Increasingly, human activities are influencing global climate. Between 1985 and 1994 temperatures have been about 0.2°C warmer than average compared with 1961-1990 and during the 1985-1995 decade the average global atmospheric CO₂ concentration has risen by about 5%.

The likely impacts of climate change on the UK for the 2020s are:

- temperatures are expected to increase at a rate of about 0.2°C per decade; higher rates of increase will occur in the south east, especially in summer; it will be about 0.9°C warmer than the average of 1961-1990 by the 2020s and about 1.6°C warmer by the 2050s;
- this temperature change is equivalent to about a 200 km northward shift of the UK climate, the difference in the current temperature between Oxford and Manchester;
- annual precipitation over the UK as a whole is expected to increase by about 5% by the 2020s and by nearly 10% by the 2050s; winter precipitation increases everywhere but more substantially over the southern UK;
- the contrast in the UK’s climate is likely to become exaggerated, for example the currently dry south east will tend to become drier and the moist north west will get wetter. Drought in the south east and flooding in the north west will both become more common;
- sea level is expected to rise at a rate of about 5 cm per decade; this is likely to be increased in southern and eastern England by the sinking land whereas in the north it will be offset by rising land (as a result of glacial unloading);

By the 2050s average sea levels will be about 35 cm higher than 1961-1990 and the probability of storm surges will increase. By 2050 the UK will be more subject to intense rainfall events and extreme wind speeds, especially in the north. Gale frequencies will increase by about 30%.

**Fig 1. The likely effects of a changing climate in the UK**

<table>
<thead>
<tr>
<th>Positive effects</th>
<th>Negative effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>• an increase in timber yields (up to 25% by 2050s) especially the north of the UK (with perhaps some decrease in the south)</td>
<td>• an increase in soil aridity, soil erosion and the shrinkage of clay soils</td>
</tr>
<tr>
<td>• a northward shift of farming zones by about 200-300 km per degree centigrade of warming, or 50-80 km per decade, will improve some forms of agriculture especially pastoral farming in the north western part of the UK.</td>
<td>• an increase in animal, especially insect, species as a result of northward migration from the continent and a small decrease in the number of plant species due to the loss of northern and montane (mountain types)</td>
</tr>
<tr>
<td>• enhanced potential for tourism and recreation as a result of increased temperatures and reduced precipitation in the summer, especially in the southern UK.</td>
<td>• a decrease in crop yields in the south east of the UK</td>
</tr>
<tr>
<td></td>
<td>• an increase in river flow in the winter and a decrease in the summer, especially in the south</td>
</tr>
<tr>
<td></td>
<td>• an increase in public and agricultural demand for water</td>
</tr>
<tr>
<td></td>
<td>• increased damage from storms, flooding and erosion</td>
</tr>
<tr>
<td></td>
<td>• increased incidence of certain infectious diseases in humans and of the health effects of episodes of extreme temperature.</td>
</tr>
</tbody>
</table>
Impact on UK forestry
The increased frequency of warm summers and very warm years will increase destruction of lowland forest in southern areas by drought and fire but will increase productivity of upland plantations. The latter effect is because temperature rather than water is the limiting factor. Thus, warmer summers will increase the profitability of coniferous plantations in the north and uplands. However, a warmer climate will also affect timber production in the rest of Europe and it is the relative increase in yields between different countries which will determine whether UK forestry becomes more profitable.

In southern Britain the risk of forest fire will increase. Most forest fires occur in the spring before the growth of new grass has covered the dead remains of the plants of the previous year. Most fires occur in young plantations. The amount and pattern of spring rainfall may therefore affect fire risk, although it should be noted that in the UK, weather is not the cause of fires (man is), but rather, weather has a catalytic effect. Decreasing spring rainfall will catalyse more fires.

Surveys of forest health conducted by the Forestry Commission (now Forest Authority) show no evidence of a long-term trend but beech trees in southern Britain deteriorated following the summer droughts of 1984 and 1990. However, drought is known to contribute to the overall harmful effect of air pollution such as acid rain and low level ozone.

UK Agriculture
It is expected that the overall effect of warmer summers on crop production will be negative - yields will fall because soil moisture will fall below critical levels and evapotranspiration will increase. However, increased temperatures affect many aspects of biological production and the net effect is difficult to predict (Fig 2).

Fig 2. Climate change and agricultural productivity

Case Study - Africa
The major impact of climate changes on agriculture in Africa would be a consequence of changing temperature and availability of soil water (Fig 3).

Fig 3. Climate change and African agriculture

Vegetation, temperature and precipitation
Vegetation type is influenced by three interactions between temperature and precipitation:
1. The minimum temperature below which a species dies
2. The minimum number of days of a certain temperature after which a species dies
3. The minimum precipitation below which a species dies

When these three are mapped and compared with the present day distribution of vegetation types there is good general agreement. By predicting how these three will change in the next fifty years biogeographers can predict the changes that may occur in vegetation types.
**Case Study - The effect of climate change on Wytham Wood**

Wytham Woods, near Oxford (Fig 4), is one of the most intensively studied areas of woodland in the world. Wytham has been monitored very closely for at least forty years and is one of eleven sites worldwide being used as an indicator of the effects of climatic change. Wytham consists of 1000 acres of protected woodland located in a meander in the River Thames. It covers two low hills, formed of Jurassic Corallian limestone, which rise about 100 m above the river. The area was previously owned by the Fennel family, who in 1940 gave the woodlands to the University on the condition that their natural beauty was preserved for all time.

**Flora and fauna**

Over 3800 species of animals and 600 species of vascular plant have been recorded at Wytham which is a SSSI. Many long-term ecological studies in Wytham Wood have examined the energy flow of the ecosystem (Fig 5).

**Change over time**

Changing climate will affect insect distribution; this in turn will affect the ecology of the tree species at Wytham. These are an important part of the surrounding hedgerows and field edges, and support a wide range of insect species (Table 1).

**Table 1. Insect species associated with common trees and shrubs**

<table>
<thead>
<tr>
<th>Tree or shrub</th>
<th>Number of insect species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oak</td>
<td>284</td>
</tr>
<tr>
<td>Willow</td>
<td>266</td>
</tr>
<tr>
<td>Birch</td>
<td>229</td>
</tr>
<tr>
<td>Hawthorn</td>
<td>149</td>
</tr>
<tr>
<td>Blackthorn</td>
<td>109</td>
</tr>
<tr>
<td>Poplar</td>
<td>97</td>
</tr>
<tr>
<td>Crab Apple</td>
<td>93</td>
</tr>
<tr>
<td>Scots Pine</td>
<td>91</td>
</tr>
<tr>
<td>Alder</td>
<td>90</td>
</tr>
<tr>
<td>Elm</td>
<td>82</td>
</tr>
<tr>
<td>Hazel</td>
<td>73</td>
</tr>
<tr>
<td>Beech</td>
<td>64</td>
</tr>
</tbody>
</table>

**Fig 5. Energy flows in Wytham Wood**

![Energy flows in Wytham Wood diagram]

**Fig 4. Location of Wytham Woods, near Oxford**

![Location of Wytham Woods map]

Global warming is already having an effect on the biogeography of Wytham Woods. Scientists at Oxford University predict that by 2050 grasslands will become infested with weeds, common species of birds will become rarer and wetlands will dry up.

The changing availability of carbon dioxide and water and changes to the average temperature and length of the growing season will affect different tree species unequally; competition between some plant species will increase and some will become out-competed and become locally rare, restricted or extinct. Increasing summer temperatures will change the numbers and species diversity of pollinating insects and will also influence the activity of herbivores which, in turn, will influence the reproductive success of tree saplings.

Thus, climate change will alter the pattern of succession; some species will suffer greater herbivory and some will suffer reduced pollination. The overall effect of these interactions is very difficult to predict but it is likely that species frequency will be altered.
Practice Questions

1. Describe the trophic structure of Wytham Woods.

2. Fig 5 shows a food web from Wytham Woods in Oxfordshire. Identify the autotrophs and top carnivores in Fig 5.

3. Suggest some of the pressures that threaten areas of deciduous woodland both now and over the next fifty years.

4. What effects will changes in climate have on vegetation?

5. What is the likely impact of climate change on the ecology of Wytham Woods?

Answers

1. Wytham Woods is an excellent example of a deciduous woodland and as such it shows a model trophic structure. Oak trees, other trees, shrubs and herbs make up the primary producers (the autotrophs or first trophic level), caterpillars, insects, voles, and mice are the herbivores or second trophic layer. Spiders, predatory beetles, shrews and moles are the next level (primary carnivores) while titmice, owls, weasels and foxes are the top trophic layer (secondary and tertiary carnivores).

2. The autotrophs are oak trees, other trees and shrubs and herbs. The top carnivores are owls and weasels.

3. The increased demand for housing, and the lack of space in southern Britain means that there will be increased pressure to develop housing in some areas that are currently woodland. In addition, demands for recreation and tourism will mean that many areas of woodland will experience increased visitor pressure. Balancing the needs of visitors and trying to manage the woodland naturally may lead to conflicts of interest.

4. There are a number of impacts. Positive ones include

- an increase in timber yields (up to 25% by 2050s) especially the north of the UK (with perhaps some decrease in the south)

Negative effects include a small decrease in the number of plant species due to the loss of northern and montane (mountain types). Moreover, it depends on the scale of the increase in temperature. If there is an increase of temperature of 0.5°C

- disappearance from the British Isles of a few niche species, e.g. alpine wood fern: oak fern.

- immigration of some continental species and expansion of some species, e.g. Red Admiral and Painted Lady butterflies, Dartford Warbler.

- increase in plant productivity by 3%.

- By contrast, if the temperatures increase is 1.5°C, increased disappearance from the British Isles of several alpine and temperate species.

- in-migration of several Mediterranean or tropical species.

- plant productivity may increase by 15%.

5. The impact of climate change on the ecology of Wytham is likely to be negative. The changes are explained in the last paragraph of this Factsheet. There will be decreases in the populations of worms, badgers, foxes, butterflies, caterpillars and birds. On the other hand, there may be increases in the number of species that are drought tolerant. Changes to the populations of pollinating insects and herbivores, along with changes to average temperatures etc. will alter the pattern of succession. The relative numbers of different tree species may change.