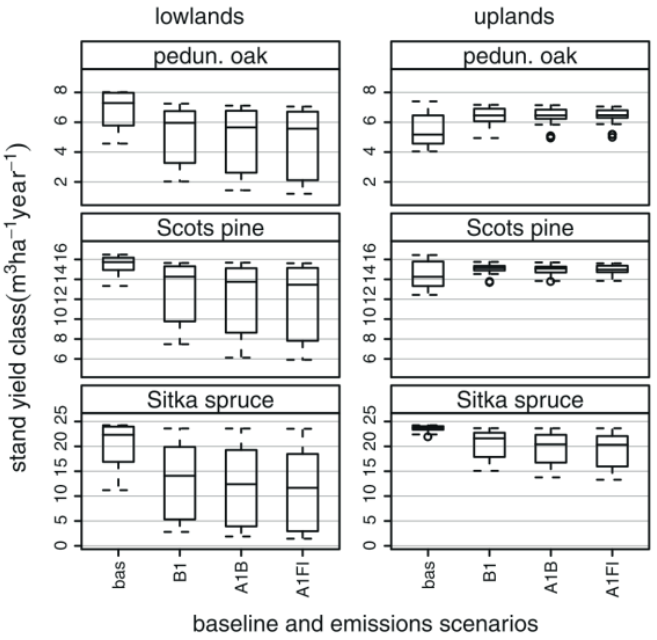

Figure 2. Changes in tree growth across for pedunculate oak, Scots pine, and Sitka spruce across Great Britain under climate change – using the the UKCP09 WG (from Petr et al., 2014)..

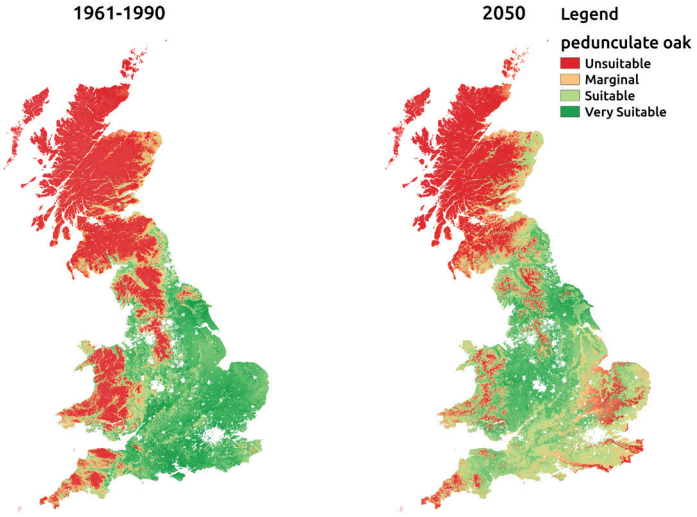

Figure 3 Tree species suitability maps for pedunculate oak for 1961-1990 and 2050 SRESA1B, with red indicating unsuitable (worst) and green very suitable (best) sites.

References

Petr, M., Boerboom, L.G.J., van der Veen, A., Ray, D., 2014. A spatial and temporal drought risk assessment of three major tree species in Britain using probabilistic climate change projections. Clim. Change 124, 791–803. doi:10.1007/s10584-014-1122-3

Pyatt, G., Spencer, J. Hutchby, L., Davani, S., Fletcher, J. and Purdy, K., 2003, Applying Ecological Classification in the Lowlands: A Case Study in the New Forest Inclosures, Forestry Commission Technical Paper 33, Forestry Commission, Edinburgh.

Ray, D., 2008. Impacts of climate change on forestry in Scotland - a synopsis of spatial modelling research.

Ray, D., Morison ., J., Broadmeadow, M., 2010. Climate change: impacts and adaptation in England's woodlands.