

Gardening in the Global Greenhouse: The Impacts of Climate Change on Gardens in the UK

Technical Report
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Preface

There are three interrelated phenomena which need to be identified in reviewing the potential impacts of climate change on gardens.

The first is climate change itself. The climatic changes expected in the UK are described in the report *Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report* (Hulme *et al.*, 2002). This report examines the potential impacts of the expected climate changes on gardens in the UK.

The second phenomenon is the occurrence of extreme weather events such as floods and droughts. Climate change is expected to increase the frequency of some extreme weather events, but predictions of such events are less certain than those for average changes in climate. Predictions of gale frequency in future are particularly uncertain.

The third phenomenon is development. The Earth's surface has changed dramatically as a result of human activity. Forests have been cleared (in the UK as elsewhere), grasslands have been ploughed and fields covered with houses, factories, motorways and airports. People travel much more widely and much more frequently than was the case even twenty years ago. Some of these changes are root causes of climate change. Others serve to intensify the impacts of climate change or to bring them to wider notice. Covering previously absorbent land surfaces with concrete alters the hydrological balance and exacerbates the severity of floods and droughts caused by extreme weather events. Building houses in floodplains increases the risk and cost of flood damage by orders of magnitude. Moving around the globe results in the spread of pests and diseases, of plants and of humans, to new areas so it is often impossible to say if changes in disease incidence are the results of climate change or of human activity.

Much of the information relating to climate change and gardens is anecdotal. In order to draw on well founded scientific research it has been necessary to move outside the garden and use data from

research on agricultural and horticultural crops, and in forestry and nature conservation. This is logical because the plants grown on farms and in forests, or which are managed in nature reserves, also play an important part in gardens. There are important differences though between monocultural stands of a crop in a field or forest and the mixture of many plants in a garden. There are also important differences between the behaviour of plants in a natural community and in a highly managed garden. These differences have been discussed where appropriate.

Our review is unusual in covering an exceptionally wide range of subject matter, from photosynthetic pathways and evapo-transpiration, to garden history and concepts of garden conservation. It has been necessary at times to deviate from the central topic to present short summaries of specific issues, such as the historical evolution of gardens and plant growth and development, to set the impacts of climate change in context. It has been difficult, always, to steer a path between scientific jargon and naïve generalisation. Those with expertise in particular aspects of the review will find some passages highly simplified but we hope readers will appreciate that this report is intended for an audience with wide ranging interests.

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Executive summary

1. In the past forty years, the importance of UK gardens in our culture and as a significant contributor to the tourist industry has been increasingly recognised. Over that same period the effects of extreme weather events on gardens have been increasingly apparent.

2. This report is the outcome of a desktop study to review the potential impacts of climate change on gardens and to identify future research needs. It was undertaken under the UK Climate Impacts Programme (UKCIP) and funded by Anglian Water, the Department for Environment, Food and Rural Affairs (Defra), English Heritage, the Forestry Commission, the National Trust, Notcutts Nurseries, the Royal Botanic Garden, Kew and The Royal Horticultural Society. The study was undertaken by Richard Bisgrove and Professor Paul Hadley from the School of Plant Sciences at the University of Reading.

The aims of the study were:

- (i) to provide an overview of the best current information on the potential impacts that climate change may have on UK gardens, garden plants and the garden industry;
- (ii) to identify information gaps in assessing these impacts on gardening, heritage gardens and the garden industry and, from these gaps, to define a future research agenda.

3. Analysis of long term weather records indicates that annual mean temperatures have increased by 1.7°C since the beginning of the Industrial Revolution in 1750. 1°C of this increase has occurred in the 20th century, with the last decade being the warmest on record. The number of cold days has decreased and frost incidence has decreased very substantially. These changes have been reflected in changes in dates of leaf emergence, flowering, appearance of many species of butterfly and other phenological events.

4. Four climate change scenarios have been developed for UKCIP (the low, medium low, medium high and high emissions scenarios) reflecting uncertainties about future emissions of greenhouse gases. The UKCIP02 scenarios suggest that mean annual temperatures in the UK will increase by 2-3.5°C by the 2080s, depending on scenario and region, with increases in the south east greater than those in the north west. These increases will be associated with more hot and very hot days and less frost and snow.

The scenarios also suggest that annual precipitation will decrease slightly as a net result of higher winter rainfall (10-30% higher under the high emissions scenario by the 2080s) and decreases in summer rainfall (a 20-50% reduction by the 2080s under the high emissions scenario). The year to year variation in precipitation will also increase leading to an increased frequency of very dry summers and very wet winters.

Mean sea levels may rise by 60cm (south east Scotland) to 85cm (London) around the coast by the 2080s, increasing the risk of damaging storm surges along some coasts. Storms may become more frequent, especially in winter, when more depressions could cross the UK.

5. Climate change will affect plant growth in several ways. For example:

- (i) increased carbon dioxide levels will increase rates of plant growth and perhaps development (bud burst, flowering and leaf fall);
- (ii) temperature will have more complicated effects but an earlier onset of growth in spring and a longer growing season are anticipated. Spring has advanced by 2-6 days per decade and autumn has been delayed by two days per decade. With the higher emission scenarios, the chilling requirement for bud-break in fruit trees may not be met in mild winters, leading to reduced yields;

(iii) the various components of climate change will interact, often in quite complex ways. For example, while carbon dioxide increases growth in most plants, increased temperatures may hasten maturity of some plants and therefore reduce or negate the impact of increased carbon dioxide.

6. Increasing temperatures are expected to accelerate loss of organic matter in soils, releasing nitrogen which may increase plant growth or, if leached from the soil, increase pollution of water-courses.

The annual moisture content of soils is likely to decrease by 10-20% across the UK by the 2080s, with substantial reductions (of 20-50%) in soil moisture possible in the summer by the 2080s.

7. Climate change will affect garden plants indirectly by affecting the range and virulence of pests, diseases and weeds. The severity of pest and disease attacks in general is likely to increase, as will the geographical spread of many organisms currently on the edge of their climate range.

8. The impacts of climate change on plants in gardens will be less than on those in the natural environment because of the attention they receive in cultivation.

Increased temperatures in themselves will rarely be directly damaging to plant growth but will enable a much wider range of plants from warmer parts of the world to be grown. Higher temperatures combined with decreased summer rainfall, though, will cause stress, especially in plants with extensive, shallow, fibrous root systems.

Extreme weather events such as gales, floods and droughts will be much more damaging than will long term and subtle changes in average climatic conditions.

9. The impacts of climate change on gardens will depend in large measure on the regional and local setting of the garden. In Scotland and north west England, change will be less marked than in the south east where summer heat and drought are

likely to pose serious problems. Throughout the UK, hilltop gardens will be particularly prone to drying and to gales while low-lying gardens will be susceptible to flooding, as at present.

The significance of climate change impacts will depend on whether the garden is a domestic garden, in which case a warmer climate and the opportunity to grow new plants may be welcomed, or a garden of significant historic interest, where conservation is important. In the latter case the cost of adapting to climate change while conserving as far as possible the form and content of the garden will often be considerable.

10. Climate change will have impacts on the many components of the garden. In particular, this report addresses the potential impacts of climate change on:

- soils, water supplies and water bodies;
- trees, shrubs, sub-shrubs, herbaceous perennials, bulbs and annuals;
- lawns;
- paths, buildings and other structures;
- garden staff.

11. Climate change will have impacts on the numbers of people visiting gardens and on the effects of those visitors in compacting wet lawns, for example. However these impacts will be relatively minor in relation to other social and cultural changes affecting visitor numbers. Each major garden will therefore have its own set of parameters determining its catchment area and anticipated threats and opportunities arising from climate change. The most important influence on a garden's attractiveness to visitors and on visitor numbers will be marketing in its broadest sense.

12. Climate change will also have impacts on garden-related industries. In terms of risks of growing and potential damage to property the impacts may be negative. In selling, the overall effects should be neutral or positive as the ability to cultivate many new plants and an increasingly outdoor lifestyle should stimulate demand. Caution in guarding against major losses from extreme weather events, and flexibility in adapting to the hazards

and benefits and problems of climate change will be the keys to commercial survival.

13. By regarding the garden as a microcosm of the wider environment and using it to develop and demonstrate practices which will alleviate and mitigate the adverse effects of climate change, the gardening community has the potential to set an example of good practice which will further increase public appreciation of and support for gardens and which could ultimately alter the course of climate change.

14. In order to achieve this goal, a programme of research is proposed in the report. In particular, the establishment of a 'garden network' to exchange and coordinate observations, ideas and actions, and to combine research activity on the natural and the cultural environment to the benefit of both, is recommended.