

Introduction

Francis Bacon (1625) commented that “when Ages grow to Civility and Elegancie, Men come to Build Stately, sooner than to Garden Finely: As if Gardening were the Greater Perfection”. In this he recognised the position of the garden as an art form and as an essential component of a civilised society. He also pointed out that the climate in England was more conducive to being outside than in any other country but that it was seldom warm enough to sit still out of doors. To this meteorological situation he attributed the love of gardens and especially of gardening in the UK. It is this involvement of the populace with plants and the ability to grow a very wide range of plants in a mild and equable climate that gives the UK a unique character and sense of place.

The relationship between gardens and climate has taken on a new significance in recent years with the gradual awareness of the existence of climate change and its potential impacts on gardens. This report is a desktop study to review the potential impacts of climate change on gardens, and identify areas for further research.

It is necessary to start by looking briefly at the historical development of gardens in order to appreciate something of the diversity and significance of gardens in the UK before considering the significance of climate change on gardens of different types.

1.1 The UK's garden heritage

The evolution of garden design has been driven by many influences but particularly by the inspiration of new ideas, a desire to react against existing established styles, by response to the cultural and physical environment of the time, by diffusion of ideas from pioneers to the wider population and by rediscovery and reappraisal of earlier styles (Bisgrove, 2000).

As a result of these various influences the UK has witnessed the development of small, enclosed medieval gardens full of herbs and other useful

plants, the larger 17th century formal gardens inspired by France and Italy, often extending into the countryside with great avenues and the 18th century landscape garden with pleasure grounds merging into broad expanses of parkland, woods and lakes. The combination of beauty and utility which the landscape garden represented helped to reshape much of the UK's lowland landscape and did much to create the ‘green and pleasant land’ which UK citizens take for granted as the ‘natural’ landscape and which tourists find so attractive.

In the 19th century gardens were greatly enriched by exotic plants from all parts of the globe and by equally exotic buildings in Chinese, Japanese, Gothic, Indian, Egyptian and other styles. The richness and diversity of plant introductions in the 19th century stimulated the creation of gardens in areas particularly suited to cultivation of these new plants: the wooded hills on acid soils near to London and other major cities, the south west of England with its exceptionally mild, moist climate and outliers such as Tresco (Scilly Isles), Bodnant (North Wales) and Inverewe (Ross and Cromarty on the west coast of Scotland).

The 19th century, especially, saw the development of the smaller suburban garden, sometimes mimicking its aristocratic counterpart but also intensifying the interest in the cultivation of plants as objects in their own right in addition to their use to create garden scenery. The introduction of exotic plants came to a climax in the second half of the 19th century as a result of growing international trade, increased wealth, improved technology for the cultivation of plants and a burgeoning nursery industry. The excitement of growing unusual or difficult plants remained a feature of 20th century gardening, to the extent that many gardeners were (and still are) more interested in their plants than in the garden as an artistic entity. The 19th century also saw the development of public parks in most major cities and towns, extensive landscapes which rivalled the large private gardens of the day and in which their superintendents vied with each other to produce the most elaborate floral displays.

The 20th century was marked by a move away from the most flamboyant excesses of the 19th century in favour of Gertrude Jekyll and William Robinson inspired wild gardens and flower gardens with carefully graded colour schemes. In the second half of the 20th century, large increases in home (and garden) ownership, increases in the media attention paid to gardens, increased travel abroad and interest in the garden as an extension of the house combined to stimulate, and be stimulated by, a flourishing garden centre industry.

At the beginning of the 21st century one can discern in the UK both the rediscovery of minimalism in gardens by the *avant garde* (Tunnard, 1938) and its rejection by the mainstream gardener (Taylor, 1936), combined with continued diffusion of the ideas attributed to Gertrude Jekyll (1908) and William Robinson (1870, 1879). These various strands were disseminated through Scandinavia and Germany in ecologically inspired but sophisticated plant communities of Karl Foerster, Friedrich Stahl and others (Hansen and Stahl, 1993) and returned to the UK in the late 20th century to inspire a new generation of gardeners at the end of the century. Interest in ecological or wildlife gardens in the UK paralleled enthusiasm for prairie restoration in the USA, both developments being partly in response to perceived damage to the environment by chemically based farming and gardening.

The fusion of European and American ideas in the 'bold romantic gardens' of Oehme and van Sweden (1990), the grass gardens of Piet Oudolf, Beth Chatto's 'dry garden' (Chatto, 1994) and the more recent revival of interest in earlier Victorian styles of flamboyant bedding all contribute to a lively current interest in more or less spectacular planting design. Christopher Lloyd's replacement of the Edwardian rose garden at Great Dixter (Sussex), a striking endorsement of Robinson's 'subtropical garden' is one of the most recent and most influential examples of the fusion of these many trends (Lloyd, 2000).

In the smaller domestic garden increased levels of disposable income, increased home ownership, the colour magazine and garden makeover programme have all widened demand for exciting and usable outdoor spaces. As new gardens shrink in size there

has also been a revived interest in allotment gardens for the cultivation of vegetables, fruit and cut flowers, allowing the small patch of land around the house to be used entirely for recreational purposes.

Nurseries have responded to the demand for novelty by offering a wider range of architectural and increasingly 'exotic' plants: phormiums, bamboos, cannas and now palms, tree ferns, bananas and olives. Climate change is beginning to make possible the cultivation of many succulent and otherwise spectacular plants which were once the exclusive province of the gardens of the extreme south west. Tresco (Scilly Isles) has spread to Tunbridge Wells and is on its way to Teeside

On a technical level the availability of sophisticated, often computer controlled, irrigation systems, pumps and other equipment is beginning to make it easier to cultivate water demanding plants or plants in containers and to create fountains, waterfalls and other such features (see section 6.2.1). At the same time the more environmentally aware gardener is turning away from such gadgetry to adopt a more ecological approach using composting, mulches, water butts and drought tolerant plants.

One important feature of the late 20th century was a dramatic increase in interest in historic or heritage gardens. The Garden History Society was formed in 1965. In the 1970s the National Trust embarked on a series of ambitious restoration and conservation projects in such gardens as Claremont (Surrey), Erddig (Wrexham) and Westbury Court (Gloucestershire) (Bisgrove, 1990). Membership of the National Trust, which now manages the largest assembly of historic gardens in the world, grew from 278,000 in 1971 to 2.6 million in 2000 and a recent survey indicates that 57% of people joining the National Trust do so because of its gardens. In 1981 English Heritage began its Register of Parks and Gardens of Special Historic Interest in England, which now includes more than 1500 parks and gardens, while the National Council for Conservation of Plants and Gardens (NCCPG) was established in 1978 to conserve the gene pool which the immensely rich garden flora of the UK represents. Most recently the Heritage Lottery Fund has grant-aided the restoration of many formerly neglected public

parks. There are now estimated to be 2,500 public parks, gardens and other designed landscapes of national, regional or local historic importance in the UK, and some 25,000 recreational open spaces (DTLR *et al.*, 2001).

The result of these centuries of development is that the number and diversity of gardens and garden owners in the 21st century is such that one would need to use the sophisticated cluster analysis techniques of the plant taxonomist to begin to classify UK gardens. A garden may be a small oasis of calm in the city, a source of productive pride growing quantities of fruit and vegetables, a national collection of saxifrages or apples, a blue-decked product of last week's television garden makeover programme, a perfect example of the work of Capability Brown or an important repository of plants collected by one of the renowned plant hunters such as David Douglas.

An important characteristic of UK gardens is that very few have been designed then made and left to mature. The majority evolved year by year and perhaps generation by generation. Most gardens are essentially private places. An increasing number of the larger private gardens rely on income from visitors to support the maintenance costs of the garden, while many of the finest gardens in the UK are now owned and managed by public bodies and by organisations such as English Heritage and the National Trust. Large gardens frequently extend into even larger parks with tree-scattered pastures, lakes and woodlands which combine visual beauty with economic value and substantial nature conservation importance.

At the beginning of the 21st century gardening is established as the leading hobby in Britain with an estimated 27 million people owning or having access to a garden. Gardens form the basis of a multi-billion pound industry (Calnan, 2002).

Over the past forty years, especially, the importance of UK gardens as part of our cultural heritage has been increasingly recognised. With increased interest matched by rapidly growing personal mobility, leisure opportunities and living standards, garden tourism by UK citizens and by overseas visitors has

also become a significant contributor to the national economy. Visitors to the Royal Horticultural Society's garden at Wisley, for example, increased from 181,000 in 1970 to 614,000 in 2000 (Prior, *pers. comm.*). The National Gardens Scheme, which includes 3,500 gardens in 2002, raised £1.2 million in 2001 and has raised over £20 million in its 75-year existence. There are 24 million visitors each year to gardens in the UK and garden tourism is estimated to be worth £300 million per year. Perhaps more important than this direct financial contribution to the economy, the quality and quantity of our gardens and parks also contribute to the image of the UK as a green and pleasant land and to the health and happiness of its inhabitants.

The UK has a remarkable history of gardens and gardening spanning a thousand years. This results in a rich heritage of gardens – formal and natural, planned and planted – and a lively tradition of making and cultivating gardens. There are estimated to be 27 million active gardeners and approximately 27,500 parks, gardens and other designed landscapes of national, regional or local importance. Gardens make a direct contribution to the tourist industry of about £300 million per year, but they are much more important in underpinning the essential character of the UK as a green and pleasant land, for the benefit of its citizens and visitors alike.

1.2 Climate change and gardens

In the second half of the 20th century there was an increasing awareness that the climate was changing, initially because of observed changes in the weather and subsequently through the development of climate modelling techniques. Recognising the potential problems inherent in global climate change the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP) set up an Intergovernmental Panel on Climate Change (IPCC) in 1988 to assess the nature and scale of these problems.

Since the 1960s the effects of extreme weather events on gardens has also been increasingly apparent. The severe winter of 1962/3 killed many supposedly

hardy plants (Anon, 1964; Booth, 1964; Salisbury, 1963). The drought of 1976 weakened large trees and caused lakes to dry out (Bisgrove, 1978). The storms of 1987 and 1990 felled an estimated 15 million trees in southern Britain alone (Rich, 1988) and the effects of devastating flooding in many parts of the country in 2000/01 are still being felt at the end of 2002 as plants whose root systems were inundated slowly die.

The increasing appreciation of gardens and the expanding catalogue of damage imposed on them by extreme weather events, combined with mounting scientific evidence of the existence and scale of climate change, has led to growing concern that the changing climate must inevitably have significant implications for the future of gardens and their management.

1.3 Background to the study

Awareness of the implications of climate change for gardens and the gardening industry led to the organisation of a workshop on Climate Change and Gardens, coordinated by the National Trust, The Royal Horticultural Society and the UK Climate Impacts Programme in April 2000.

The purpose of the workshop was to develop an understanding of the potential implications of climate change on gardens and garden-related industries, to begin to identify research needs and to test support for a study into the issue. The workshop was attended by sixty participants including representatives from botanic gardens and gardens organisations, commercial horticulturists, landscape consultants, the horticultural press, local and national government representatives, universities and other research organisations.

The primary outcome of the workshop was the expression of need for a desktop study to review the potential impacts of climate change on gardens and to identify future research needs.

This report is the outcome of that expression of need. It has been undertaken within the framework of the UK Climate Impacts Programme with funding from 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.

1.3.1 AIMS AND OBJECTIVES

The primary 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 key information gaps in our knowledge and understanding of these impacts on gardening, heritage gardens and the garden industry.
- (iii) To define a future research agenda.

The objectives were:

- (i) To identify the aspects of gardens and gardening most at risk from climate change, and the general patterns of distribution and type of garden most vulnerable to these changes.
- (ii) To identify those aspects of gardens and gardening which might benefit from climate change.
- (iii) To suggest techniques and practices which might be used to reduce the negative impacts and derive maximum benefit from the positive aspects of climate change in gardens.
- (iv) To present findings in a report to increase the gardening public's awareness of climate change and to communicate the wider benefits of environmentally sound practices in adapting to and perhaps mitigating the effects of climate change.

1.3.2 METHODOLOGY

The main focus of the study was a review of the literature, including searches of bibliographic databases. This review was facilitated and supplemented by the authors' expertise in horticultural plant physiology and landscape management. The authors also derived much support and information from the study's Steering Committee. Colleagues in or associated with the School of Plant Sciences at the University of Reading also provided valuable information.

The literature review was supplemented by consultation with key experts in the garden and landscape sector. A questionnaire (see Appendix 1) was sent to the director, curator or head gardener of fourteen major gardens strategically distributed throughout England, Scotland and Wales to obtain information on how past weather had affected their gardens and to explore expectations in relation to climate change. Three leading nurserymen were interviewed about the commercial impacts of climate change. Their contribution to this study is gratefully acknowledged.

This report first summarises observed changes in the UK climate and the changes expected over the coming century from the UKCIP02 climate change scenarios. It then considers potential implications of anticipated future changes for gardens, working from the small scale of the plant cell to the large scale of the landscape as follows:

- the effects on plant growth and development
- the effects on plants as individual organisms
- the effects on plant communities
- the effects on gardens, garden types and garden components such as borders, shrubberies, woodlands, water features and architectural structures
- the effects on human use of gardens and the consequent impacts
- the resultant economic/financial implications of climate change in gardens
- adaptive responses to climate change

It concludes with recommendations for research and action.

A long series of extreme weather events – frosts, extreme heat, floods and droughts – have caused severe damage to many gardens in the past forty years. A growing awareness of the reality of long term climate change has led to concern for the future of UK gardens.

Following a workshop to discuss the implications of climate change on gardens, a decision was made to commission this desktop study within the UK Climate Impacts Programme to consider the issues in more detail.