A coastal landscape featuring sand dunes in the foreground, covered with tall, golden-brown grasses. A path leads through the dunes towards a sandy beach and the ocean in the distance. The sky is a clear, pale blue.

Climate Change and the Visitor Economy

Challenges and Opportunities
for England's Northwest

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1. Visioning a future Northwest visitor economy
2. The impact of weather and climate on tourist destinations in the Northwest
3. Moorland wildfires in the Peak District
4. Integrity of the Sefton dune system
5. Public space in Manchester
6. Footpath erosion in the Lake District
7. Physical capacity
8. Capacity building in less vulnerable locations
9. Policy implications

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Foreword

Climate change is now widely recognised as the biggest global challenge facing humanity. However, it remains an issue that many of us regard as a 'green' issue for the future and someone else's problem.

We are all affected by climate change and we need to take account of this in our strategic planning and development of public policy.

The visitor economy is one of the fastest growing sectors of the overall UK economy and it is important that we ensure that such growth continues in a sustainable manner. In England's Northwest, the visitor economy is a particularly important business sector. It's future is dependent on the resources, natural and man-made, that draw people to visit, including world-class landscapes such as the Lake District, our coastlines and our cities.

The results of this study show that the relationship between the weather and visit levels is more complicated than we may at first presume. Man-made attractions will always be more easily adapted to ensure the quality of the visitor experience but the natural landscape is not so able to respond quickly or adequately.

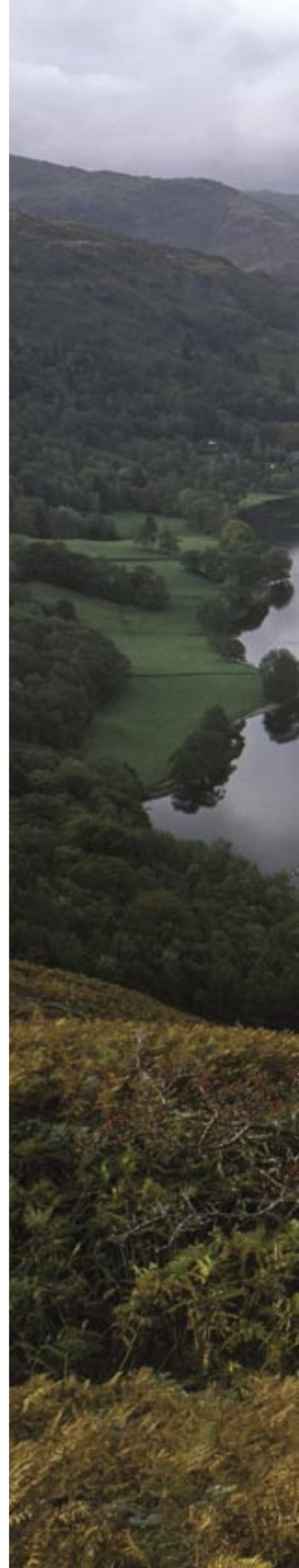
It is essential, therefore, that the management of both man-made and natural attractions needs to consider the likely impact of climate change. The insight that this report provides offers the opportunity to prevent major problems arising in the future and to ensure that the visitor economy of the region continues to be successful.

It has been my privilege to chair the Management Board of this project over the last two years, and I would urge you to carefully consider and respond to its conclusions.



Marc W. Etches

Chairman, Climate Change and the Visitor Economy
Management Board



Executive Summary

Changes to our climate could have profound implications for tourism, the leisure industry, as well as the wider visitor economy. Having a better understanding of those future impacts and how best to adapt to them is critical. This study is the first attempt in the UK to systematically assess the likely impacts of climate change on this important and fast growing economic sector (currently worth £7bn to the region). The central question addressed by the research was:

How can the visitor economy realise the opportunities presented by climate change, whilst ensuring that the resource base is sustained under growing visitor demand and climate related reductions in environmental capacity?

The focus of the work has been on the Northwest of England but the lessons learnt are of much wider relevance.

Until recently, the common belief that the warmer, drier summers brought about by climate change would stimulate a boom in visitor numbers, has not been questioned. However, the relationship between climate and visitor demand is complicated, and the economic opportunities may not be this straightforward. Although based on limited data, the research findings suggest that recreational behaviour in the Northwest appears to be fairly resilient to the weather – this resonates with other recent research findings internationally. Climate influence on visitor behaviour is more likely to be overshadowed by socio-economic trends, particularly how we choose to spend our leisure time in the future.

Climate Proofing the Visitor Economy

Understanding the interactions between climate change, visitor behaviour and environmental capacity is vital if **policy makers** are to respond effectively to the opportunities and challenges that climate change will bring. Tourism policy needs to recognise the reliance that the visitor economy has on key landscapes and work to ensure that their use as a visitor resource is sustainable. The promotion of visitor resources in more resilient locations, for example Regional Parks, could contribute to relieving pressure on the most vulnerable landscapes.

The link between climate change and visitor demand is ambiguous – whilst this may vary for different locations and attractions we cannot overly rely on climate change to boost the economy. Good management, and better planning, by the **tourism industry** is needed to exploit future opportunities. Marketing strategies should consider the potential vulnerability of locations and efforts made to direct visitors to more robust attractions and areas. Business opportunities will arise to provide innovative services that help to reduce visitor impacts, while increasing specialisation of visitors will see new market niches being opened up.

There are considerable climate-related risks to valuable landscapes and the detailed impacts on different landscape character areas need to be better understood. **Landscape managers** need to initiate, or continue, physical monitoring programmes on the state of the landscape.

Adaptation responses need to address both capacity and demand issues within an effective management framework. The most effective response will be through **new and existing land management partnerships**, as well as the promotion of working links between universities and a wide range of stakeholders.

In the face of climate change **visitor facilities** may need to be upgraded to ensure continued quality of visitor experience under more extreme conditions.

The **visitor economy** also needs to address its 'ecological footprint', particularly its contribution to global warming. Promotion of domestic breaks, improvements in green accreditation schemes, greater use of public transport and more efficient use of resources are areas that could be addressed.

Whilst the impact of climate change on visitor demand remains uncertain, the landscapes they visit will come under increasing threat. England's Northwest has a diverse range of visitor resources, from metropolitan areas to high quality natural landscapes. The most vulnerable of these landscapes also tend to be those that hold most appeal for visitors, and as such they are already under considerable pressure. Climate change is likely to further impair their ability to accommodate visitors. Responding to this challenge will require measures that sustain the environmental capacity of these valued landscapes whilst developing new opportunities in less vulnerable locations. Although demand management is likely to become increasingly important, particularly in relation to road congestion in the worst affected parts of the region, a more effective response may be to direct adaptation efforts to landscape protection and sustaining visitor access. This will, however, require significant investment.

As well as providing an examination of the regional picture, the research also focused on four case studies to evaluate capacity issues at the more detailed landscape scale. Findings highlight that impacts differ according to landscape type, emphasising that adaptation responses will need to be evidence-based.

As this report shows, some of our most valuable destinations face great pressures in the future, from both climate change and a growing visitor economy. It also shows that we cannot assume that climate change will deliver a boom in tourism. Most importantly, it maps out a new and challenging landscape for anyone concerned with tourism and the visitor economy today, a landscape where good management, smart investment and sensitive adaptation could reap significant benefits for this most dynamic of sectors.

Climate Change Impacts in Case Study Areas

The Sefton coastal dunes provide an internationally significant habitat for biodiversity and are home to a number of world-class golf courses. Climate change will bring sea-level rise but, providing the integrity of the frontal dunes is maintained, the dune system can provide an effective defence. However, impacts of climate change on the water table under the dune system could affect biodiversity and the management of golf courses. Visitor levels could increase in summer as people are drawn by the more pleasant climate on the coast.

Moorland wildfires in the Peak District National Park pose a significant, and potentially costly environmental threat. Climate change could exacerbate this risk. The flammability of the moorland will increase as a result of changes in vegetation cover, and a higher probability of 'dry spells'. This increase means that the occurrence and intensity of wildfires, which are generally started by human carelessness, could worsen without careful management.

Footpath erosion in the Lake District National Park is already a significant problem and climate change, in combination with changes in visitor behaviour, is likely to exacerbate this. Along with slope and trampling, intense rainfall is a critical factor in erosion, and this is forecast to increase under climate change. Footpaths are particularly vulnerable when trampling and rainfall alternate and, with walkers becoming better equipped and more prepared to go out in bad weather, this is more likely to occur.

Public space in city centre Manchester plays an important role in the visitor economy. Warmer weather is likely to increase demand for access to public space and could help boost the café culture. However, with temperatures disproportionately high in the city centre during hot spells, there is the risk that residents and visitors will opt to leave the city centre. Equally, protection from wetter winters will also be required to maintain human comfort.

Introduction

Understanding the impacts of climate change, and how best to adapt to them, is a research and policy area in its infancy. What is known is that we will have to adapt to some degree of climate change in the future, even with reductions in greenhouse gas emissions.

This Climate Change and the Visitor Economy (CCVE) research was commissioned as the pilot project for the Department for Environment, Food and Rural Affairs (Defra) Cross-Regional Research Programme on Climate Change Impacts and Adaptation. The research was carried out in England's Northwest, a region that promotes the natural environment as one of its key tourism offers. However, the research methodologies and findings are transferable to other regions of the UK, and to some extent internationally.

A focus on the visitor economy was seen as appropriate not only due to its considerable economic importance but also because the tourism sector is likely to be one of the most heavily influenced by changes to our climate.

The Regional Climate Change Scoping Study concluded that *“there are potential benefits resulting from climate change in some economic sectors, especially tourism and recreation, but we can be less certain about the scale of such benefits and they are unlikely to be distributed evenly across the sector”* [1].

The term ‘visitor economy’ within the project is meant to include not only tourism - typically defined as a planned journey and involving an overnight stay - but also recreational and leisure activity. This is important as day visits make up 90% of the regional visitor economy.

Table i: Climate change in England's Northwest (from UKCIP dataset)

	2020s (2011-40)	2050s (2041-2070)	2080s (2071-2100)
CHANGE IN AVERAGE ANNUAL TEMPERATURE	0 to 1°C	1 to 2°C	1 to 4°C
CHANGE IN MAXIMUM SUMMER TEMPERATURE	0 to 1°C	1 to 3°C	2 to 6°C
CHANGE IN SUMMER RAINFALL	5 to 15% decrease	10 to 30% decrease	15 to 50% decrease
CHANGE IN WINTER RAINFALL	5 to 10% increase	0 to 20% increase	15 to 30% increase
CHANGE IN WINTER SNOWFALL	20 to 25% decrease	30 to 60% decrease	40 to 100% decrease
CHANGE IN SUMMER AND AUTUMN SOIL MOISTURE CONTENT	0 to 10% decrease	10 to 25 % decrease	20 to 40% decrease
CHANGE IN SEA LEVEL	Not available	7 to 36cm (UK)	7 to 67cm

A number of academic studies have examined the relationship between climate and tourism, but much less is known about the complex interactions between climate change, visitor behaviour and environmental capacity. For instance, although climate change is likely to affect tourist behaviour, it could also have adverse direct and indirect impacts on vulnerable locations in the region. These tend to be the highest quality landscapes and hold the greatest attraction for visitors. As a result of their recreational value, these sensitive landscapes are already under considerable threat from visitor pressure; the impacts of climate change on the landscape may further impair its ability to accommodate visitors. Therefore, one of the most critical issues facing those involved with the regional visitor economy is how best to respond in the face of climate and non-climate change to ensure the sustainability of the visitor economy. In reality, this means that measures will need to be taken to increase the environmental capacity of vulnerable locations, whilst managing tourism and recreational demand in such a way as to avoid destroying the resource base that attracts people in the first place.

The CCVE project sought to address these issues by examining how those involved with the Northwest visitor economy can realise the potential opportunities presented by climate change, whilst ensuring that the resource base is sustained under growing visitor demand and climate-related reductions in environmental capacity. Details of the predicted changes in climate for the Northwest are shown in Table i, with values representing both low and high greenhouse gas emission scenarios.

For the UK as a whole, under the medium-high scenario, a hot ‘1995-type’ August goes from a 1% chance of occurring in the 2020s, to 63% in the 2080s.

The Research Programme

To examine the interactions between climate change and the visitor economy, the research focused on both the most sensitive (coast and rural uplands) and least sensitive (urban centre) landscape domains.

Based on the UK Climate Impacts Programme (UKCIP) risk and decision-making framework ^[3] (see Figure 1), the research programme was set out as a series of eight interlinked issues:

1. Understanding climate-related visitor response.
2. Exploring visitor response to climate change.
3. Changes in visitor demand under differing socio-economic scenarios.
4. Interaction of climate change and socio-economic change on regional visitor behaviour.
5. Influence of climate change on environmental capacity.
6. Case study analysis of costed adaptation responses in 'vulnerable' locations.
7. Case study analysis of capacity building in 'less-vulnerable' locations.
8. Interaction with related sectors especially farming, forestry, health and transport.

The first four issues focused on the drivers affecting visitor demand. The research set out to understand how longer-term climate trends and daily variations in weather have influenced visitor behaviour in the region over the past thirty years. These findings were subsequently used to inform an exploration of how visitor behaviour might change in the future under the UKCIP climate scenarios for the 2020s, 2050s and 2080s.

Recognising that climate change is not the only influence on future visitor behaviour, socio-economic scenarios were also developed. The two differing regional scenarios (enterprise and stewardship) were based on the UKCIP socio-economic framework ^[4], though refined to produce storylines that were tailored to the Northwest region. Drawing all this data together, the research finally undertook an integrated assessment of both climate and non-climate drivers, and the likely affect on future visitor behaviour.

Issue 5 represents a shift in the focus of the research to the interaction between climate change and environmental capacity (see Figure 2). The capacity research was carried out at two different scales of analysis. The first of these was the regional scale, which enabled a synoptic view of physical and ecological capacity to be explored.

Figure 2: Dimensions of environmental capacity ^[5]

PHYSICAL CAPACITY: the point at which site facilities (such as car parks, visitor centres) or access routes become congested.

ECOLOGICAL CAPACITY: the level at which unacceptable change starts to occur in floristic composition, soil structure and wildlife populations.

PERCEPTUAL OR SOCIAL CAPACITY: the point at which the recreational experience starts to deteriorate.

ECONOMIC CAPACITY: the threshold beyond which the investment needed to sustain environmental quality becomes prohibitive.

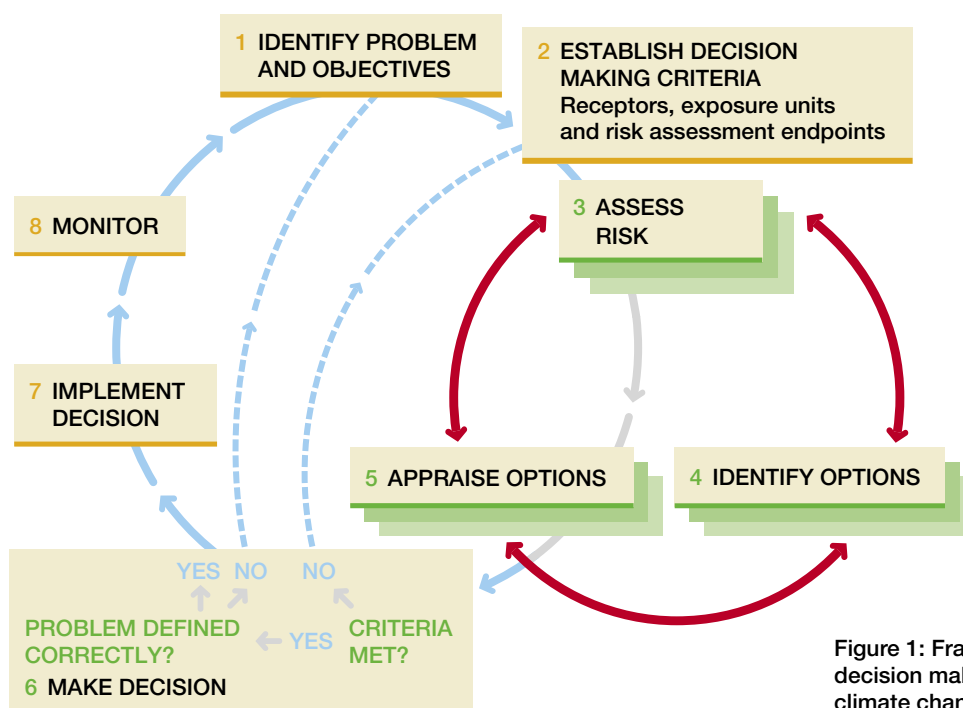


Figure 1: Framework supporting decision making in the face of climate change risk ^[3]

More detailed work was then conducted at the landscape scale. The four case studies examined by the project were:

- Integrity of the Sefton Dune System
- Moorland wildfires in the Peak District
- Footpath erosion in the Lake District
- Public space in Manchester city centre

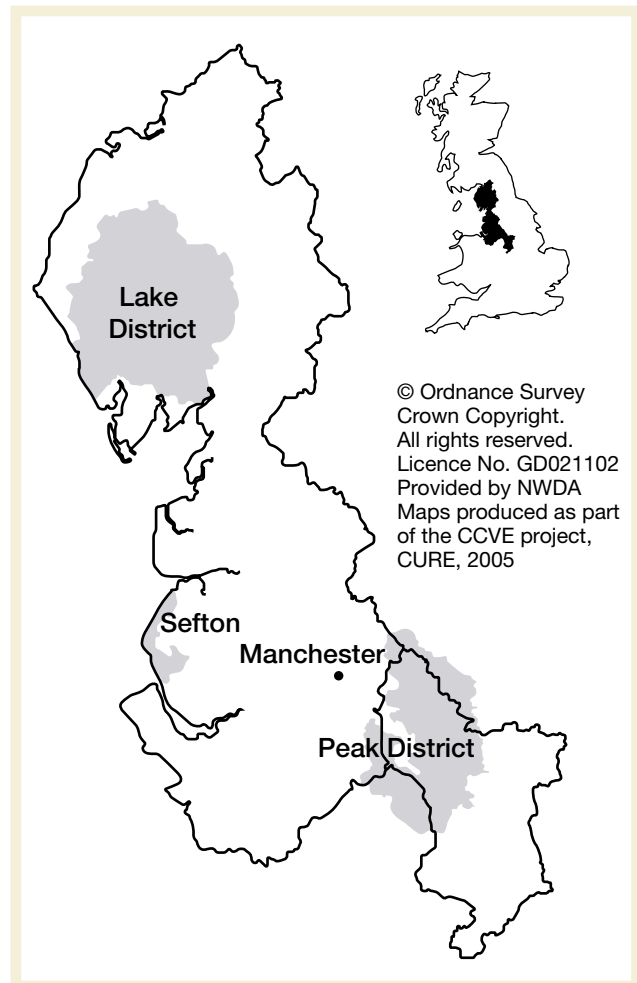
Taking the Lake District and the Peak District case studies as examples, issue 6 set out to quantify the costs and benefits of adaptation options, as identified by stakeholders. The final two research issues focused on demand management, in particular evaluating opportunities for capacity building in less vulnerable locations, for example, the proposed programme of Regional Parks in the Northwest, and the interaction with other sectors, notably forestry, farming, health and transport.

The research was multi-disciplinary and solutions-oriented with extensive stakeholder engagement at a number of 'risk' workshops. These provided the opportunity for members of the research team to engage with experts and stakeholders to help scope out the key issues.

State of the art tools and methodologies were applied in the analysis, including Geographic Information Systems, climate scenarios and the latest downscaling techniques, socio-economic scenarios, econometric analysis and statistical modelling. Full use was also made of the suite of UKCIP tools including, climate and socio-economic scenarios, the risk framework for decision-making under uncertainty, and a costings methodology ^[6].

A series of technical reports underpin this project summary and are listed on the inside front cover.

Image A: Location of case studies



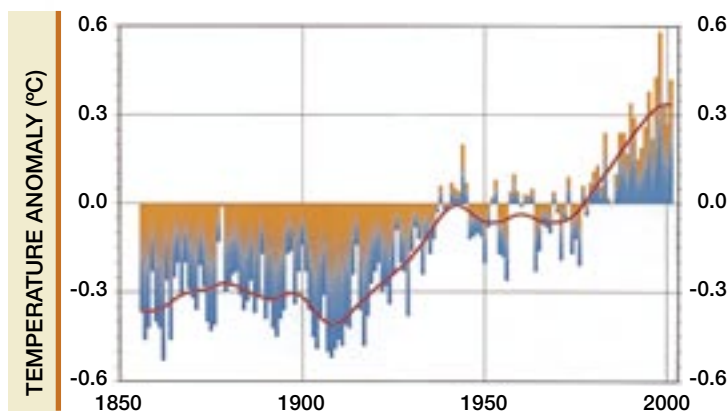
A Changing Climate

Throughout history, the Earth's climate has been continually changing influenced by natural factors such as volcanic activity, changes in the Earth's orbit, changes in solar output, and oscillations in the climate system. The difference between this and the recent changes in climate we are experiencing is the pace at which it is happening. There is increasing evidence that emissions of greenhouse gases from the burning of fossil fuels is causing the climate to change beyond its natural variability. The rate of global warming has increased to $0.17 \pm 0.05^\circ\text{C}$ per decade, probably exceeding any 100-year rate of warming during the past 1000 years [7]. Human activities have caused the atmospheric concentrations of carbon dioxide, the main greenhouse gas, to increase by 34% above pre-industrial levels, with an accelerated rise since 1950.

The evidence for climate change in Europe is convincing. Average temperatures have increased by 0.95°C in the last 100 years, a faster rate of increase than global temperatures. The 1990s were the warmest decade on record, and 1998 the warmest year, followed by 2002 and 2003 [7]. Glaciers in eight of the nine glacial regions in Europe are retreating; a loss of 10% of the remaining glacier mass in the Alps was caused by the hot dry summer of 2003 alone. Melting of land glaciers and thermal expansion of ocean water has resulted in a sea level increase around Europe of between 0.8mm to 3.0mm a year in the past century.

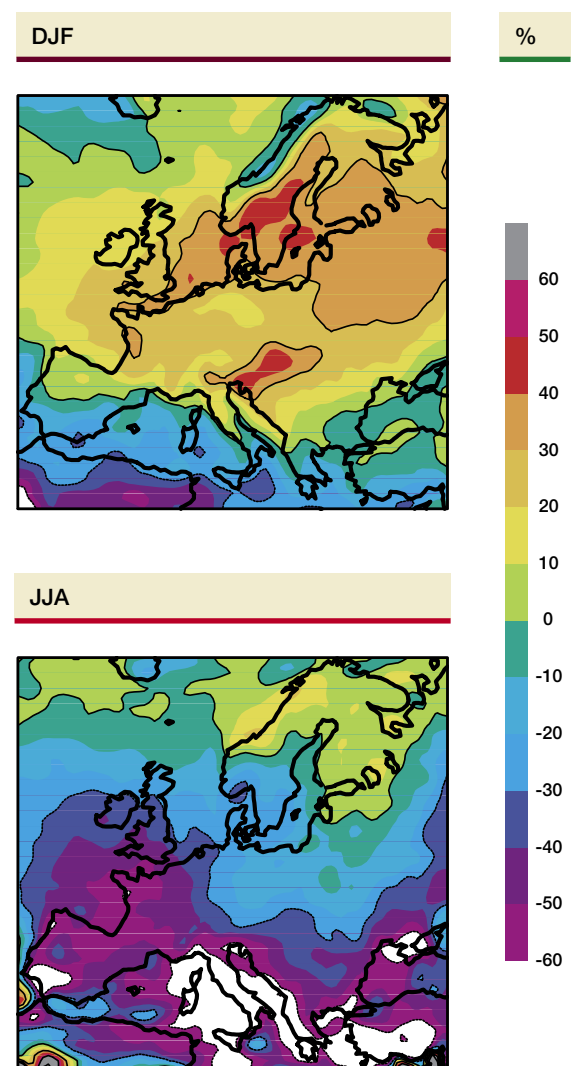
It is widely accepted that further changes in our climate are inevitable. The long memory of the climate system and inertia in our energy systems means that much of the change in climate over the next 30 to 40 years has already been pre-determined by past and present emissions of greenhouse gases.

Figure 3: Changes to global average surface temperatures (1860-2001) from land and sea-surface data (compared to 1961-1990 average) [8]



Annual trends in rainfall suggest contrasting changes between northern Europe (10-40% wetter) and southern Europe (up to 20% drier). Extreme weather events, such as heatwaves and droughts, have been on the increase; extremely cold days and frost have decreased in most of Europe. The heatwave in summer 2003 was responsible for around 35,000 excess heat-related deaths in western and southern Europe [9]. The summer drought in 2005 saw extensive forest fires in southern Europe which destroyed thousands of hectares of forests and caused many fatalities, with Spain and Portugal severely affected.

Figure 4: Simulated changes in winter (DJF) and summer (JJA) precipitation from the period 1961-1990 to 2071-2100: high emissions scenario from the Rossby Centre regional climate model [10]



Modelling Climate Change

Modelling climate change is not an exact science. Uncertainties exist, both in the amount of future greenhouse gas emissions and in modelling the complex climate system. However, recent advances have allowed scenarios of climate change to be developed at a scale suitable for investigating regional climates and impacts. The following data was used to assess impacts of climate change on the visitor economy of England's Northwest.

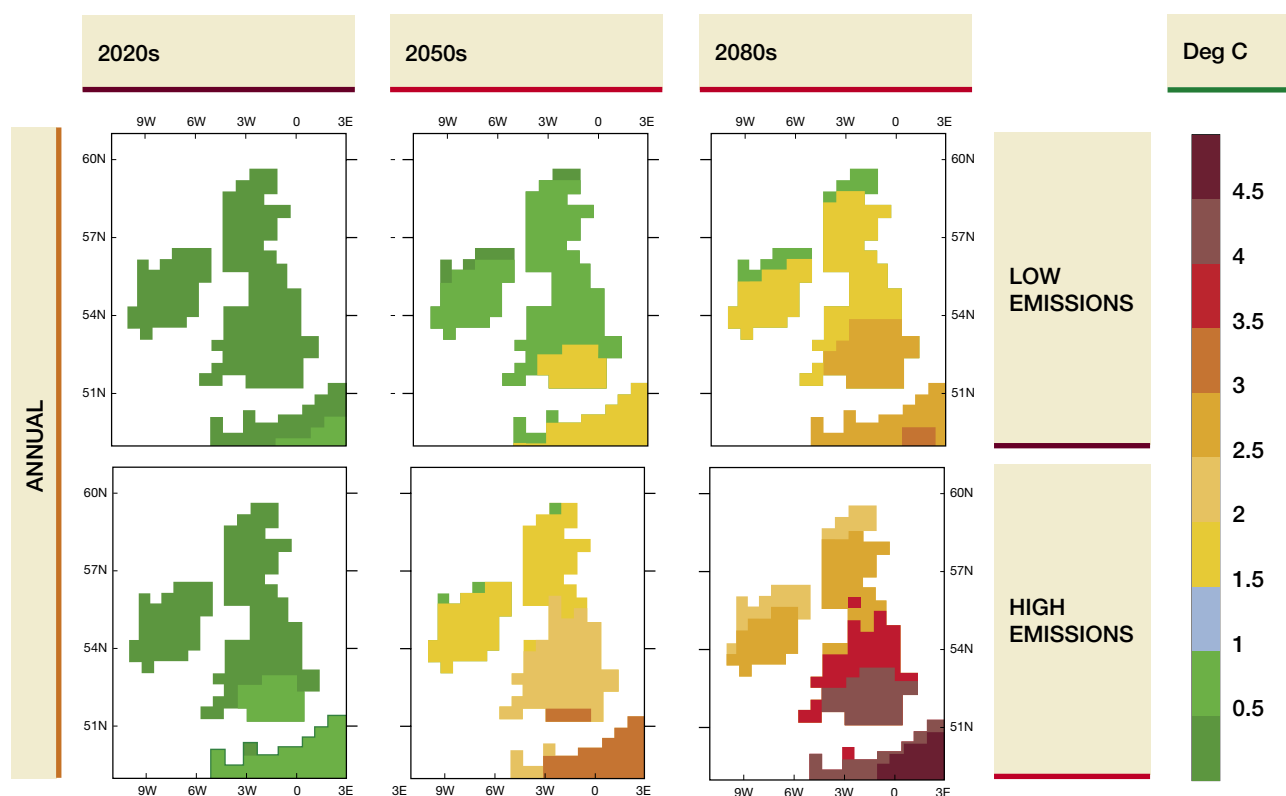
UKCIP02 Climate Change Scenarios

The UK Climate Impacts Programme 2002 (UKCIP02) climate change scenarios are the most current, detailed and reliable scenarios for the UK^[6]. They were developed by the Hadley Centre for Climate Prediction and Research and Tyndall Centre for Climate Change Research. There are four scenarios in total. These describe alternative future climates for the UK, depending on potential world development and the emissions of greenhouse gases, and are based on work published by the Intergovernmental Panel on Climate Change

(IPCC)^[11]. These scenarios are labelled low, medium-low, medium-high and high. They are generated for three 30-year periods centred on the 2020s, 2050s and 2080s, at a resolution of 50km². Projections for changes in monthly average weather variables are provided for each scenario. The major implication of these scenarios is an increase in annual temperatures of 1-5°C by the 2080s (see Figure 5). Temperatures will increase in all seasons and warming will be greater in the Southeast than in the Northwest of the UK. High summer temperatures will become more frequent and warmer winters will bring fewer frosts and less snow.

Little change is expected in annual rainfall, but greater changes will be seen in its seasonal distribution, with winters getting 10-35% wetter and summers up to 35-50% drier by the 2080s. All scenarios take into account the cooling effects of the weakening Gulf Stream, but increased greenhouse gas heating still exceeds this cooling effect. For the purposes of this project, two contrasting scenarios were chosen, high and low, to reflect the greatest uncertainties.

Figure 5: Changes in annual average temperature in the UK
Source: UKCIP02 Climate Change Scenarios (funded by DEFRA, produced by Tyndall and Hadley Centres for UKCIP)



CRU Daily Weather Generator

Developed by the Climatic Research Unit (CRU) at the University of East Anglia, the CRU daily weather generator enables a finer temporal and spatial scale of weather generation. Measurements of past meteorological data for a specific site are used to generate daily weather variables, such as rainfall and temperature. The generated daily weather series is then perturbed using scaling factors from the UKCIP 2002 scenarios, to provide site-specific data. This also enables investigation into extreme events.

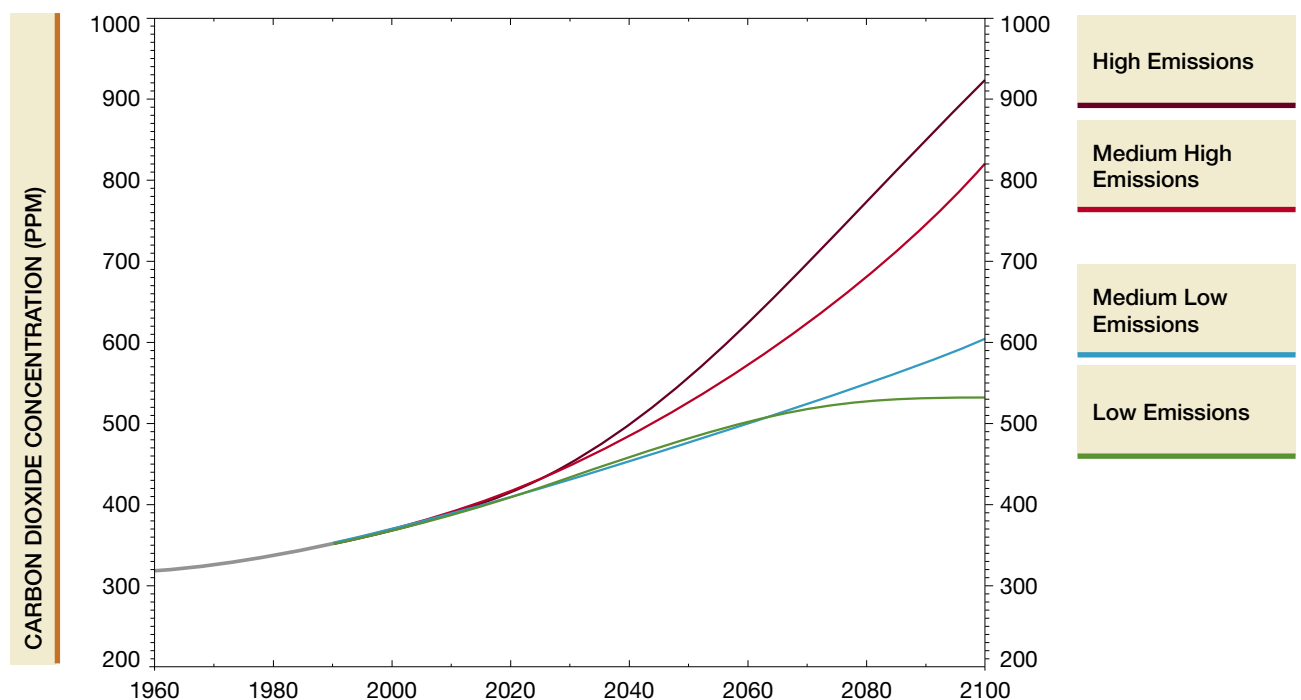
Conclusion

The potential changes shown by the climate models will reposition the Northwest region in both a UK and European context. Although the region's position towards the western end of a steepening climate gradient provides some protection from the worst impacts of climate change, the change in the climate of the Northwest is still likely to be significant, including changes in daily weather, seasonality and extremes.

Rainclim Rainfall Generator

Rainclim is a rainfall simulation model developed at the University of Newcastle which enables the simulation of hourly rainfall at a single location. This is particularly useful for a better understanding of rainfall trends and investigation into extreme rainfall events.

Figure 6: Global carbon dioxide concentrations from 1960 to 2100 for each of the four emissions scenarios ^[11]



The Visitor Response

As a result of increasing leisure time and our modern desire for holidays and recreation, tourism is one of the fastest growing sectors in the UK. A central aim of the CCVE project was to explore how visitors are likely to behave in the future, when influenced by a combination of climate and non-climate related factors.

Climate Change and Tourism

The widely held belief that climate change, and the onset of longer, drier, hotter summers, would bring Mediterranean conditions to the UK and automatically stimulate economic benefits for the regional visitor economy needs to be treated with caution. To try and understand some of the complexities involved, it is useful to distinguish between tourism and recreation, as well as differentiating between climate and weather. For example, when choosing our annual holidays we tend to base the selection on a combination of destination and time of year. We pay much more attention to climate information – the average pattern of weather over a period of time – when choosing where and when to holiday, whereas recreational or leisure activity is more weather dependent and reliant on short-term forecasts.

A change to the world's climate is likely to alter the attractiveness and competitiveness of certain worldwide tourist destinations. The most commonly cited example is the possible deterioration in the appeal of the Mediterranean during summer as human comfort becomes harder to maintain once air temperatures exceed around 31°C. It is also feared that these destinations may be further adversely affected by water shortages, fire outbreaks and increasing incidence of pests and diseases ^[12].

The likely reaction of UK tourists to these changes remains uncertain. Although Northern European countries are likely to benefit from more settled summer weather – one such example being the reinforcement of the move towards an urban 'café culture' – there is little evidence at the current time to suggest that we would automatically give up our holiday abroad to become domestic tourists, rather than switching to other foreign destinations.

It is also highly uncertain as to the extent that the UK would benefit from an increase in the numbers of foreign tourists. British weather has not been a primary consideration for visitors in the past, with heritage, culture, the natural environment, and visiting friends and family tending to be much more important determinants.

Recent findings reflect this uncertainty. Some research has found a regular and quantifiable relationship between climate and tourism – people were more willing to stay at home following the hot summer of 1995 ^[13] for example. Other anecdotal evidence from the hot summer of 2003 illustrates that the good weather did not result in an automatic increase of visitors to all locations; rather the weather was so hot that visitors tended to go to coastal locations instead. Destination type will therefore be an additional influence on visitor behaviour under climate change. It is important to note that other work has emphasised that certain visitor activities may be independent of climatic drivers. For instance, evidence suggests that socio-economic influences such as income and age, are likely to be just as important, if not more so.

It should not be forgotten that tourism is a major contributor to global warming and hence influences our future climate. To avoid the worst consequences, the visitor economy needs to promote sustainability principles to a much greater extent. In turn, this could lead to positive marketing opportunities.

Image B: Wildfires in Portugal, 2005



Image C: Urban café culture, Manchester



Understanding Weather and Climate Related Visitor Response

There have been relatively few attempts to systematically assess the effect of weather upon visitor behaviour. Part of the CCVE remit was therefore to gain a better understanding of how day-to-day changes in weather, and longer-term changes in climate, have influenced regional visitor behaviour.

The analysis was limited in scope as it was necessary to rely on data from only one major attraction due to a lack of consistent, long-run data for other tourism offers in the region. As a consequence, the study drew solely upon 27 years of visitor data from Chester Zoo, a predominantly open-air attraction, and the second most visited paid visitor attraction in the Northwest. Its comprehensive data set was matched with temperature and rainfall data from a local weather station. The econometric analysis took account of a wide range of variables including weather, regular and unusual events, time of the year, time trends, and even closures – the most important being as a result of foot and mouth disease in 2001.

The analysis came up with some interesting, though counter-intuitive, findings. Although visits were found to be readily explicable, this was on the basis of socio-economic rather than weather variables. From the results obtained, visitor behaviour is best explained by the rhythm of the year and the pattern of school and bank holidays. Visits are also strongly influenced by habitual behaviour – this is consistent with long run changes in the use of leisure time in the UK. Significantly, little weather influence was found. Temperature appears to have no impact on visit levels over the long term, whereas rainfall merely acts to postpone visits. For Chester Zoo, there is no evidence of a long-run shift in behaviour due to climate change, though there may be more immediate responses to a particular day's weather. The main impact of climate change is therefore likely to be on the attraction's infrastructure.

These findings may be of more relevance to leisure activity rather than tourism, and other forms of visitor behaviour such as trips to beaches or water-based recreational facilities in particular may be subject to greater weather influence. However, the evidence uncovered suggests that visitors to the region are fairly resilient to weather conditions and that other factors are more important.

Socio-economic Trends and Visitor Behaviour

Although tourism has been identified as a sector which is sensitive to climate change, the influence of socio-economic trends should not be underestimated. In the UK, the growth in tourism and recreation is expected to continue as disposable incomes increase, the number of retired people rises, and we look to exploit greater levels of leisure time. These factors are likely to contribute to an increased seasonal spread of holidays, higher demand for short breaks, and the need for 'time-efficient' access to destinations. The value we place on different types of tourism such as nature-based tourism may also alter, partly reflecting changes in wider society.

On the basis of emerging trends, tourist boards have begun to target key markets, including family visits, short breaks and day visits, sustainable tourism and, increasingly, specialised recreational activity. Studies have documented long-run changes in the use of leisure time in the UK, with evidence pointing to growing specialisation in how we spend our leisure time. Fewer people are participating in any given activity, but those who do tend to spend more time at their chosen activity and seem to be willing to travel further to participate. This applies with equal force to outdoor recreation, coastal resorts and visitor attractions.

Conclusion

An important message for those involved with the regional visitor economy is that they cannot rely on climate change alone to boost the sector. Effective forward planning and management will be needed to exploit future opportunities and to stimulate demand. Facilities will however be affected and investment will be needed in response to climate change. Building in resilience is key because extreme events or 'sideswipes' – terrorism, fuel shocks, and even disease outbreaks such as foot and mouth – could have profound implications for the regional visitor economy in the future.

Focus on Northwest England

With a population of 6.7 million, the Northwest is the third most populated region in England. The settlement pattern reflects the region's industrial history, with most people concentrated in the Mersey Belt, together with the coastal zones and Pennine fringes (see Image D).

The first regional scoping of climate change impacts in the UK was undertaken in Northwest England ^[1]. This emphasised the suitability of the region for a study of this kind:

"The Northwest of England, embracing the counties of Cheshire, Merseyside, Greater Manchester, Lancashire and Cumbria, is unique in its character being a microcosm of the English landscapes, ranging from dense urban cores to dispersed agricultural settlement. It is this degree of diversity, held within a relatively small geographical compass, which makes the region an excellent test-bed for assessing the impact of climate change, whether it is physically, economically or institutionally."

The diversity of the region is captured effectively by the Landscape Character Map of England^[16]: in the Northwest there are no fewer than 30 landscape character areas. Because of the complexity involved in reviewing climate change impacts across so many landscape character areas, the climate change scoping study followed the approach taken in developing a pilot regional landscape strategy for Northwest England ^[2].

The Visitor Economy of England's Northwest

The high quality landscapes in the region are undoubtedly one of the most important attractions for visitors. Regional tourism literature cites the region as 'the most beautiful corner of England' with 32 National Nature Reserves, four Areas of Outstanding Natural Beauty, three National Parks and one Heritage Coast. The importance of this asset base has recently been recognised in a report on the potential for nature-based tourism in the region ^[14].

The importance of tourism has risen significantly in recent years. Visitor trips to the Northwest have increased by 40% since 1990. The visitor economy now generates £7bn of expenditure and supports around 150,000 jobs. Visits number around 260 million per year, with day trips accounting for a large slice – around 90%, and a total spend total of £3bn. The Regional Tourism Strategy^[17] is to be delivered by a range of partners including the Northwest Regional Development Agency, the new Regional Tourism Forum and five sub-regional Tourist Boards. The partners will be responsible for tourism management, including destination marketing, relations with the industry, research, and project delivery. As part of the overall strategy, it is intended that thematic marketing campaigns will highlight the features considered to be the greatest selling points (see Table ii).

Table ii: Northwest thematic marketing campaigns ^[17]

THE COUNTRYSIDE	Emphasising the world-class countryside in the region
CULTURAL BEACON	Celebrating the cultural life of the region, building on Liverpool being named European Capital of Culture 2008
NIGHT NIRVANA	Emphasising the booming nightlife in the area
POWERHOUSE	Promoting the region's unique industrial heritage
SPORTS MECCA	Promoting the sporting strength of the region (football, golf, the Grand National, etc.)
ON THE WATERFRONT	Emphasising the region's lakes, rivers, canals and sea-fronts
FANTASTIC FOOD	Promoting the use of local ingredients and specialities and developing gastronomic quarters
FAMILY FUN	Promoting attractions such as Blackpool Pleasure Beach
SUPERB SHOPPING	Promoting the region's strong retail offering

As the regional tourism strategy is geared towards increasing visitor numbers to the Northwest, this will lead to a substantial challenge. Increased levels of tourism will, without careful management, increase pressure on the facilities and landscapes that visitors are there to enjoy. Increased tourist activity will also have effects on transport infrastructure and water demand, resulting in greater congestion, pollution and resource use. Sustaining the regional visitor economy will depend on maintaining the quality of the environment in the face of both visitor pressure and the impacts of climate change.

Physical Capacity of the Regional Transport Network

Road traffic in the UK accounts for 495 billion vehicle kilometres per annum (2003), having increased by about 79% from 1980. The majority of this increase occurred between 1980 and 1990, with a slowdown in the rate of increase after this date. There are a variety of reasons to explain the rise, including an increase in car ownership – over a quarter of households now have access to two or more cars, an increase in the number of drivers, and falls in occupancy levels^[18]. National Road Traffic Forecasts predict that by 2031, traffic will more than double from 1996 levels.

These forecasts mean that a greater number of roads will be operating at capacity, resulting in increased congestion and considerable increases in journey times. However, congestion is a complex problem. Roads are not congested all of the time – levels of congestion are dependent on the time of day, week and month, and also vary with road type. Although congestion is a growing problem, it cannot be solved by continually increasing capacity. The likelihood of increased car use is supported by time-use surveys which indicate that both obligatory – travel to work and schools, and leisure travel – travel as leisure and for the purpose of engaging in a leisure activity, have increased between 1975 and 2000^[19]. The evidence indicates that we are spending a lot more time travelling, partly because trip length has also been increasing for the last 10 years.

The National Travel Survey (2004)^[20] indicates that just under a third of all trips are for leisure purposes and account for 41% of total distance travelled. Of these trips, 75% are taken by car. This confirms that tourism transport is an important contributor to road traffic, although average vehicle occupancy for leisure travel and day trips is higher than for commuter and business travel (2.0 persons and 1.2 persons respectively).

The rise in leisure travel is viewed positively by the tourism sector. However there are environmental consequences: only 11% of trips are by train, and even fewer by bus (4%) or organised coach (2%). These figures have remained relatively constant over recent years. It is clear that investment in transport systems is essential to avoid excursions taking longer because of traffic congestion or poorly integrated public transport.

In the Northwest, congestion due to tourism traffic is a well-documented problem on the M6, with heavy traffic heading north towards the Lake District and Blackpool, especially at weekends in the summer period. Studies have shown that there is seasonal congestion at Junction 32 heading onto the M55 in October as tourists head to see the Blackpool Illuminations.

Image D: Population distribution in England's Northwest^[15]



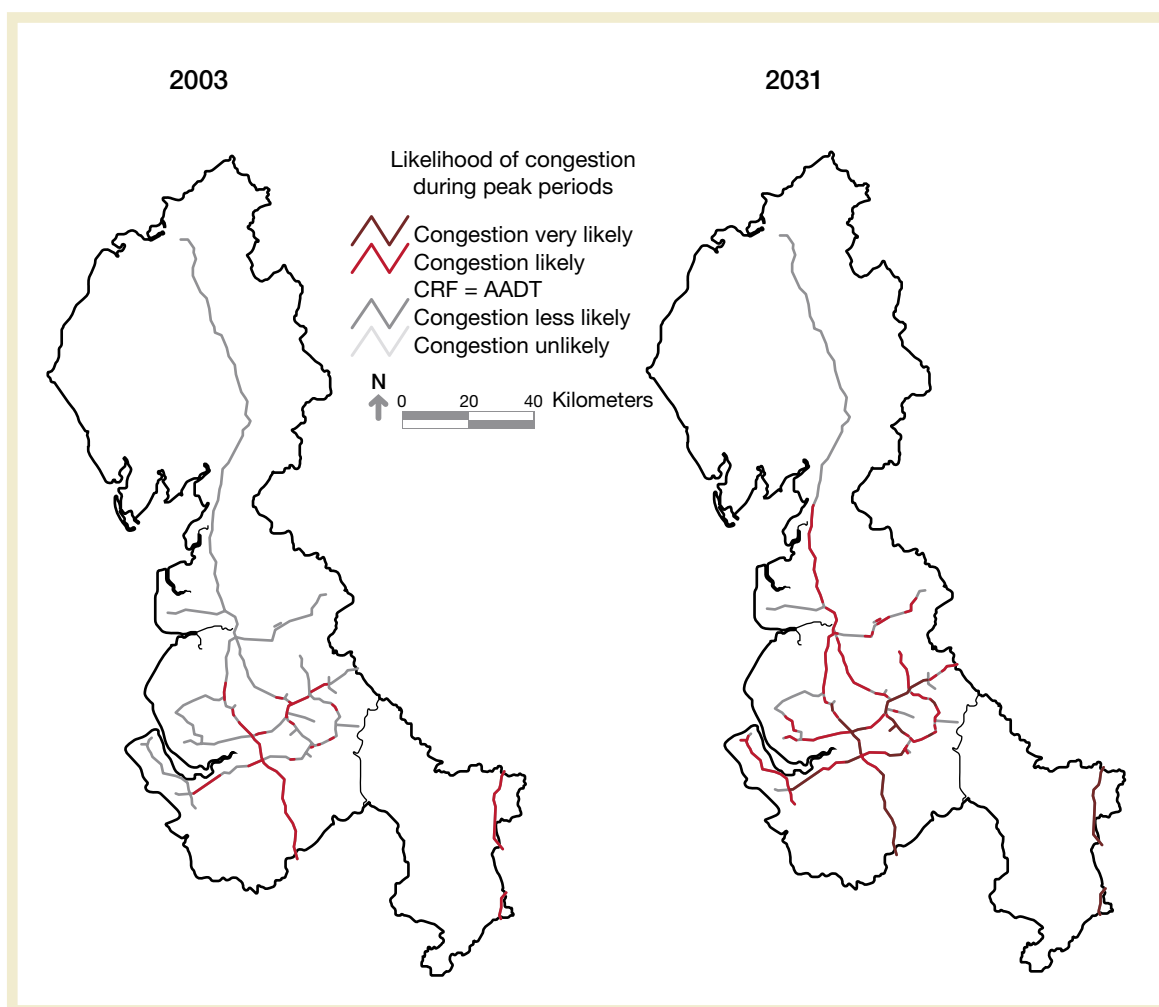
Image E: Topography of England's Northwest^[15]



Research for the CCVE project shows the likelihood of congestion on roads during peak periods on an average day in 2003 and for 2031 (see Image F). For many of the roads in the network, peak periods are likely to be associated with commuting. In areas with heavy recreational travel, the time of day associated with congestion may differ. Evidence suggests that much of the southern part of the regional motorway network will experience increased congestion levels by 2031, assuming no change is made to the physical capacity of the network.

These results also assume that there is no feedback response in driver behaviour or other policy measures put in place to reduce flows. Without such policies, parts of the network are set to become considerably more congested, with implications for all users of the regional road network, not least those who will be travelling for recreational purposes.

Image F: Congestion reference flow (likelihood of congestion on roads during peak periods) in 2003 and 2031



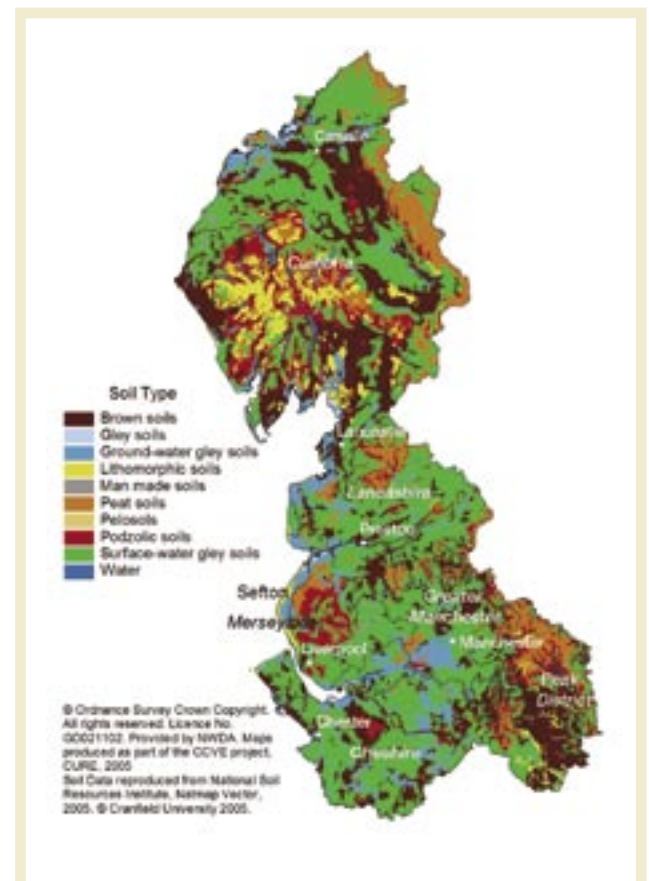
Environmental Capacity of the Receiving Landscapes

Analysis of environmental capacity (covering physical, ecological, perceptual and economic capacities) is about clarifying, and where possible quantifying, the relevant thresholds and applying a variety of strategies to ensure that they are not exceeded. As highlighted, there are significant physical capacity issues within the regional transport network and these are likely to intensify. These problems will be replicated, especially at peak times, in and around the receiving landscapes. Physical capacity issues at the landscape scale were examined in more detail for the Sefton Dunes and Lake District case studies.

Ecological capacity is rather more difficult to define at the regional scale. One approach is to utilise a regional soils map (see Image G) to identify which are particularly vulnerable to erosion by wind (in the coastal zone) and water (in the uplands). Factors such as visitor pressure or overgrazing, which weaken the protective vegetation cover, increase the vulnerability of these soils to erosion. The soils in the rural case study locations, to a greater or lesser extent, have low carrying capacity in this respect. The coastal and upland ecosystems are strongly influenced by climate change, as well as the interaction with visitor pressure.

When ecological carrying capacity is exceeded, landscape impacts may be observed which breach the limits of acceptable change. A variety of responses may be possible, some of which may in turn affect the visitor experience (perceptual capacity), or make severe economic demands on the managing agent (economic capacity). The following set of case studies undertaken for the CCVE study seek to understand the complex nature of these interactions, and to explore potential outcomes under a changing climate.

Image G: Soils of Northwest England



Case Study 1 Integrity of the Sefton Dune System

The dune systems of England’s Northwest, and Sefton in particular, are of international significance as havens for biodiversity. Although much modified, the dunes are essentially a natural environment; a wildscape where the landscape expresses the physical processes which shaped, and continue to dominate, the area’s local distinctiveness. This special character provides the setting for a world-class cluster of links golf courses and an informal countryside access and recreation network of regional significance.

The Visitor Economy

At present the visitor economy of the Sefton Dunes is local or, at best, sub-regional. The opportunity exists to further develop specialist, high value tourism, such as golfing breaks and ecotourism, which could attract visitors from beyond the region. The limiting factors, which could hinder tourism schemes, are the physical capacity of the golf courses which, for the most part, are dominated by local users, and the ecological capacity of the dunes themselves.

The majority of visitors are car borne, despite the availability of rail access. Motorway access to Sefton (M58 and M57) is good and currently well below capacity. However, the road network within Sefton is congested and road traffic forecasts suggest that this situation will intensify. An integrated public transport system linking different locations along the coast should be part of any strategy to develop the visitor economy of the area.

Climate Change Impacts

There is a strong east/west climate gradient across the Mersey Basin with decreasing rainfall, longer sunshine hours and somewhat cooler temperatures towards the coast. This gradient will be intensified by climate change, especially under the ‘high’ scenario (see Figure 7).

Visitors to the Sefton coast from beyond Merseyside are known to be attracted for either nature, bird watching or to visit the beach. Insufficient data prevented detailed analysis of visits to the area, but an annual count of visitors has been made on all access routes to Formby Point on a summer Sunday on eight occasions between 1975 and 2000 [21]. Visitor numbers for these days range from 2,956 to 13,318 around a mean of 6,024. This variability may be weather dependent; the peak count occurred on ‘a particularly hot day’. As conditions become less comfortable in urban areas on hot summer days, it seems likely that the coast, with its equable climate and much improved bathing water quality, will become even more attractive as a visitor destination. This will inevitably lead to increased visitor loading at peak times.

Climate change will strongly influence the physical parameters which shape the ecology, and with that the environmental capacity, of the dune system. With sea level rise expected to range from 7 to 67cm in Northwest England by the 2080s, the importance of the dune system as a flexible coastal defence, protecting settlements and important agricultural

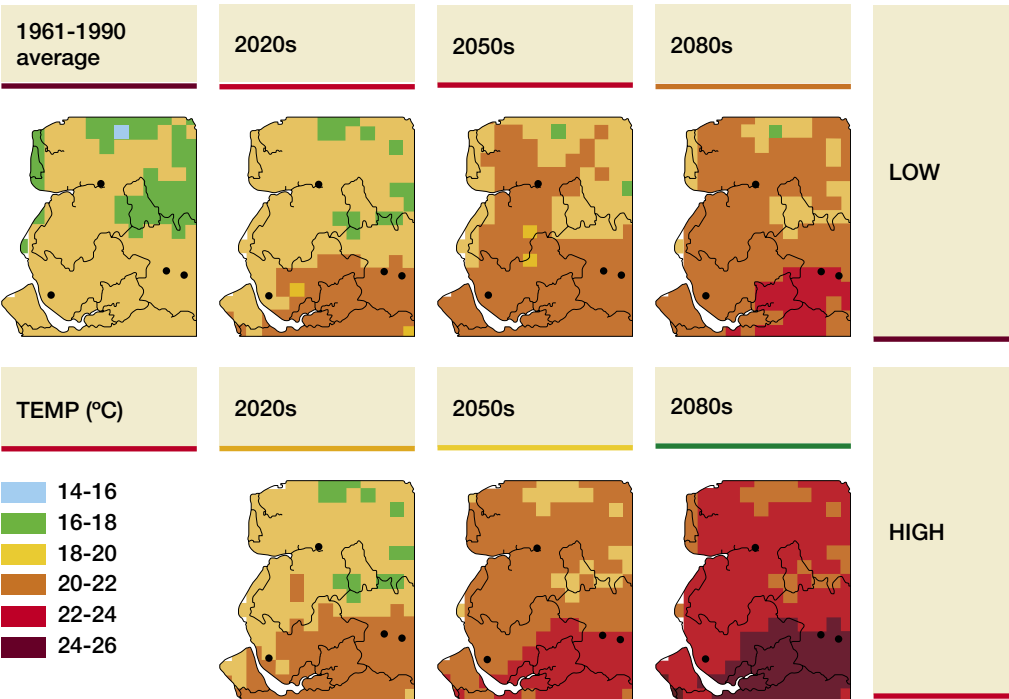


Figure 7:
Climate scenarios for
average summer maximum
temperature around the
Merseyside Coast
(Produced using data supplied
by UKCIP and the Met Office)

areas, will intensify. A sandy foreshore, backed by a dune system, is able to adjust naturally to wave attack. However, it is necessary to sustain the integrity of the frontal dunes so as to maintain the sand mass close to the point of wave attack.

Increasing visitor numbers could impact on the natural ecosystem. Marram, the dominant grass of the frontal dunes, is known to be vulnerable to trampling. As the vegetation cover decreases under visitor pressure, bare sand is more easily mobilised and carried inland by the wind. It is imperative that access to and through the frontal dunes continues to be managed in a way that sustains their coastal protection function.

Another impact of climate change on the area concerns the water table, or ream, which provides a connected layer beneath the entire dune system. The hydrological system is self-contained and the level of the water table fluctuates seasonally. Over longer time periods, it reflects the changing balance between water input (principally rainfall) and output (principally evapotranspiration)^[23]. The water table integrates any medium or longer-term shift in the balance between rainfall and evapotranspiration; it is therefore a sensitive indicator of climate change. The amplitude and positioning of the water table is critical for both biodiversity and recreational use. For example, golf requires water to maintain greens and fairways in summer, but too high a water table in winter restricts access to the playing area.

Modelling the Changing Water Balance

The depth of the water table has been recorded systematically over a long time period at the Ainsdale National Nature Reserve. Researchers at Southampton University have developed an effective model of dune hydrology which successfully tracks historic changes in the water table over a thirty year period ^[23]. This model is now being projected forward to take account of changing patterns of rainfall and evapotranspiration under the climate change scenarios. Preliminary results from this first model run imply:

- Increased variability in predicted water table levels.
- Drier average soil moisture conditions in mid/late summer.
- The possibility of runs of more than 5 years with water table levels 1m lower than at present.
- Slightly larger winter-summer range of level change.
- Continuation of occasional years with high water table levels, but with longer drier periods in between.

Implications for the Dune System

A pattern of change along these lines has significant implications for the dune system. In the frontal dunes, marram will be placed under additional water stress. However, evidence suggests that it should cope with harsher climatic conditions ^[25]. The implications for the 'fixed' dunes are more serious. These could range from reduced biodiversity in wet hollows (dune slacks) and increased stress on fixed dune communities and greater vulnerability to destabilisation by 'blow-outs'. Consequently, we may see a reduction in fixed dunes and a more mobile dune landscape of the type experienced early in the 20th Century. This may bring some benefits to wildlife, but could be problematic for recreation and adjoining settlements. The golf courses will need to cope with drier summers and, on occasion, wetter winters. At present, management responses to changing hydrology are not well integrated. However, the low flow rate of water laterally through the sand means that there may be scope for more creative management of the water table without necessarily prejudicing adjacent land uses.

Conclusion

Changes to climate and visitor behaviour may bring new opportunities to Sefton and, more widely, to the regional economy. However, the ecological challenge to the dune system will be severe. An extension in time and space of current physical and biological monitoring is required to provide essential management information. This monitoring should also include systematic recording of visitor numbers. Fortunately, a proven management mechanism – the Sefton Partnership – is already in place to provide the required adaptive capacity. The Sefton Coast Management Scheme was originally developed on the principle that the great majority of visitors, especially at peak times, are there to visit the coast rather than the dunes and, as such, it is possible to manage visitor flows and protect the ecological integrity of the dune habitats. The scheme acquired an international reputation for reconciling visitor pressure with conservation needs along a dune coastline – a new opportunity now exists for the Sefton Partnership to provide an international demonstration project for anticipating and managing the response to a changing climate.

Case Study 2

Moorland Wildfires in the Peak District National Park

The rural upland areas of England are highly valued as key visitor attractions. In 1951, the Peak District National Park (PDNP) was established as England's first National Park. Within easy reach of several major urban areas, it receives up to 30 million visitors every year. Most of these visitors are attracted by outdoor activities such as hill walking and mountain biking, or simply to experience the high-quality natural environment on offer. However, there are problems associated with the popularity of the PDNP. Visitor pressure continues to cause the loss of habitats and species despite the best efforts of visitor management and restoration schemes ^[25]. Some pressures, like overgrazing and acid rain, are now reducing, but climate change is an increasing concern.

Increases in temperature and changes to rainfall patterns will have considerable management implications for the PDNP. Under the UKCIP02 high emissions scenario for the 2080s, summer maximum temperature is predicted to increase by 3.0°C to 5.5°C over the whole of the Peak District. This could result in an average maximum daily temperature of between 20.5°C and 23°C. The scenarios show little change in annual precipitation, but this masks significant changes in both the seasonality and spatial distribution of future rainfall. By the 2080s, a decrease in average summer rainfall of between 23 and 45% is expected for the Peak District with significant consequences for moorland habitats, many of which require a high number of rain days and total rainfall.

Climate change impacts are complex. As well as these direct impacts, there are indirect effects caused by the cumulative impact of lower precipitation and higher temperatures on soil moisture, as well as evapotranspiration from moorland vegetation. The impact of climate change on habitats, biodiversity and fire risk are all considered priority management issues, though it is the latter impact that was the focus of this particular case study.

Wildfire Risk: Climate Change, Visitors and Environmental Capacity

Humans are considered to be the main culprits for the majority of wildfires. These are fires that are either started accidentally, maliciously, or are a result of managed fires that get out of control. A small number of fires are started by natural causes.

Fires pose a significant, and potentially costly, environmental threat. Not only do fires damage the fragile upland ecosystem, they can also adversely affect water quality, cause erosion scars, release CO₂, and can have considerable economic implications by disrupting transport through the closure of major roads and airports.

There are two main factors that determine the risk of fire outbreaks: flammability and ignition sources. The interaction between climate change, visitors and environmental capacity is likely to increase this risk in the future.

Flammability is a function of both weather and fuel loading (which in turn is a consequence of habitat type and moorland management). In terms of weather conditions, research has indicated that there is a strong relationship between the incidence of wildfires and the preceding weather. Prolonged dry weather can make vegetation more flammable and higher maximum temperatures are also associated with greater fire risk, reflecting the dangers of hot, sunny days in sparking fires. The obvious concern is that the warmer, drier summer conditions predicted under a changing climate, together with a lengthened summer season, will greatly increase the risk of wildfires, with significant implications for moorland areas, and especially on peatland soils which can themselves be a source of fuel.

Image J: Smoke plume from Bleaklow and two other moorland fires, 18 April 2003 (Image courtesy of Defra).



The second risk factor is ignition sources. Since the great majority of fires are caused by human carelessness, the likelihood of ignition sources is enhanced by increased accessibility – roads, paths, car parks and access land – as well as the Peak District's increasing attractiveness to visitors.

Modelling fire risk

This ‘fine-scale’ GIS-based modelling (based on reported fires since 1976) identified where the risk of fire was highest by analysing spatial relationships between wildfires and the key variables of habitat, aspect and accessibility.

The diagram illustrates the relationship between landscape features and ignition hazard/ignition source. It is divided into two main sections: Vulnerability to ignition hazard and Accessibility source of ignition.

Vulnerability to ignition hazard

- HABITAT**
Biomass, substrate, (inc. management)
- OPEN WATER**
Constraint
- ASPECT**
Likelihood of drying

Accessibility source of ignition

- ACCESS LINES**
 - Roads
 - Pennine Way
 - Trampled paths
 - Eroded paths
- ACCESS AREAS**
Access land
- ACCESS POINTS**
Car Parks

Case Study 2

Mapped results show that most fires occurred on bare peat, eroding moorland or bilberry bog, whilst heather communities had the fewest fires. This suggests that informed management practices could be used to reduce vulnerability to wildfire. Risk is also greatest in proximity to access routes, with most fires occurring in the vicinity of roads and paths. There were significantly more reported fires on Access Land than non-Access Land, leading to implications for increased fire risk with the extension of Access Land under the Countryside Rights of Way Act (see Image L for fire risk distribution).

Temporal analysis was also applied to predict when fire risk is likely to be highest, based on preceding weather. This evaluated the chance of fire outbreaks at different times of the year, days of the week, and under different weather conditions – all whilst allowing for seasonality in the data. The temporal modelling work, when combined with UKCIP climate models, was then able to show how fire risk can be expected to increase under different climate change scenarios.

Evidence from the analysis highlights the complexities associated with the seasonal nature of fires. The occurrence of fires varies with the time of year and even within each week. The peak months for fires in the PDNP were found to be April and May, though it should be noted that there are also fluctuations from year to year.

Daily precipitation, past rainfall, temperature lags and the 'dry spell' indicator function were all found to be

statistically significant. Daily maximum temperature and recent fire activity also heighten fire risk. It was found that some months of the year had a heightened risk, reflecting the changing flammability of moorland vegetation and recreational use.

Climate change is likely to bring wetter winters, but hotter and drier summers. Simulations suggest that weather extremes and climate variability are much more critical than changes to either average temperatures or rainfall. The non-linear relationship between the risk of wild fires and key weather variables, such as dry spells, means that even a slight increase in the frequency of extended periods of hot dry weather could have significant impacts.

This indicates that some factors contribute more to fire risk than others. Although climate variables are important in influencing flammability – particularly the role of moisture in 'damping' down fire risk – these were not found to be as great an influence on fire risk as human activity. Most fires are reported at weekends and bank holidays, reflecting the impact of recreational activity. For example, a typical British spring bank holiday is almost five times more perilous than seven days of dry weather. It is therefore human-impact, in combination with amenable weather conditions, which emerges as the main influence of fire risk in the PDNP. Management responses to protect these sensitive landscapes will therefore need to address both environmental capacity and visitor behaviour issues.

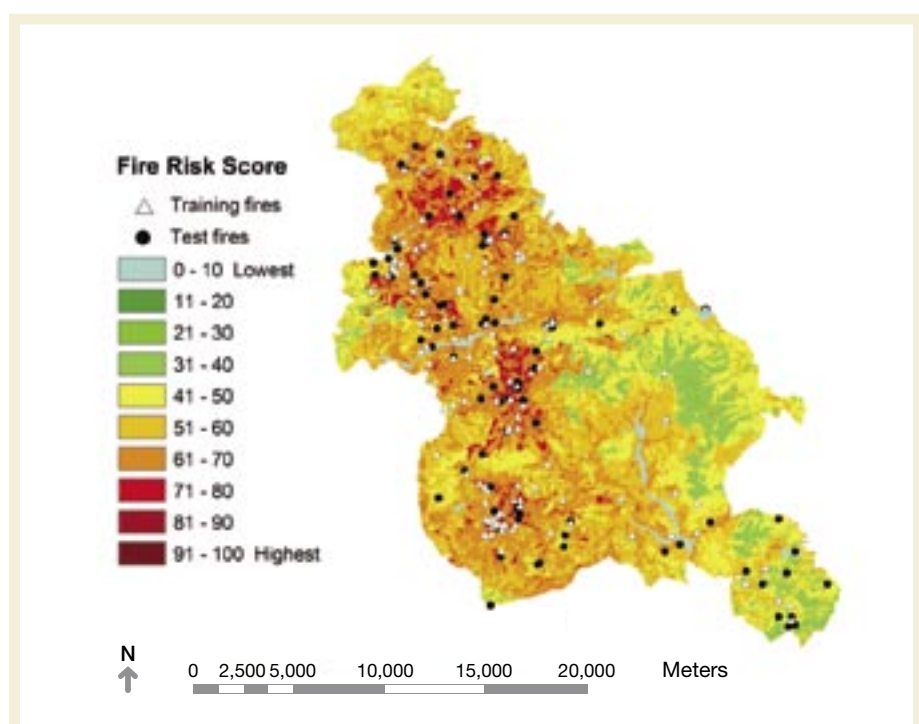


Image L: Dark Peak risk map: prioritising vulnerable habitats

Conclusion

As a result of direct and indirect impacts, climate change is likely to increase both the probability of wildfire incidence and the number of multiple fire days. Fire severity may also increase, causing an extension of the burnt area. Climate change is likely to change the habitat and distribution of vegetation types, thus affecting vulnerability to fires. This has implications for the management of moorlands – rotational burning practices on heather moor may be an increasingly useful way of reducing fuel load and ultimately fire risk. Careful management practice is needed for the habitats most vulnerable to wildfires. Other preventative measures can also contribute to reducing flammability and act to bolster environmental capacity. These could include the reseedling of areas to create less vulnerable habitats, gully blocking to raise the water table and the dousing/wetting of vegetation.

Since the majority of fires are started by human negligence, a response to this is a necessary component of any management strategies. Moor closure is an extreme and controversial preventative option at times of high fire risk. However, other less-stringent access restrictions, for example access to car parks, could be imposed during high-risk periods. The closure of moors impacts on both landowners and visitors and would certainly have an adverse effect on the visitor economy. Furthermore, there are concerns that closing the moors may be counterproductive since there would be fewer people to spot fires and report them, thereby increasing the risk of the fire spreading. Influencing visitor behaviour to reduce negligence can be achieved through education and raising the awareness of footpath users is integral to management strategy.

There is currently no legal requirement to extinguish moorland wildfires. However the ‘do nothing’ approach would be in direct conflict with the objectives of a national park – to protect and enhance the natural environment. Traditionally, fire beaters have tackled wildfires, but since the 1980s helicopters using dipper buckets have been increasingly used. However, both options are subject to growing resource pressures, either in terms of sufficient manpower or the financial resources required in the use of helicopters.

The options discussed highlight a variety of management solutions to reduce moorland fire risk. It is important to note that the PDNP has effective management structures already in place that deal with fire risk management. These innovative partnerships, exemplified by Moors for the Future and the Fire Advisory Panel, have pioneered wide-ranging stakeholder engagement and the use of local knowledge. They should be considered valuable existing mechanisms for responding to the future implications of climate and non-climate change.

Dealing with increased fire risk in the future will not only require additional funding to implement appropriate adaptation measures, but also the transference of the latest scientific knowledge to best inform effective adaptation responses. Although additional work is needed to produce a final validated and integrated model, this research has shown that the combination of climate modelling with temporal and spatial analysis has the potential to act as a powerful tool for predicting and managing future fire risk.

Case Study 3

Footpath Erosion in the Lake District National Park

The Lake District National Park (LDNP) is a much-cherished landscape. The area was first popularised by William and Dorothy Wordsworth in the 19th Century, whilst Wainwright encouraged a more athletic approach to the more remote peaks in the 20th Century.

The LDNP welcomes around 12 million visitors a year, with the quality of the landscape and scenery being the reason most people visit. Visits are dominated by day visitors and repeat visits, and over 87% of visitors use the upland footpath network. In fact, a small survey in the Bassenthwaite area suggested that three quarters of visitors wish to climb a 'peak'.

The Lake District provides a clear demonstration of how recreational pressures interact with the natural environment. Visitors gain great pleasure from this spectacular environment and the Lakes tourist industry is keen to welcome more visitors, especially in off-peak and shoulder seasons. At the same time, increased access to the Fells, loss of protective snow cover and the more intense rainfall in winter brought about by climate change, is likely to erode the more heavily used upland footpaths. As a consequence, public access will become difficult, soil will wash into tarns and lakes as silt and, if left unchecked, trampled paths will become wide erosion scars visible from great distances.

Footpath Erosion

Footpath erosion is a complex process due to the large number of factors involved and the interrelationships of cause and effect. It is primarily influenced by a triangle of factors: water (rainfall intensity), variation in path gradient (slope) and recreational pressure (trampling). While many paths are stable, others can deteriorate rapidly. A small increase in visitors can have a disproportionate affect on a steep path, which could be further exaggerated under changing climatic conditions. Previous monitoring of Lake District path erosion found that extremes of erosion were localised, but occurred on most paths^[26]. Signs of active erosion processes were observed on about one-third of the sites and appeared on most paths with a slope of more than 17 degrees. Experimental work on a model path demonstrated the efficiency of trampling as an erosive agent, especially in combination with wet weather and waterlogged soil.

The aim of the CCVE work was to produce a model of current day footpath erosion capable of estimating the relative degree of erosion across upland paths in the Bassenthwaite catchment. An erosion model was constructed using GIS analysis developed from digital data resources and field survey work in the Bassenthwaite catchment of the LDNP.

Figure 8: Footpath erosion in the Bassenthwaite catchment

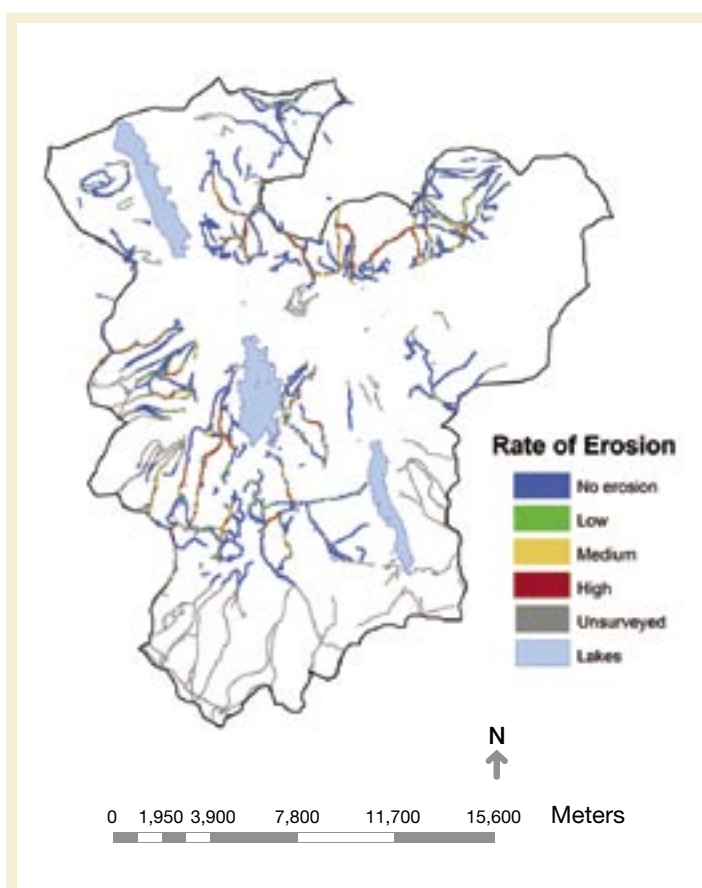


Image N: Bassenthwaite Lake



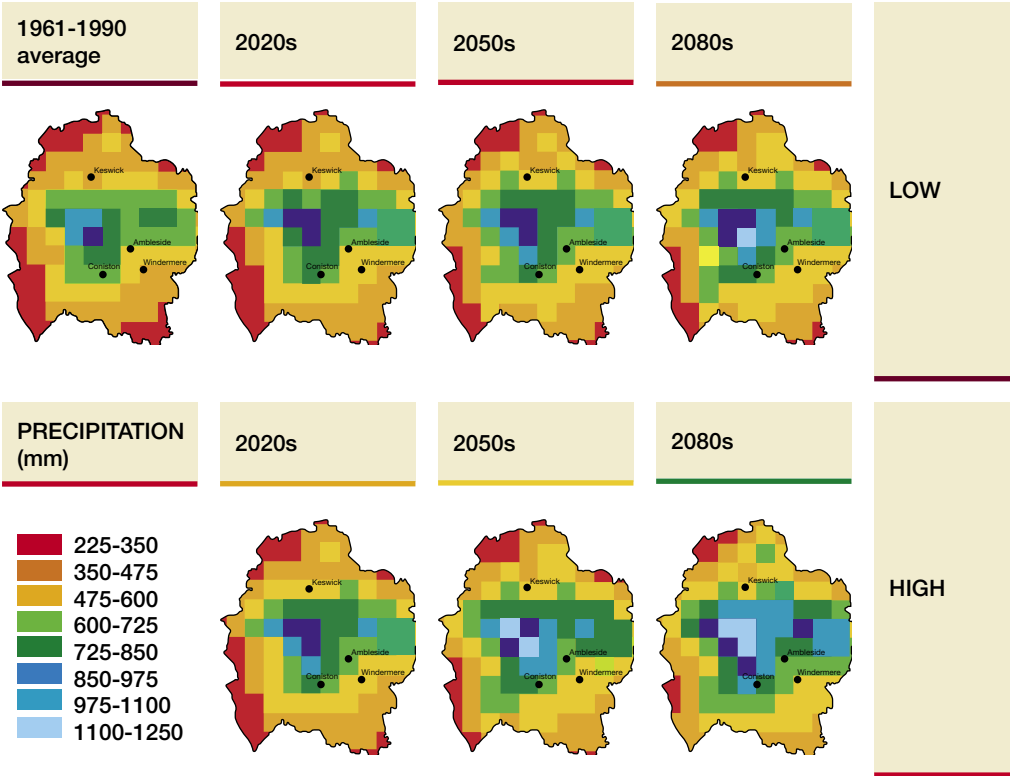
The field survey work, undertaken during the summer of 2005, suggested that the variation of path width, amount of bare soil, and depth of gulying are associated with slope, popularity, rainfall, and, to a lesser extent, vegetation and soil type. This data formed an input into the model of current day footpath erosion. The model developed provides the basis for further analytical work to incorporate the impact of climatic changes, to assess the most vulnerable parts of the footpath network, and to provide a methodological framework applicable to other catchments in the UK. This was not possible within the CCVE project due to a lack of temporal data available for footpath erosion modelling.

Evidence from research and aerial photography in the Bassenthwaite catchment suggests that almost 50% of upland paths are on gradients vulnerable to active erosion processes (see Figure 8). This implies some 150km of upland paths are candidates for erosion. An earlier survey by the Lake District National Park Authority (LDNPA) of 180 paths across the whole Park in 1999 found that 145 of these required urgent treatment.

Climate change scenarios suggest an increase in average winter night-time temperatures of 1.5-3°C and a reduction in protective snowfall of between 40-90% by the 2080s. Warmer winters will ultimately eliminate snow cover that currently protects the Lakeland Fells during winter. Instead, a freeze-thaw cycle is likely to set in which breaks down exposed rock through mechanical action. Torrential rain causes the most damage to upland footpaths by turning pathways into stream gullies. Meteorological evidence suggests daily precipitation has already become more intense in winter and less intense in summer over the period 1961-2000 [27]. This could become more prevalent as increases in winter rainfall between 14-27% are expected by the 2080s (see Figure 9) and the total amount of rainfall falling in intense events is also likely to increase.

Figure 9: Climate scenarios for average winter precipitation for the LDNP

(Produced using data supplied by UKCIP and the Met Office)



Case Study 3

A rise in the intensity of winter rainfall accompanied by the absence of snow cover is likely to accelerate path 'wash-outs' on slopes. A heavy pulse of rain, for even just an hour, can be especially damaging. The critical issue is the rate of rainfall, not just the level. The consolation is that there is already evidence of fewer summer downpours, which can be especially damaging during a long, dry summer, and an earlier onset of spring will bring vegetation growth which helps 'fix' paths and protect underlying top-soil from initial erosion and 'pigeon-holing' (see Image O).

Visitor pressure

Footpaths are particularly vulnerable when trampling and rainfall alternate. Trampling disturbs the soil cover, rendering particles more easily moved by the impact of subsequent raindrops. For example, research on a Lake District path with moderate slope results in three times the amount of rainfall erosion on trampled soil than occurred on undisturbed soil^[26].

Future climate change and shifts in the patterns of recreation are likely to exacerbate footpath erosion. This will be the result of a combination of increased intensity of rainfall and fewer, but more enthusiastic, walkers and mountain bikers keen to go out on the Fells all year round. Fell walkers and mountain bikers in particular, are likely to be keener, have all the right clothing and equipment, pursue their hobby in both winter and summer, and drive long distances to reach the Lakes. This evidence is consistent with views expressed by stakeholders that state there are now fewer casual walkers on the Fells in August, but more enthusiastic walkers and ramblers' intent upon completing the Wainwright peaks in the winter months. It is important to note that sheep are also responsible

for eroding paths, though the pressure has reduced in recent times. Grazing reduces the robustness of the vegetation, but attracts walkers, as the 'bowling green' sward is pleasant to cross. Grazing by sheep rose from the 1950s to the 1990s, then dropped away, reinforced by the outbreak of foot and mouth.

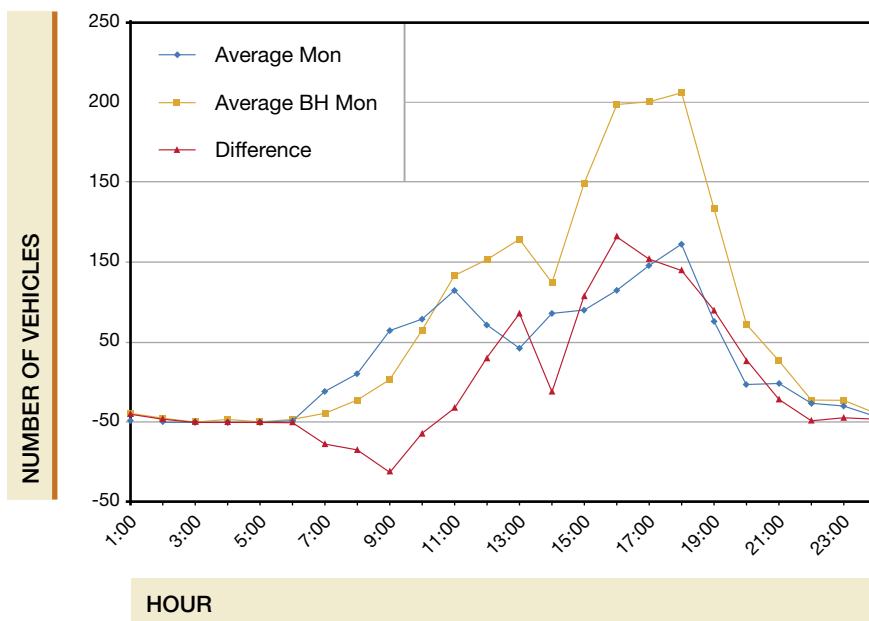
With 89% of visitors travelling to the Lake District by car, congestion, pollution, noise and reduced perceptual capacity are problem issues. Traffic flows in the LDNP have grown at a faster rate than the national average over the last five years – 7.2% compared to 4.5% nationally – and are set to increase in the future by at least the same rate as nationally (a 65% increase from 1996 levels expected on rural roads by 2031). Many roads within the Park boundaries are dominated by recreational traffic, but use is highly variable, changing on an hourly, daily and seasonal basis. Heavy congestion is a particular problem on local roads, which are not equipped to carry heavy flows, especially during peak periods such as weekends and bank holidays. The existence of a mid-morning to early-afternoon peak and extended late-afternoon to evening peak appears to be a characteristic of recreational routes and key recreational times (see Figure 10). This suggests times where additional traffic management is required and when integrated public transport options would be most effective – this is already recognised to some extent, being one of the key priorities of both the Park Plan and the related transport strategy.

The high use of cars for recreational visits raises secondary problems, such as informal parking. Surveys in the Bassenthwaite catchment revealed that most formal car parks reach full capacity by mid-morning, encouraging overspill into nearby grass verges and roadsides.



Image O: The 'pigeon-holing' problem in the Lake District

Figure 10: Bank holiday vs. non-bank holiday traffic in May 2003 (ATC data provided by Capita Symonds for the B5322)



Adaptation Strategies

There is a range of adaptation strategies available. Firstly, there is straightforward correction of erosion damage. However, footpath repair or restoration can be costly – resources include labour, temporary incursion of helicopters to move machinery and materials, and mechanical equipment involved in the repair. Precise costs vary with details such as the cost of using helicopters rather than manual lifts, or even the lift capabilities of individual types of helicopter. For the LDNP, repair materials are always sourced locally.

A further complication is that paths do not erode at a constant rate. Rather, they tend to fail suddenly. It is better to restore a path at an early stage when it is showing minor, tell-tale signs of imminent failure. At this stage, costs may total around £5,000. Minor damage can deteriorate to the point of major damage in as little as six months, causing the repair costs to rise to as much as £30,000. Steep, heavily used paths can be restored with a set of zig-zags replacing a direct but eroded route. There are best-practice guidelines for path repair and restoration. These were presented to a House of Commons Select Committee on the Environment and have since become national guidelines for footpath maintenance and repair.

Other potential responses are also costly. These include raising awareness of the problem to modify the behaviour of walkers and others, and regular monitoring and management of footpaths by ‘linesmen’ to anticipate future damage. In extreme cases, demand management of visitors could be introduced – visits could be spread over a wider area with encouragement to use other access routes, for example through altering car-parking provision. However, this causes inconvenience to those whose trips are either cancelled or diverted.

Conclusion

Damage to Lake District footpaths in the face of a changing climate highlights the importance of anticipating and adapting to climate change. An exemplary policy framework is already in place to monitor the impact of recreation upon the Fells. The LDNPA has a ‘Path Group’ which includes an officer from the Park, a representative of the National Trust, an architect and five rangers, plus their uplands path advisor. All schemes for footpath repair go through this group. On National Trust land, wardens and upland managers prioritise the workload. English Nature, the National Trust and the LDNPA approve all work, whether LDNPA or National Trust led, in order to maintain standards. Further input comes from an Access Advisory Group, with public scrutiny from a vocal climbing press.

Case Study 4 Public Space in Manchester City Centre

Traditionally the image of Manchester has been that of a bleak Northern city, often linked to its industrial past. In recent years, this image has been shed and has undergone a transformation, exemplified by the hosting of the Commonwealth Games in 2002. Manchester now receives the third highest number of foreign visitors after London and Edinburgh. The upturn is reflected in the city’s economy, which now contributes £28bn to GDP – some 38% of the total for the region – with the visitor economy accounting for £845m of this.

Despite this, the urban fabric continues to suffer from its industrial legacy. The city centre has high-density development, with narrow streets and high buildings. These contribute to the ‘hard-edged’ and ‘claustrophobic’ feeling of the area. The sense of lack of space is further reinforced by deficiencies in both the green and blue infrastructure. For instance, there is no significant park in the urban core and the rivers in the city were traditionally used for sewage and industrial purposes, and so diverted through culverts and hidden from view.

Manchester city centre has undergone significant redevelopment and as a result, many areas of open and green space have been lost, in part, a reflection of the fact that public spaces nationally have tended to be undervalued and under-funded in recent times. The forecasts for continuing residential growth in the city centre reinforce the pressure on the remaining public space. This poses a significant challenge for the city, as it is increasingly recognised that quality public space makes a valuable contribution to both environmental capacity and the visitor economy. Well maintained public spaces create space for nature, act as community resources, boost local economies and enhance the health benefits for residents in the form of physical, mental and emotional well-being ^[28].

Public Space in the Future

Although underpinned by socio-cultural change, warmer summers and more pleasant evenings are likely to supplement the trend towards ‘outdoor lifestyles’. In Manchester this may have positive implications for the burgeoning café culture and there is likely to be increasing demand for access to public spaces in response to over-heating buildings on hot days ^[29].

While there may be some tangible benefits to the visitor economy, most British cities are not designed to cope with high summer temperatures. Although Manchester’s urban heat island is not as pronounced as other major cities such as London, maintaining human comfort under a changing climate will become an increasingly critical issue. Scenarios show peak temperatures reaching 34°C in the 2080s, with significant thermal discomfort likely from the 2050s onwards. Without adaptation responses that provide cooling, shading and shelter, there is the possibility that residents and visitors will leave the city centre during these hot, uncomfortable periods, or avoid it all together.

Human comfort research carried out in Manchester by researchers at Oxford Brookes University has shown that when outdoors, people respond to season and weather, particularly wind and sun, with a general preference for more greenery and less air movement (except in hot, still weather). Hence, the design of outdoor spaces needs to provide access to, or protection from, wind or sun. The impacts of climate change, and in turn, human comfort, should be considered in the design of any new developments within Manchester’s public realm. This does not only relate to higher summer temperatures, but also the need for shelter in wetter winters.

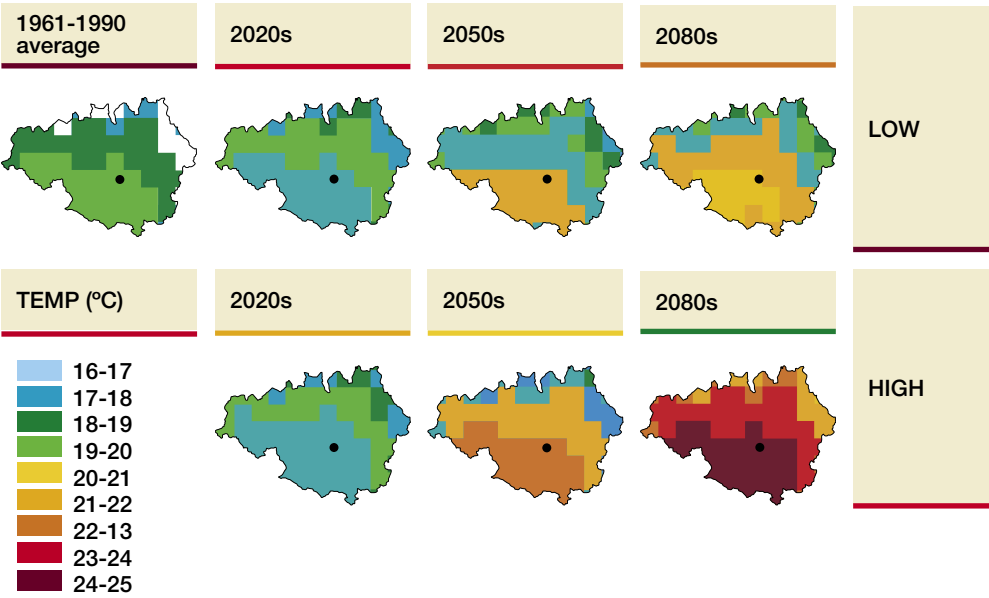


Figure 11: Climate scenarios for average summer maximum temperature for Greater Manchester (Produced using data supplied by UKCIP and the Met Office)

Strategic consideration of green and blue infrastructure for the city centre, and how it links to surrounding areas, is also of paramount importance. The presence of vegetation is often a crucial element in public areas. Greenspace has an important role to play in adapting urban spaces to climate change; for instance, they can provide cooler microclimates and assist rainfall infiltration, with tree shade being particularly effective at reducing surface temperatures. Greenspace research carried out by the University of Manchester has shown that an established tree canopy in Grosvenor Square (Oxford Road) creates conditions 15°C cooler at the surface than impervious areas with no cover. This makes the current lack of shading in the city centre a priority issue. Tree planting is one possible solution and, although an expensive measure in the city centre, a tree strategy for Manchester is currently in operation as part of an initiative to make Manchester the greenest city in Britain. Other options include the use of urban furniture, such as awnings, for shade.

Often overlooked, rivers and waterways also make important contributions to more agreeable urban conditions. The opening up of waterways, which is consistent with the aims of the Waterways Strategy ^[30] has significant potential for making an important contribution to the visitor economy. The Castlefield Urban Heritage Park in Manchester provides an existing example of linking leisure and cultural activity with a waterside focus.

Responding To Change

Highly managed urban areas will behave differently to countryside locations in the face of climate change. However, strengthening resilience to climate change is equally important, and will involve considerable urban design challenges that need to be faced sooner rather than later. Existing public space in Manchester is criticised for not being well integrated and it is clear that a more interlinked network of public spaces would bring numerous benefits. Improving the quality and attractiveness of the urban public space, in a time when 'city-breaks' are an expanding section of the tourism market, would add value to the city's visitor economy.

Considering the current level of provision of public space in Manchester there is obviously scope for improvement. However, the lack of space and limited turnover of infrastructure means that it may be necessary to consider more creative solutions. Ironically, the bombing of Manchester city centre in 1996 acted as a catalyst for regeneration, successfully opening up a network of public space that was previously restricted. An innovative option for 'new' public space could be the selective pedestrianisation of roads in the city centre, with links to canals and rivers beyond. Initiatives at the street level, such as wider pavements and covered walkways, would also stimulate opportunities for the visitor economy.

Conclusion

Although the focus of the case study was on the city centre, the whole city is best treated as an integrated system, planning for change over the long-term. Preparing a green and blue infrastructure plan at the scale of Greater Manchester city-region would be a welcome first step following on from the pioneering River Valley initiatives of the 1970s. Any coherent strategy for improving public space would also need to bring together a disparate set of policies, including environment, transport, waterways and tourism. Here, partnership working is likely to be critically important - the public sector is not the only delivery agent for improvements to the public realm; business and other interests are also likely to have pivotal roles. Policies therefore need to enable the involvement of a range of stakeholders in delivering new public space, ultimately improving the quality of the urban environment and the visitor experience.

Image Q: Piccadilly Gardens on a hot sunny day



Climate Proofing the Visitor Economy

Climate proofing is about reducing the vulnerability of social, economic and environmental assets. The European Environment Agency has recently proposed a definition of vulnerability as, “a state induced from adverse impacts of climate change, including variability and extremes, and sea level rise, of both human and natural systems”^[31]. It is important that we think in terms of systems rather than sectors, as the visitor economy is critically dependent on the accessibility and quality of its destinations, whether they are facilities or landscapes.

The economic impact of dislocated access was dramatically illustrated by the foot and mouth epidemic when direct loss to the UK tourist sector, in both rural and urban areas, amounted to £2.7-£3.2bn, with additional indirect costs of £1.8-£2.2bn^[32]. These losses dwarfed the direct costs to the farming community. The CCVE project was therefore concerned with a system which links the visitor economy to the landscape, with climate change exerting a strong influence on landscape condition as well as visitor demand (see Figure 12).

All systems have capacity for self-adjustment, but the pace and intensity of climate change is such that planned adaptation is needed to reduce vulnerability. The adaptation response involves “policies, practices and projects with the effect of moderating damages and/or realising opportunities associated with climate change”^[31]. These responses may be brought to bear on all parts of the system. We will consider the components in turn before considering the system as a whole.

Climate Change

As discussed previously, the project utilised the UKCIP02 Climate Scenarios. It is worth summarising here the aspects of climate change about which there is the greatest confidence. These include:

- Average temperature increases.
- Summer temperature increases more in the Southeast than in the Northwest.
- High temperature extremes increase in frequency.
- Low temperature extremes decrease in frequency.
- Sea-surface temperature warms.
- Thermal growing season lengthens.
- Winter precipitation increases.
- Winter precipitation intensity increases.
- Snowfall decreases.
- Summer soil moisture decreases.
- Sea-level rises.
- Extremes of sea-level become more frequent.

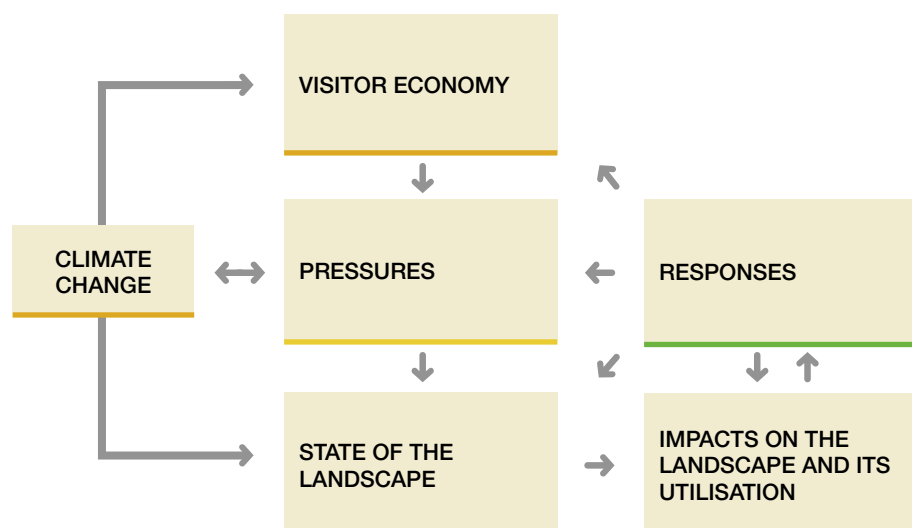


Figure 12: A conceptual model linking climate, visitors and landscape

The spatial implications of climate change can be explored at a regional scale because the scenarios have been downscaled to a 50km² resolution and can be further refined to 5km² resolution by linking these outputs to current climate patterns within the region. It should be emphasised that there are considerable uncertainties built into the scenarios, especially the assumption that climate relationships will remain constant under climate change.

The Visitor Economy

The relationship between climate change and the visitor economy depends, to some extent, on the scale of enquiry. In the medium to long-term, it has been suggested that worsening conditions in Southern Europe may usher in something of a re-orientation of tourism from North/South to East/West, along what has sometimes been called the North European Trade Axis. It was surmised at the outset of the CCVE project that warmer drier summers and more equable conditions in spring and autumn may both increase the intensity of recreation visits and extend the tourism season.

The relationship between visitor behaviour and the weather is best revealed by econometric analysis of long runs of daily visitor data. The difficulty of obtaining good quality survey data was a major disappointment and is a situation that will need to be remedied if reliable strategic planning and decision-making is to take place. The notable exception was the dataset from Chester Zoo. Analysis showed that visitor behaviour was strongly habitual and rather insensitive to the weather, with no detectable climate related long-term trends. The important message is that visitor numbers are best sustained by effective marketing and that there is no foreseeable climate bonanza for facility managers. Rather, the changing climate may make new demands on the design and management of facilities. Although Chester Zoo may not be representative for the entire sector, it can still be considered a bona-fide outdoor visitor experience.

Visitor Pressure

The most obvious pressure is associated with travel to and from tourist destinations. Most visitors travel by car, which not only adds to congestion but also contributes to the problem of climate change through greenhouse gas emissions. The regional transport network already experiences severe congestion and this is replicated, at peak times, in and around the tourist destinations themselves. National forecasts suggest that the problems will intensify and congestion is likely to become acute before it is politically acceptable to introduce an effective response, for example road pricing. There is a need for the development of an integrated, less car-dependent infrastructure in the most valued and visited landscapes. This lends strong support for the Regional Development Agency's proposal for Regional Park Resources – high quality visitor landscapes close to the main centres of population ^[33].

Many factors will influence future patterns of visiting ^[34]. Time budget studies suggest that we are becoming cash-rich but time-poor and therefore more specialised in our demands on the countryside. Far from visitors being deterred by adverse weather, for example increased frequency and intensity of winter rainfall, the availability of increasingly sophisticated clothing and equipment means that visitor loading will continue at times when the landscape itself is most vulnerable to damage.



Image R: Aerial shot of Chester Zoo

State of the Landscape

In the countryside, the CCVE study focused on 'climate sensitive landscapes', where vulnerability to wind and water erosion or damage by fire was likely to interact with visitor pressure. The study set out to analyse whether the carrying capacity of the landscape would be reduced by climate change – affecting its ability to accommodate visitor pressure. This proved to be the case in all the rural landscapes examined.

Methods are emerging for assessing sensitivity of landscape character areas at the regional and the landscape scale, and for linking this in turn to notions of capacity ^[35]. The research team strongly supports the systematic scoping out of climate impacts in all landscape character areas and the methodology for that proposed recently by Scottish National Heritage and the Countryside Agency ^[36]. This identifies three interlinked 'Principal impact themes' – natural environment, cultural heritage and land use. The CCVE study focused to a great extent on the natural environment, though the cultural heritage deserves at least equal emphasis. Similarly, it needs to be recognised that socio-economic changes, for example reform of the Common Agricultural Policy (CAP), and structural change within the farm economy, are likely to have profound effects on the state of the landscape which will, in turn, influence recreational carrying capacity and landscape perceptions. In the Northwest region this would further reinforce the case for Regional Park Resources which are located, for the most part, in less sensitive landscapes. One such example is Delamere Forest in the Mersey Belt. Similar approaches have also been taken within high value landscapes themselves, for example Grizedale Forest in the Lake District National Park.

In the urban area, climate change brings new opportunities to the visitor economy. Measures which seek to enrich and 'green' the outdoor realm of our city centres will help to see this promise fulfilled.

Landscape Impacts

This study has explored a variety of situations where recreational use interacts with climate variables to produce significant impacts. The use of stakeholder workshops was extremely helpful for drawing on expert local knowledge to clarify the nature of the impacts and to tease out those issues of greatest concern. However, it is then necessary to quantify the impacts and to develop models that explain system behaviour. This requires availability of data which relies on systematic long-term recording of the state of the environment. Here the research team was fortunate in being able to access high-quality data – the fire log of the Peak District Rangers or the data on ground water levels collected over a 40-year period in the Ainsdale National Nature Reserve. We recommend strongly that landscape managers not only scope out potential climate inputs but identify key 'state of the environment' variables for long-term monitoring in all visitor landscapes, including city centres. The development of models to explain system behaviour is challenging and this was only made possible by an effective partnership between university-based research teams and landscape managers on the ground; a mode of working that we naturally endorse.



Image S:
Greening our city centres

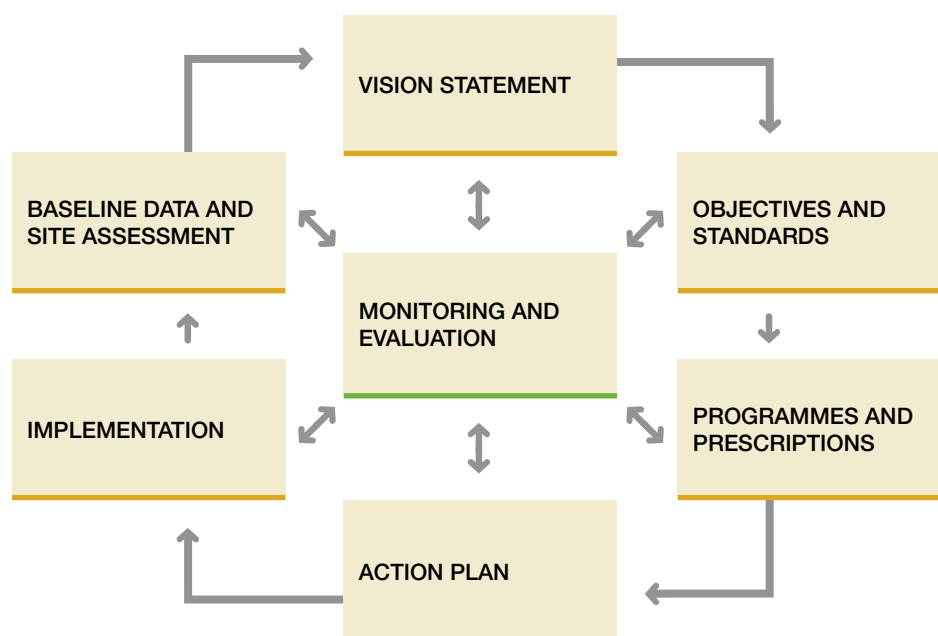
The Management System

Various notions of environmental capacity have been employed in this research. The difficulty comes when attempts are made to operationalise the concept and to use this as a basis for management decisions. Research has exposed these weaknesses and suggested that an alternative approach, which defines Limits of Acceptable Change (LAC), may overcome some of these difficulties. LAC helpfully shifts the focus from “How much use is too much?” to “How much change is acceptable?”^[37]. However, this requires a reliable and well-designed environmental monitoring programme, both to establish the LAC parameters and to determine when the limits are being approached or exceeded. Despite its promise, LAC has been rarely used in the UK – the Cairngorm ski area is the notable exception^[38]. An alternative approach, such as a Sustainable Visitor Management System, which meshes well with the effective management partnerships already in place in the CCVE case studies, may be preferable (see Figure 13).

Conclusion

In exploring the relationship between climate change, visitor behaviour and environmental capacity, we are dealing with a complex system. Improved monitoring of both people and the environment is called for in the interests of effective resource management, especially in response to climate change. The ability to respond depends on adaptive capacity and requires effective partnership working at the landscape scale that engages all key stakeholders in the management process. We have been greatly impressed by the quality of partnerships already in place, as evidenced by the case studies. If these are representative for the UK, it bodes well for our ability to respond effectively to climate change.

Figure 13: The sustainable visitor management system^[38]



Preparing for change

Preparing for Change

With its detailed analysis of the interaction between climate change, visitor behaviour and environmental capacity, CCVE is the first regional project of its kind. The research findings have challenged the commonly held belief that climate change will bring automatic benefits to the regional visitor economies of the UK. Instead, it was found that there are likely to be significant implications for sustaining the environmental capacity of our valued landscapes. This has implications throughout the visitor economy, from the national level down to individual facilities, and forward planning and good management will become increasingly important.

What is clear is that there is a continuing need to understand what the impacts of climate change are likely to be in the future, and how those involved with the visitor economy can best prepare for change. The complexity of the climate change issue necessitates the involvement of a wide range of stakeholders if risks and opportunities are to be addressed. The working relationships established between the universities, public and quasi-public bodies and stakeholder communities for this project proved extremely effective and it is recommended that these relationships are replicated and promoted elsewhere.

The work has shown that a variety of measures are possible. Broadly speaking, responses can take place at three levels of scale:

AT THE REGIONAL SCALE: policy responses can be developed through the Regional Economic Strategy, the Regional Spatial Strategy and through thematic strategies and programmes linked to tourism and related sectors, such as health, transport and forestry.

AT THE LANDSCAPE SCALE: in more vulnerable countryside locations, climate change is likely to reduce the capacity of the landscape to accommodate visitor pressure. It may prove to be the case that the more effective response is not demand management but investment in both capital and revenue to protect the landscape and sustain visitor access. This will require significant resources and may, in some cases, adversely affect landscape perception.

WITHIN TOURIST FACILITIES: climate change is likely to make new demands and impose new costs rather than simply boosting visitor demand. However, some facilities are already so heavily used as to be close to or above physical and perceptual capacity. In such cases demand management is already necessary to cope with current pressures, for example, the National Trust's Beatrix Potter House in the Lake District.

Implications for policy

Due to the nature of this study, it was not possible to explore all the implications of the findings, nor provide detailed policy recommendations. However, appropriate authorities should ideally address the following discussion points, as well as explore in greater detail what the implications could mean for their organisation.

- Climate change is not considered to any great extent in current tourism-oriented policy. This research has demonstrated that the implications of climate change for the visitor economy are complex and could be highly significant, particularly for the natural resource base on which much of tourism and recreation in the region is based.
- The adverse impacts on valuable landscapes will need to be managed carefully if we are to avoid tensions between sustaining the integrity of these landscapes and continuing to allow the recreational opportunities that they provide. Findings from the study have illustrated that climate change impacts will be specific to different landscapes and therefore effective strategies need to be evidence-based where possible. It is recommended that a systematic assessment of climate change impacts in all landscape character areas be undertaken to help inform decision-making.
- Climate change will bring additional pressures to bear on land managers. If the qualities of landscapes are to be maintained, then increased resources will ultimately be needed. This may require additional investment. Innovative funding measures, such as visitor payback schemes, should be explored. Prevention, rather than waiting until problems occur, is likely to be the most cost effective response.
- The aim of regional tourism policy to encourage and increase visit levels has not been questioned by this work. However, any increase will need to be planned for and carefully managed. Marketing strategies need to consider explicitly the potential vulnerability of locations. There are opportunities to direct visitors to more robust attractions such as Regional

Park resources, which have the potential to relieve pressure on vulnerable locations whilst still adding value to the regional visitor economy.

- The impact of congestion on businesses is increasingly recognised. However, this does not appear to be the case for the visitor economy. Little consideration has been given to either the impact of recreational road transport or the impact that congestion can have on the visitor economy. Traffic problems can impact negatively on the visitor experience and the landscape. Improved public transport links are an important element of any response. It may also become necessary to consider additional mechanisms, such as road pricing, to alleviate problems in the worst affected areas.
- There are already important links between tourism/recreation and the forestry sector. Forest parks such as Delamere Forest provide a model for what can be achieved by the Community Forest projects in the Mersey Belt, and Regional Parks such as East Lancashire. Forestry can also provide a resilient visitor attraction within the highest value landscapes, for example Grizedale and Whinlatter in the Lake District National Park. The Northwest Regional Forestry Framework recognises this potential.
- Rural diversification is seen as central to reviving the rural economy. An integral part of this could be development that contributes to the visitor economy. The development of new rural tourism resources needs to consider the impacts of climate change, and the implications for water resources, infrastructure etc.
- Many of the regional landscapes that appeal to visitors are managed by agricultural practice. The integral connection between the visitor economy and the agricultural sector therefore needs to be clearly recognised. Structural change in the farm economy in response to CAP reform and other pressures has profound implications for the region's landscapes. One possible outcome in the more vulnerable locations may be reduced grazing pressure with complementary new investment in countryside management.
- There are real opportunities for closer links between the visitor economy and health agendas. Increased outdoor activity contributes to improved health, and the provision of locally accessible recreational resources close to major urban areas could contribute to a programme to improve the health of people in the region. This would also be beneficial by acting to disperse visitors more widely and hence reduce pressure on key locations.
- Climate change is likely to make our cities increasingly hot and uncomfortable in summer months. The planning, design and possibly retrofitting of city centres is therefore crucial if acceptable

levels of human comfort are to be maintained. For instance, both greenspace and water act to reduce temperatures by creating cooler microclimates within urban areas. Coincidentally, measures to adapt the city to a changing climate will also enhance the quality of the urban environment for visitors and residents alike.

- It is not just a matter of impacts and adaptation; it is also imperative that the visitor economy works towards a reduction in greenhouse gas emissions. Promotion of domestic breaks, improvements in green accreditation schemes, and the promotion of more sustainable practices are some examples of potential solutions.

Implications for the Business Sector

- The study has shown that the predicted boom in visitor numbers due to climate change is uncertain. The demand side of the visitor economy is likely to be more strongly influenced by socio-economic trends, as well as changes in how we spend our leisure time. Effective planning, management and marketing will be crucial to the development of new opportunities.
- The increased specialisation in recreational activities offers opportunities to further develop niche markets such as nature-based tourism.
- A crucial element of good planning and management will be the explicit consideration of climate change impacts (see tools developed by UKCIP^[3]). If visitors are to enjoy their experience, it is likely that the facilities will need to be upgraded to take account of a changing climate. Hotter, drier summers in particular will necessitate measures to ensure a comfortable visitor experience, such as increased shading in outdoor attractions. New buildings need to be designed to cope with high temperatures so avoiding the need for air conditioning, which contributes to CO₂ emissions^[29].
- Opportunities exist for businesses to develop innovative services that also serve visitor demand functions. For example, the provision of shuttle buses in busy localities and landscaping schemes to improve the quality and functioning of hotel premises and street cafes.
- There is a need for greater partnership working to ensure that the combined impact of climate change and visitor behaviour does not breach the carrying capacity of valuable landscapes. Where they exist, proven management mechanisms should be supported to maximise adaptive capacity. Best practice examples have been highlighted throughout the report.

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Sustainability Northwest

Sustainability Northwest (SNW) is an independent charity that works to inspire, innovate and advance the sustainability agenda for England's Northwest through a partnership ethos. Backed by both business and the public sectors SNW actively engages with all sectors to advocate the search for sustainable solutions and to promote a better quality of life for all in the region. SNW managed the CCVE project. For more information see, www.snw.org.uk.

UK Climate Impacts Programme

This is one of a number of studies conducted under the umbrella of the UK Climate Impacts Programme (UKCIP). UKCIP helps organisations assess how they might be affected by climate change, so they can prepare for its impacts. Based at the University of Oxford, UKCIP was set up by the Government in 1997 and is funded by the Department for Environment, Food and Rural Affairs (Defra). For more information, see www.ukcip.org.uk or email enquiries@ukcip.org.uk.



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