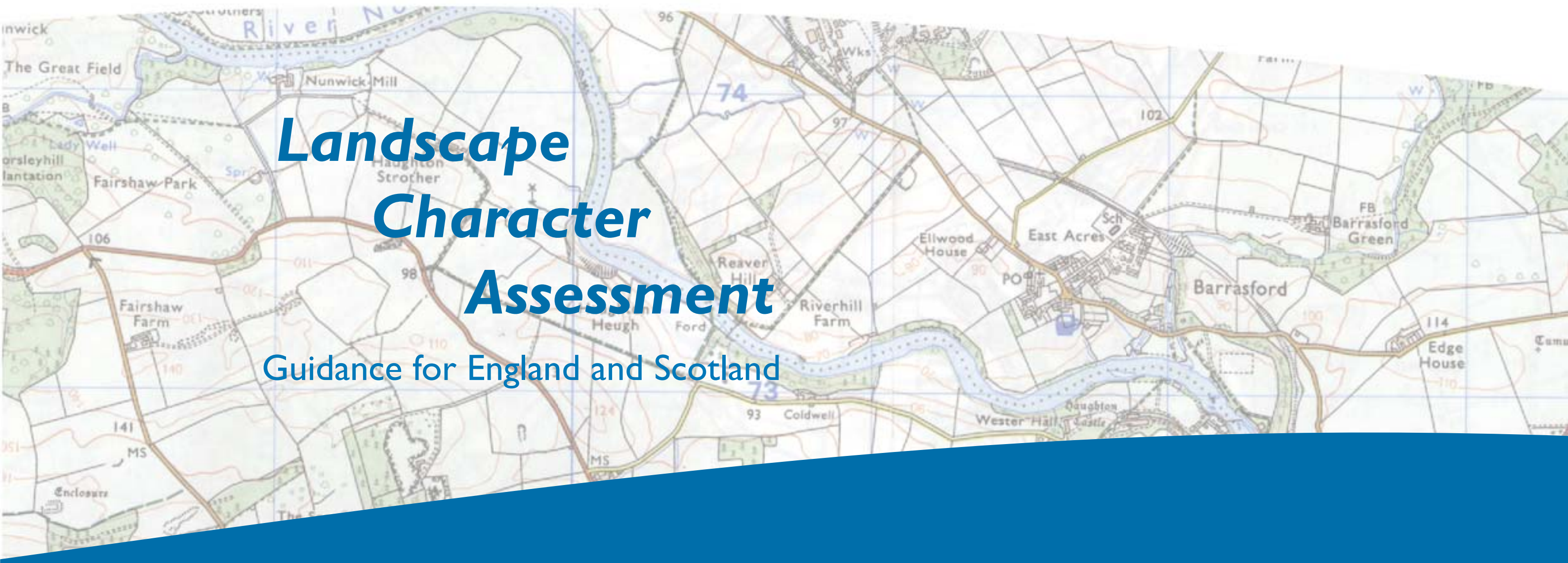
SCOTTISH NATURAL HERITAGE

The Countryside Agency



Landscape Character Assessment

Guidance for England and Scotland

TOPIC PAPER 9: Climate change and natural forces - the consequences for landscape character

A paper outlining how Landscape Character Assessment can be used as a tool for responding to potential climate change effects on landscape character

INTRODUCTION AND BACKGROUND

Introduction

"Evidence is growing that the UK climate is warming and we expect this trend to continue. Adaptation will be an essential part of the response to the threat of climate change" [1] .

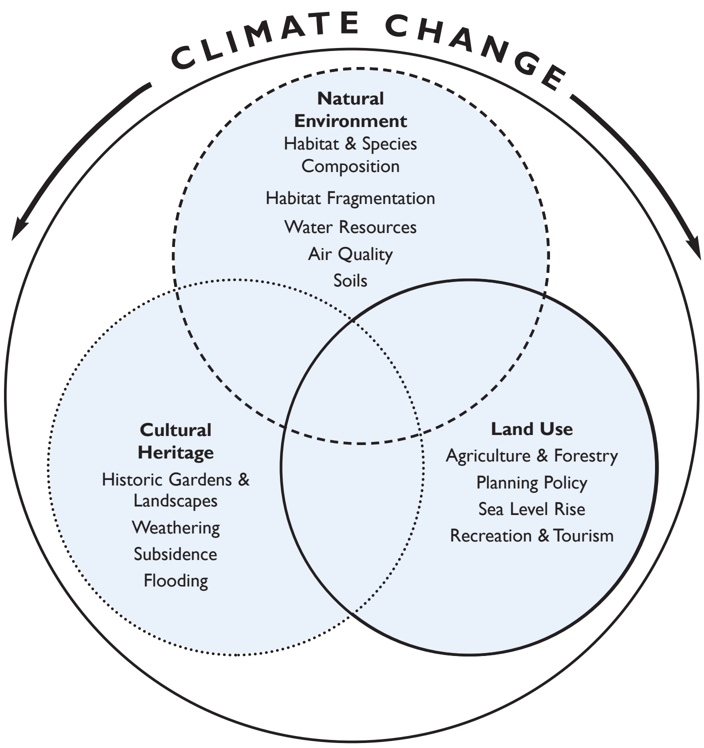
1. Climate change has led to increased temperatures and wetter winters. Additionally, sea levels have risen and extreme weather events, such as heavy rainfall and high temperatures, are occurring more frequently. Climate changes could, directly or indirectly, lead to changes in landscape character. Direct impacts of climate change on landscape character include flooding events, longer growing seasons or low river flows. Although climate change impacts such as increased summer temperatures may not influence landscape character directly, there could be downstream effects on landscape components such as agricultural land use. In some cases the resultant change in landscape will be dramatic such as the loss of whole landscapes through rising sea levels, whilst in other cases the change will be more subtle and gradual.

2. This paper examines possible landscape change over the next century, in step with current models of climate change, identifying where adaptation could be necessary. As such it recognises that within this timeframe, the most effective and fundamental means of managing the interaction between climate change and landscape change is at a higher level, through managing and reducing the carbon dioxide emissions that contribute to climate change i.e. mitigation.

3. Within landscape character the component attributes of the landscape are shaped, to varying degrees, by climatic conditions. Climate influences both natural (for example vegetation and land use patterns, associations of species and habitats) and cultural (for instance the siting and style of settlement) landscape attributes. As such it is important for Landscape Character Assessment practitioners and users to understand the potential effects of climate change on landscape character.

4. Following Landscape Character Assessment Guidance [2], the term landscape is interpreted as the interaction of natural (geology, soils, climate, fauna and flora) and cultural (historic and current impact of land use, settlement, enclosure and other interventions) factors. Climate change will affect the natural environment, land use and cultural heritage aspects of landscape character. The principal variables are set out in **Figure 1**, with the themes identified interacting with one another to greater or lesser degrees (for instance sea level rise may impact upon all three landscape components).

Figure 1: Climate Change: Principal Impact Themes in Respect of the Natural Environment, Land Use and Cultural Heritage



5. The degree to which climate change will impact on the components of landscape will vary as will the rate at which the impact will occur. For example changes in habitat and species composition could occur over the long term in comparison to changes in water resources, which will impact the landscape relatively quickly.

6. Potential impacts on the natural environment component of landscape character cover changes in existing habitat and species composition. Water resources, atmospheric quality and soils, key natural components of the landscape, could also alter as a result of climate change. For example habitats such as raised bogs, may be affected by changes in water availability. Land-use changes could be subtle and be the result of myriad individual land management decisions at the local scale. Agriculture and forestry will be most affected but equally the response of land use planning policies, for instance through a presumption against building on flood risk areas, could affect landscape character. Although planning policy may be impacted upon it should be noted that planning policy can be used as a potential mitigation/adaptation process. The cultural heritage, typified by historic buildings and archaeological sites, is fundamental to landscape character and particularly vulnerable to the effects of climate change. The impacts on ancient landscape features such as field patterns or ridge and furrow, could well be significant but subtle and the result of other changes such as land use. Key impacts on the cultural component could involve historic landscapes and gardens, weathering, subsidence and flooding.

7. Changes in climate and extreme events could combine to affect landscape character in all its physical and cultural facets. By anticipating climate change, and understanding the potential impact upon landscape character, suitable planning and management practices could, where appropriate, be adopted.

8. It is recognised that climate change may be incorporated into the Landscape Character Assessment process at various stages. Within Stage 1 "Characterisation" forces for change pertinent to a specific landscape are identified. Climate change impacts such as rising sea levels may be identified as a 'force for change' within a coastal landscape. Within Stage 2 "Making Judgements" further work could allow the possible effects of climate change impacts on landscapes to be identified. For instance a consequence of a rise in sea level is the loss of coastal marshes. It is at this stage that informed judgements may be made on whether or not intervention is required to mitigate the potential effect. Subsequently the preparation of landscape guidelines could consider the potential effects, good or bad, of climate change impacts on landscape character and the need for any appropriate planning and management measures (see UKCIP [May 2003] *Risk, Uncertainty and Decision Making* at www.ukcip.org.uk).

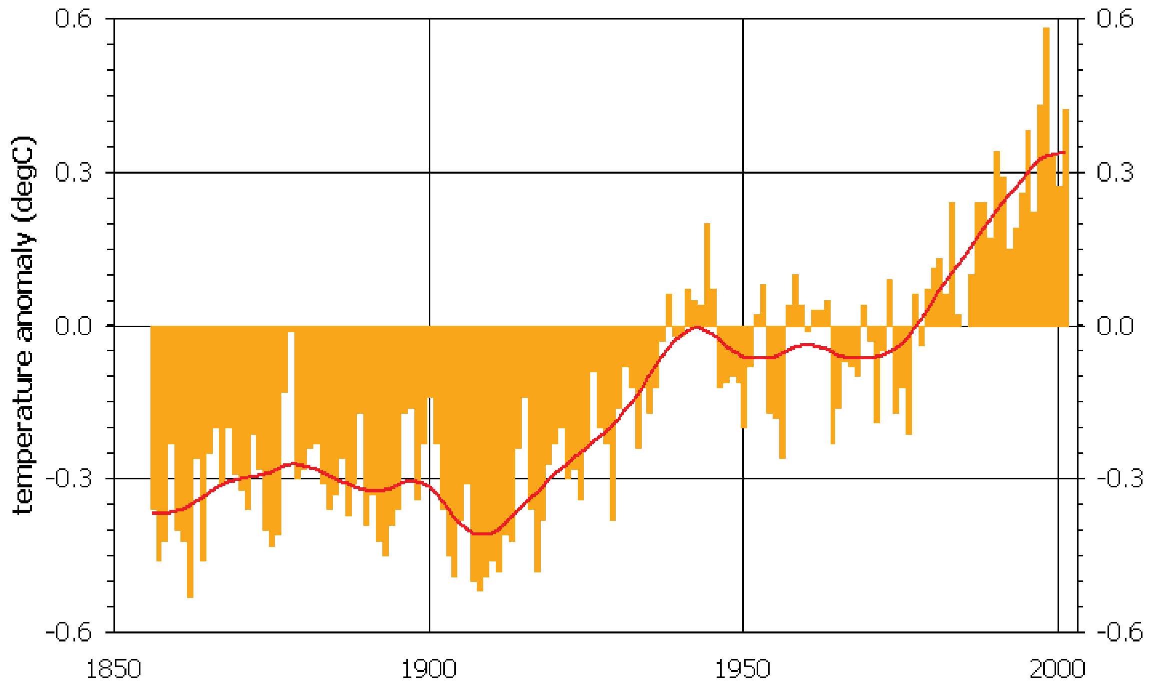
9. The potential effects of climate change upon landscape and its component features have begun to be addressed in a variety of ways. Responses to date have looked at ways to avoid or reduce the possible effects of climate change (i.e. mitigation) and how we may come to utilise the new conditions (i.e. adaptation). The potential effects upon landscape of flooding in urban areas, for example, has in some locations been mitigated through the provision of flood defences. In some cases the possible effect of climate change on landscape has been accepted i.e. the loss of coastal marshes. However such effects can be compensated for elsewhere, for instance through the provision of wetlands further inland. In other cases responses have focused on adaptation such as the planting of drought tolerant tree species in order to maintain characteristic tree cover. The viability and suitability of techniques used to address climate change depend on environmental, economic and social considerations.

10. This Topic Paper outlines the evidence which has been gathered to demonstrate how climate is changing and is likely to change, identifying those variables particularly relevant to the study of landscape. It identifies some of the key impacts on landscape which could possibly occur, suggests how the issue might be incorporated into Landscape Character Assessment and offers suggestions as to how climate change impacts might be responded to in terms of mitigation and adaptation.

OUR CLIMATE IS ALREADY CHANGING

11. Global temperature has risen by about 0.6°C over the last 100 years and 1998 was the single warmest year in the 142 year global instrumental record [3]. Hot summer days with temperatures exceeding 25°C, like the hot summer of 1995, have become more common. The thermal growing season for plants in central England has lengthened by about one month since 1900. **Figure 2** shows the observed increase in temperatures globally.

Figure 2: Observed increase in global-average surface air temperature (1860 to 2001).
These temperatures are a combination of surface air temperatures over land and sea-surface temperature over oceans. Individual bars show annual values as deviations from 1961-1990 average. The curve emphasises variations over timescales of at least 30 years. This data set is maintained by the UK's Metereological Office's Hadley Centre and the Climatic Research Unit at the University of East Anglia and has been used in all Intergovernmental Panel on Climate Change assessments.



12. UK winters have also been getting wetter, with more frequent heavy downpours. Again recent evidence seems to supports these observations. For example, late 2002 and early 2003 saw a series of floods across the southern half of the country.

13. The average rate of sea level rise around the UK coastline during the last century, allowing for natural land movements, has been about 1mm per year. After adjusting for natural land movements, average sea level around the UK is now about 10cm higher than it was in 1900.

14. Climate changes occur naturally but the Inter-Governmental Panel on Climate Change (IPCC) states that "*...most of the warming observed over the last 50 years is likely to have been due to increasing concentrations of greenhouse gases*" [1]. Confirmation of this is obtained when observed trends are simulated using climate models. Only when human induced and natural patterns of change are combined does the model show close correlation with the climate record.

WHAT FURTHER CHANGES COULD THERE BE?

Climate Change Scenarios

15. In order to understand how our climate may change in the future, large scale computer models are run using different levels of greenhouse gas (GHG) emissions. The different levels of GHG emissions are based on a range of socio-economic scenarios including different rates of economic and population growth, consumption patterns, technological development and approaches to regulation of emissions. **Table 1** illustrates the link between the different emissions scenarios, concentrations of CO_2 in the atmosphere and potential temperature rise. In 2002, the

UK Climate Impacts Programme (UKCIP) produced scenarios of climate change based on outputs from the Hadley Centre's climate models.

Table 1: Levels in atmospheric CO_2 concentrations and temperature difference from present for the 2080s period (2071-2100 average) for different emissions scenarios.

UKCIP02 climate change scenario	Increase in global temperature, °C	Atmospheric concentration of CO_2, Parts per million
Low Emissions	2.0	525
Medium-Low Emissions	2.3	562
Medium High Emissions	3.3	715
High Emissions	3.9	810

16. The UKCIP scenarios are related to the scenarios used by the IPCC. Pre-industrial CO_2 concentrations were about 280 ppm, and were 370 ppm by 2001.

17. Due to the nature of climate modelling (moving from global to regional resolution) and the computing resources required, the outputs used for the UKCIP02 scenarios represent the average temperature over a slice of time i.e. a 30 year period. Hence the 2080s referred to in the scenarios represents the average conditions between 2071 and 2100, with the 2080s as the midpoint. Given the long term uncertainties of climate modelling, this level of detail is adequate for future planning.

Model Resolution

18. There are a number of different spatial levels at which climate models operate:
- Global - coarse resolution e.g. HadCM3;
- Global - high resolution e.g. HadAM3H; and
- Regional e.g. HadRM3.

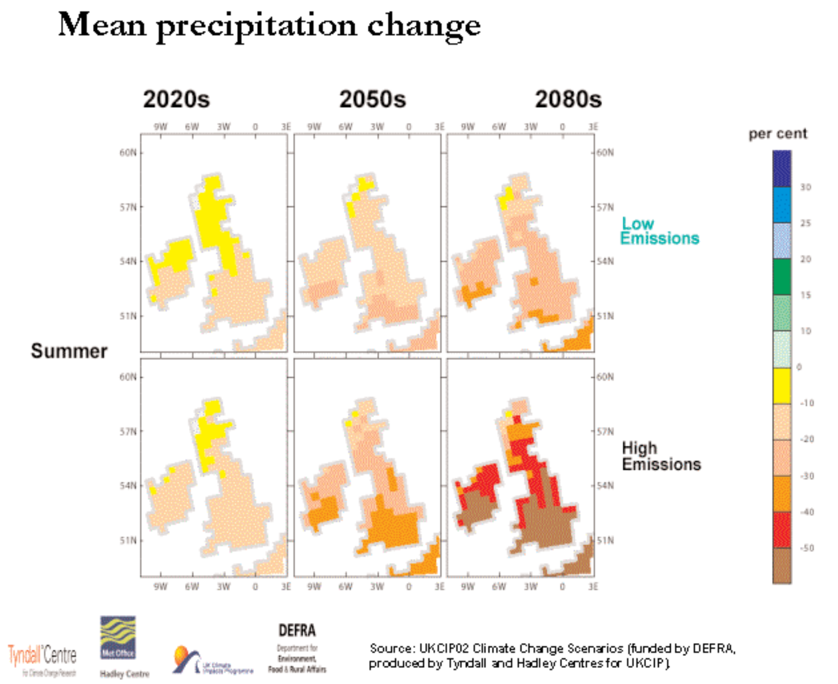
19. These all require different levels of computing power and produce outputs with various resolution. The coupled ocean-atmospheric model HadCM3 produces patterns of climate change across the whole surface of the earth at a relatively coarse level i.e. between 250-300km grid boxes that cover the UK. As a consequence of its low resolution, whilst most descriptions are adequate for most purposes, some aspects of the climate are not described as well as they could be. In order to obtain a higher resolution for the UKCIP02 scenarios, the outputs from HadCM3 experiments provided the boundary conditions for a higher resolution (about 120km grids) global atmosphere model (HadAM3H). The outputs from this model then provided the boundary conditions to drive the high resolution (about 50km grids) regional model of the European climate (HadRM3). This approach improves the quality of the simulation of the European climate.

20. Further levels of detail can be obtained by using downscaling techniques: either dynamical or statistical. Dynamical downscaling is how the 50km grid resolution was achieved for UKCIP02 scenarios i.e. using a low resolution model to drive a higher resolution model - see above. Statistical downscaling (SDS) uses relationships calibrated from observations to infer relationships between global circulation model (GCM) outputs and local climate. Statistical downscaling is useful for higher resolution applications e.g. less than 50km grids, that may be useful for site specific assessments. However, like other climate models, they do not produce a single prediction and can produce results that vary from the lower resolution models. This could be useful for policy makers as it produces a range of scenarios to consider for strategy and planning purposes. Also, there are uncertainties associated with SDS and more research needs to be done to reduce these.

Possible Future Climate Changes - The Headlines

21. The following precipitation and temperature figures present the results of the models for the low and high emissions scenarios for the 2020s. 2050s and 2080s, on a map of the UK as represented by the 50km grid boxes from climate models.

Figure 3: Modelled summer (June, July and August) average temperature changes for 2020s, 2050s and 2080s for low and high emissions scenarios



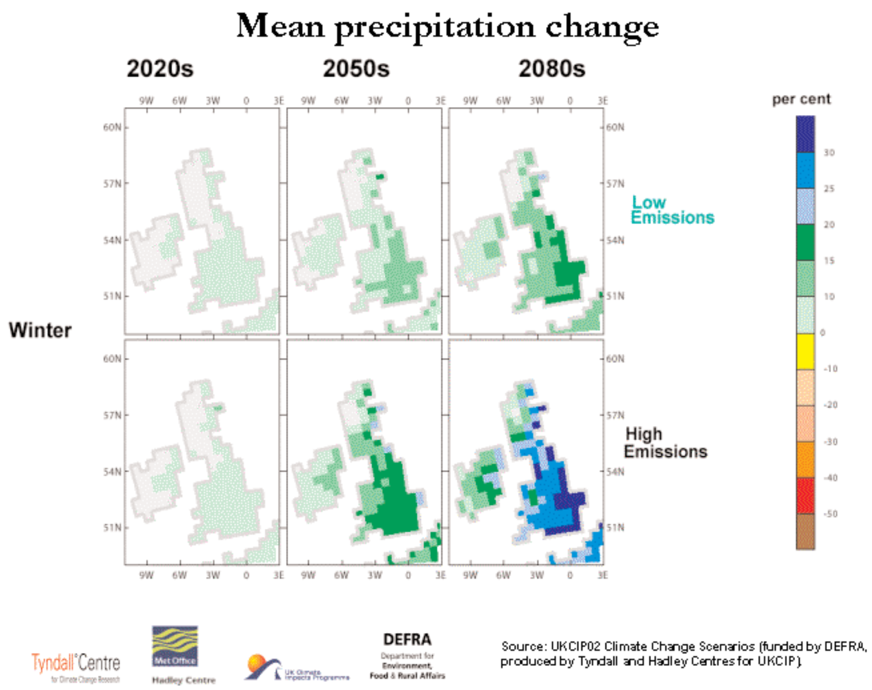
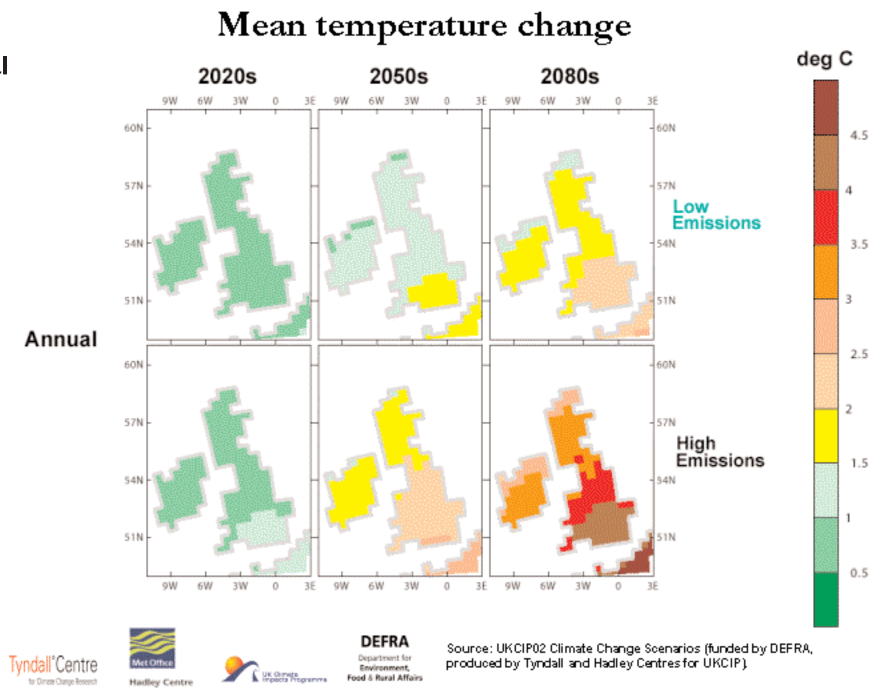


Figure 4: Modelled winter (December, January and February) average temperature changes for 2020s, 2050s and 2080s for low and high emissions scenarios

Figure 5: Modelled annual average temperature changes for 2020s, 2050s and 2080s for low and high emissions scenarios.



22. In summary, **Figures 3 and 4** show, for some regions and scenarios, winters will be up to 30% wetter and summers will be up to 50% drier by the 2080s. **Figure 5** shows an annual warming by the 2080s of between 1° and 5°C depending on region and scenario. Greater warming will occur within summer and autumn rather than winter and spring, with summer warming being greater in the southeast than the northwest.

23. A summary of potential climate changes derived from the UKCIP02 scientific report is provided in **Table 2**.

Table 2: Potential climate changes

Climate Variable	**Potential Change**
Temperature	Annual warming by the 2080s of between 1° and 5°C depending on region and scenario Greater summer warming in the southeast than the northwest Years as warm as 1999 become more common Number of very hot days increases, especially in summer and autumn Number of cold days decreases, especially in winter Thermal growing season increases everywhere, with largest increases in the southeast Soil moisture decreases in summer and autumn in the southeast but increases in winter and spring in the northwest More frequent stagnant summer anticyclones in southeast
Precipitation	Generally wetter winters for the whole of the UK Precipitation intensity increases in the winter Total snowfalls decrease significantly everywhere Greater contrast between summer (drier) and winter (wetter) precipitation

Cloud cover	Reduction in summer and autumn cloud, especially in the south, and an increase in radiation Small increase in winter cloud cover
Storm tracks	Winter depressions become more frequent, including the deepest ones
Humidity	Specific humidity increases throughout year [4] Relative humidity decreases in summer [5]
Sea level	By the 2080s, sea level will be between 26 and 86cm above current level in southeast For some east coast locations, extreme sea levels could occur between 10 and 20 times more frequently by the 2080s

What does this mean?

24. It is useful to use recent examples of extreme seasonal conditions to illustrate what the climate may be like in the future. **Table 3** presents some climate analogues to illustrate the potential changes. It shows that the occurrence of extremes could grow over the coming decades.

Table 3: Percentage of years experiencing various extreme seasonal anomalies across central England and Wales for the Medium-High Emissions scenarios. The anomalies are shown relative to the average 1961-1990 climate.

	Anomaly	**2020**	**2050**	**2080**
Mean Temperature				
A hot '1995 type' August	3.4°C warmer	1	20	63
A warm '1999 type' year	1.2°C warmer	28	73	100
Precipitation				
A dry '1995 type' summer	37% drier	10	29	50

CONFIDENCE

25. In the scientific report for the UKCIP02 scenarios a number of expert judgements made by the authors were based on their understanding of the physical reasons for the changes, consistency between climate models and the statistical significance of the results. These are relative rather than absolute judgements but the changes for which there is high confidence are provided below (**Box 1**).

Box 1: Confidence in Climate Change

Areas of climate change identified by UKCIP which have a high confidence rating are as follows;

- 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

UNCERTAINTIES

26. Although our understanding of potential climate change is improving, along with the models used to support this, there are still a number of areas of uncertainty.

27. It is not known which of the emissions scenarios will be nearest to the actual future emissions. The actual emissions could even lie outside the range of emissions modeled. The climate models include interactions between oceans, atmosphere and land. There is a version of the Hadley Centre model which includes the interaction between the carbon cycle and climate. This model hasn't been used for the UKCIP02 scenarios as it is only a recent development. There are also reactions between atmospheric chemicals as climate changes. The net effect of these two feedbacks would likely be a larger warming of the UK climate. The Hadley Centre global model has been developed over many years and has been extensively validated. However, other models have been used in the IPCC assessments and there is no easy way to attach higher or lower confidence to the results of the various models. A brief comparison is presented in the UKCIP02 scientific report.

28. Although it is important to consider natural variability in impacts and adaptation studies, it cannot be predicted over long time scales. Consideration of the effect of natural variability is presented in the UKCIP02 scientific report.

29. The Gulf Stream is a current of warm water that keeps northwest Europe warmer than locations on similar latitudes. It is part of a larger ocean circulation system and is driven by differences in water density caused by temperature and salinity. A shut down of the Gulf Stream in the future is not predicted by any climate model, although most show it weakening. A cooling of the UK climate due to changes in the Gulf Stream over the next 100 years is considered unlikely.

THE POTENTIAL IMPACTS OF CLIMATE CHANGE ON LANDSCAPE CHARACTER

Introduction

30. Landscape, as a physical entity, is a blend of natural and cultural elements and influences, informed by local geography and history. The particular way in which these elements interact and how they are perceived by us define landscape character and stimulate human interest and value in terms of biodiversity, historical resonance, identity, enjoyment, inspiration and economic value. Climate influence, along with geology, soils, landform and biota is a key defining variable of the physical character of landscape, and as such the impacts of changes in climate are likely to be complex and subtle.

31. It is important to recognise that perceptual and aesthetic characteristics of landscapes may also be affected by climate change. For example, characteristic landscapes such as snow-capped mountains in the Scottish highlands may change, whilst increased cloud cover and poor air quality may influence visibility into, out of and within landscapes. Changes in landscape character as a result of climate change could prompt shifts in perceptions and preferences for certain landscapes. This raises the issue of which landscapes are valued, on what basis and by whom. Three principal dimensions of landscape character - the natural environment, land use and cultural heritage - are used here to identify the potential impacts of climate change. The precise manifestations at a local level, the cumulative effects and particular human responses are complex and thus very difficult to predict.

32. Within this paper no attempt has been made to judge whether these impacts might have a net positive or negative gain, noting that the significance of individual impacts and their cumulative effects upon landscape character will differ from one landscape to the next dependent upon a given landscape's individual characteristics. It is important to stress that "landscape" is not a physical objective concept; it is defined to a large extent by peoples' perceptions, and these may differ widely among different stakeholders. This in turn requires that a broad range of stakeholder views (not all in harmony) should be considered in seeking the "best" solutions.

The Impacts of Climate Change on the Natural Environment

33. One of the key indicators of whether and how fast climate change is occurring is the observed response of flora and fauna to changes in temperature and hydrological balance. Potential impacts on landscape character include:

changes in habitat and species composition; the fragmentation of habitats; changes in water resources; and changes in air quality and soils.

Habitat and Species Composition

34. The MONARCH Study (Phase 1) investigated the potential impacts of climate change in Britain and Ireland on a range of species and habitats [6]. Continued work (Phase 2) will provide a detailed understanding of impacts on ecosystem processes. The following is a summary of the potential impact of climate change on habitat and species composition.

35. Habitats and species compositions could alter in response to climate change. There may be an northward/uphill movement of species/habitats including managed grasslands. Raised bogs, montane habitats, soft coastal habitats and chalk rivers are particularly sensitive to the loss of suitable climatic conditions. Extinction of Scottish mountain species may even occur. Other habitats vulnerable to significant changes in species distributions and community composition are native pinewoods, calcareous grasslands and mesotrophic lakes. Soft coastal habitats (supra littoral sediments) are vulnerable to changes in coastal defences developed in response to climate change [7]. Additionally as spring is now earlier woodland, pastoral and arable landscapes will possibly experience earlier greening.

36. Loss of species for which a particular area was protected may affect protected habitats which in turn may challenge existing management techniques. Conversely new species, for example the northward migration of species from France to the south coast of England, and their associated habitats, could emerge as a result of different climatic conditions hence influencing conservation policy and practice.

37. Extreme events such as flash floods may lead to the increased erosion of upland soils whilst prolonged summer droughts could leave heathland habitats vulnerable to fire.

38. It should be noted that changes in habitats and species are unlikely to be readily apparent in the landscape in the near future. This is because for many species migration/movement will be at a slower rate than the rate of climate change. Also species, in particular trees, will remain in situ even though their regeneration may be prevented.

Habitat Fragmentation

39. Severe weather events, such as the storms of 1987 and 1990, led to significant loss of individual, often mature hedgerow trees. An increase in such events, although there is a low confidence level in this area, combined with increased temperatures and more variable rainfall patterns (leading to water shortages), could contribute to the loss of woodland associations such as beech woodlands within the Chilterns [8]. Additionally existing habitat fragmentation may prevent species expanding or contracting their range resulting in further habitat fragmentation and possible species/habitat losses.

Water Resources

40. Water resources may be effected by climate change. Drier summers may lead to reductions in groundwater levels. This, exacerbated by demands for irrigation [9], could reduce water availability during summer months. Furthermore, the expected decrease in summer rainfall could result in less water being available to dilute pollutants affecting water quality. This may be exacerbated by the increased leaching of pollutants in periods of heavy rainfall. Areas that experience flooding may increase and expand as a result of both seasonal changes in precipitation (with extra precipitation likely in the winter months) and more regular, extreme weather events. Extreme weather events may also lead to increased turbidity resulting in a decline of water quality.

Soil Quality

41. Soils could be affected by climate change in a number of ways. Changes in soil could affect landscapes as soil attributes are often fundamental to landscape character determining habitats/species compositions and influencing land uses.

42. Changes in soil moisture, which could affect the type of flora supported, are dependent on changes in precipitation, temperature, evaporation, wind speed and radiation. Different soil types could experience a range of impacts. Poorly drained, heavy clay soils could be subject to increased flooding during the winter and increased rainfall intensity. Conversely during dry, hot spells, soils could dry out, leading to increased risk of subsidence. Hot, dry spells could also lead to soil desiccation and increased risk of erosion. This would be exacerbated if followed by intense rainfall. At present, soils act as a carbon sink - they absorb more carbon dioxide than they emit. However, soil microbial activity could increase due to higher temperature and this could result in more carbon dioxide being emitted to atmosphere. Results from the Hadley Centre's model of climate change and the carbon cycle show that by the middle of the century, soils worldwide would emit more carbon dioxide than they absorb. The resultant effect of these changes could be to further increase average global temperatures in the future.

43. Climate change could alter air quality with an increased incidence of pollution haze, linked with higher summer temperatures and atmospheric pollutants. This in turn could affect flora and fauna.

The Impacts of Climate Change on Land Use

44. Land use, as the physical expression of human influence on the land, will need to respond in tandem to the impacts on the natural environment. Many changes are likely to be subtle and be the result of myriad individual land management decisions at the local scale. Agriculture and forestry will be most affected but equally the response of land use planning policies could well be influential on landscape character.

Agriculture & Forestry

45. Climate change impacts could affect the area of land utilised for agriculture and forestry and the crops directly. Agricultural land may diminish. Rising sea levels could result in saline intrusion into prime agricultural land (half of the UK's Grade 1 land is <5m AOD) [10]. One possible response is that the use of land for current agricultural purposes may need to be reviewed in marginal areas and alternative agricultural or other uses sought. For example agricultural land susceptible to flooding could potential provide flood water storage. Also land currently seen as unsuitable for agriculture, such as moorland, may become increasingly favoured as soils conditions and climate alter across regions. Impacts on land use and forestry are summarised (**Box 2**). Whilst higher CO_2 levels, higher temperatures and a longer growing season could benefit agriculture and forestry, reduced water availability, increased flooding and extreme events could have negative impacts.

Box 2: Land Use and Forestry

Land use affects carbon stocks. Expanding forest areas and allowing agricultural land to revert to a more natural state will cause carbon stocks to increase. On the other hand, cultivating moorland for agricultural, forestry or urban use will result in the decay of organic matter and CO_2 will be emitted.

Over the last 50 years, there has been a considerable expansion in forest cover in the UK. More broadleaf trees have been planted during the last 10 years. A computer model using data on planting from 1920 onwards shows that the overall carbon uptake of Scotland is about 40 per cent of the UK total and that the uptake from woody biomass in Scotland represents around 60 per cent of the UK total.

Land use statistics show an increase in forestry generally, and a difference in balance in land use between England/Wales and Scotland. England and Wales have a higher proportion of land used for farming while Scotland has a higher proportion of natural land. Land use change will have the greatest impact in terms of carbon for peaty soils, and this will particularly affect Scotland where peatlands are common.

The effects of land use change are still a big unknown and have not been fully built into the climate change strategy process. However, around 75 per cent of the removal of carbon in the UK due to uptake of new forest planted since 1990 is estimated to be in Scotland. A sensible programme is needed to increase forest expansion. To reduce emissions from soils, it will be necessary to encourage better soil management and allow land to revert back to a sustainable, natural situation. We also need to be able to track land use and to consider how land use change fits into other mechanisms for reducing CO_2 emissions.

Source: www.sussex.ac.uk/Units/gec/pubs/reps/scotrep.htm
Taken from a spoken presentation by Dr R. Milne Centre for Ecology and Hydrology.

46. Crops may change in response to changes in soil moisture with shifts towards drought tolerant crops. New crops such as short rotation coppice may be introduced as a response to opportunities for carbon-neutral power generation. Additionally tillage practises may change as a result of different climatic conditions. Increased frequency and intensity of new and existing pests and diseases may lead to the demise of certain crops. There could be increased pressure for increased on farm water storage. Extreme weather events may also impact upon crops and forests. Extreme drought conditions may lead to increased frequency of fire damaging forests and crops alike. Wetter winters are expected to restrict the use of land by animals and machinery.

Land Use Planning Policies

47. In responding to the impact of climate changes (such as through a presumption against building on flood risk areas), the impact of new policies on landscape character, such as in the location and design of new development, will need to be taken into account in developing and implementing land use plans. Other potential changes in land use planning policy includes the development of sustainable drainage systems and the allocation of land specifically for this purpose. Such shifts in planning policy reflects a broad shift from prohibitive planning towards more positive planning.

Sea Level Rise

48. The coastal 'squeeze' of natural habitats between sea and landward pressures due to rising sea levels, could affect 60,000ha of mudflats, salt marshes and beaches [11]. Increased coastal erosion and incursion could also occur with increasing sea levels. Erosion rates in parts of eastern England and along the South coast are likely to increase up to three times the current rate of retreat [12]. An illustration of the potential impacts of climate change on a coastal landscape is provided (**Box 3**).

Box 3: Hampshire Coastal Landscape at Risk

Hampshire's low-lying coastal landscapes are likely to be increasingly at risk from rises in sea level and more frequent storm surges which may overtop some existing sea and tidal defences. The Environment Agency has undertaken research to establish which areas are likely to be vulnerable. The shingle bank at Hurst Spit, which acts as a barrier protecting the western approach to the Solent and the Keyhaven saltmarshes, needed extensive reinforcement and restoration after severe storm damage during the 1990s. The soft coastal cliffs at Milford and Barton on Sea are also at risk from erosion as are those at Chilling. The County's internationally important coastal wetland landscapes, and their valuable wildlife habitats such as mudflats and saltmarshes are likely to be 'squeezed' between existing sea defences and rising sea water levels.

Recreation & Tourism

49. Favourable weather conditions such as warmer summers could encourage various outdoor pursuits and interests. The impacts of increasingly outdoor lifestyles might be centred on already pressured areas such National Parks/Areas of Outstanding Natural Beauty/National Scenic Areas due to their good public access provision. This could result in increased pressures such as congestion (which in turn may lead to demands for more transport infrastructure) and erosion.

50. There could also be negative impacts on snow-reliant pursuits such as skiing and snowboarding, on tourism on remote areas/islands affected by increased ferry cancellations due to the increased occurrence of extreme weather events, and on the opportunities for wildlife watching as an outdoor pursuit and tourism attraction. As summers become drier, visitor access to uplands, heaths and forests may be restricted to reduce the risk of fire resulting in increased visitor pressures elsewhere. Also poor visibility due to smog and haze may discourage the use of some recreational areas with popular vistas.

The Impacts of Climate Change on Cultural Heritage

51. Cultural heritage, typified by historic buildings and archaeological sites, is fundamental to landscape character and particularly vulnerable to the effects of climate change. The impacts on ancient landscape features such as field patterns or ridge and furrow, could well be significant but subtle and the result of other changes such as land use. Key impacts could possibly centre on historic landscapes and gardens, weathering, subsidence and flooding.

Historic Landscapes and Heritage Gardens

52. Historic landscapes and heritage gardens could be affected by climate change for example through the threat to the survival of their component attributes and increased visitor pressures. In addition, several adaptation options are closed off because of "heritage" status, for example, it may not be possible to flood-proof an old property without drastically changing it - here external protection has to suffice.

53. Damage to archaeological sites through soil desiccation and changing farming practices could subsequently affect the integrity of historic landscapes. Within historic gardens the maintenance of specimen plants and fine grass swards may not be viable within new climatic conditions (**Box 4**).

Box 4: Sheffield Park Garden, East Sussex

Like many historic gardens, Sheffield Park Garden is a living work of art, a Grade I listed garden, laid out in the 18th century by Capability Brown and further developed in the early 20th century by Arthur Soames, who introduced an exciting collection of rare and unusual trees and shrubs.

Milder, wetter winters and drier summers have produced changing climatic conditions throughout the South East and the garden has fallen victim of both these weather extremes. Early leaf emergence combined with late frosts and declining summer rainfall have all had a negative effect on the garden. This has exacerbated the continuing impact of the 1987 hurricane, which wreaked massive damage at Sheffield Park. A total of 2,213 trees and shrubs were left dead or seriously damaged after the storm, a quarter of the garden's planting. The autumn storms of 1990 brought further losses. The continuing damage may not be highly visible but weakened root systems which then failed to cope with subsequent years' droughts, has led to a further reduction in the tree canopy with further losses triggered by pests and diseases.

The challenge today is in identifying what practical measures have to be taken to ensure the garden's future - an issue that was not a consideration a decade ago. A major new planting initiative offers the best chance of survival for this heavily wooded landscape in a changing climate. The planting programme at Sheffield Park Garden begins this autumn and over the next five years 9,000 trees and shrubs will be planted.

Planting like for like will not result in the garden's survival in a changing climate. Measures designed to minimise or adapt to the impact of climate change such as ground and soil preparation, planting techniques and timing, watering, pest control and plant physiology will all be monitored and recorded.

A carefully selected mix of coniferous and deciduous trees have been chosen, not only to reflect the historical plant collections at Sheffield Park but also to compare how each species fares in different environments. This scale of planting, breadth of species and their genetic variations, plus diversity of conditions will provide an unrivalled environment for study.

The first year's replanting will concentrate on re-establishing a major shelter belt in the north east corner of the garden and will afford vital protection from prevailing winds. A comprehensive land drainage system will also be reinstated ahead of each phase of planting. This will help to ensure the effective capture and distribution of the rain and alleviate the effects of flooding and root waterlog.

Source: www.nationaltrust.org.uk/environment/html/gardens/papers/climate02.htm

54. The impact of visitors, on historic gardens in particular, may increase as individuals take advantage of 'good' weather conditions or extended opening seasons. Equally, the presence of visitors to such gardens shortly after or during periods of high precipitation may lead to grass damage.

Weathering
55. Weathering may increase gradually over time or dramatically as a result of an extreme climate event. Increased decay of building fabric over time through climate conditions such as driving rain or increased solar radiation may occur. Such factors may compromise the durability of vernacular building materials [13], shortening building life expectancies. Catastrophic damage may occur as a result of increased incidence of extreme events such as flooding.

Subsidence
56. Effects of desiccation of foundations due to changes in soil moisture and drier summers may affect historic buildings which are often built on timber piles or rafts. Consequently building may suffer subsidence which can be difficult and costly to manage.

Flooding
57. Both riverine and coastal flooding could increase as a consequence of climate change. Recently the severe damage caused to buildings within towns located in the Vale of York illustrates how our cultural heritage may be affected by riverine flooding. Sea level rise impacts may lead to the flooding of historic coastal landscapes and sites.

Conclusions
58. The above analysis has identified some of the impacts of climate change on landscape, these being complex in character, often closely interrelated and varying over time and space. At local, landscape, regional and national scales climate change impacts could be primary, secondary and tertiary in nature.

- **Primary impacts**: these are direct influences on the physical landscape such as changes in habitats and species, erosion rates and changes in appearance such as an absence of snow cover.
- **Secondary impacts**: these relate to downstream effects, perhaps the result of longer term adaptation by species and human responses such as changes in farming patterns, for example a shift uphill of managed grassland.
- **Tertiary impacts**: these emerge as a result of wider changes in human behaviour to challenges and opportunities posed by climate change. Revised planning policy in flood zones or the construction (or abandon ment) of sea defences are examples of this kind of impact on landscape. Such changes brought about through mitigation actions are often not considered alongside more direct climate change impacts.

59. Identifying which elements of landscapes will be subject to primary, secondary or tertiary impacts is an issue which demands further detailed study.

INCORPORATING CLIMATE CHANGE INTO LANDSCAPE CHARACTER ASSESSMENT

Climate Change within Existing Landscape Character Assessments

60. Climate change may be, and has been, incorporated into the Landscape Character Assessment process within Stage 1 "Characterisation". Some assessments recognise climate change as a 'force for change' that may affect the landscape in the future. In the Solway Coast AONB Landscape Character Assessment the main prospects for change includes 'the possible effects of sea level rise, including the need to improve flood defences and the consequent pressures on the coastal margin' [14].

61. Further work can allow the likely effects of climate change impacts on landscape to be identified. The Hampshire Landscape Strategy [15], looks at the possible impacts of climate change on the landscape for the County as a whole whilst the Chilterns Landscape report [16] (**Box 5**), looks at the influence of climate change on specific landscape attributes such as beech woodlands and chalk streams.

Box 5: The Influence of Climate Change on the Chilterns Landscape

A number of winterbournes have sections in their upper reaches that normally dry out naturally in the summer, but in recent years there has not even been winter flow in these sections … caused by a combination of water abstraction and recent drought.

The years of low rainfall in the late 1980s and early 1990s have had an impact on trees as well as streams. Drought leads to reductions in both the growth rate and crown density of beech and experience in the Chilterns area suggests mortality also occurs. Further years of drought could therefore hasten the decline of the Chilterns beech woods, and might also affect other trees and habitats such as chalk grassland. However, predictions of the climate change resulting from global warming are not yet sufficiently well developed to know whether the rainfall pattern of recent years is part of a longer term trend.

Source: Countryside Commission (1992)

62. The Lancashire Landscape Strategy [17] dealt with climate change issues under 'Forces for Change' and looked broadly at the possible influence of climate change on the landscape of Lancashire in the future (**Box 6**).

Box 6: Consideration of Climate Change Issues in the Lancashire Landscape Strategy

In Lancashire the coastal zone will be subject to increasing risk of tidal inundation from a combination of high tides, tidal surges and high waves in the Irish Sea. Much of Lancashire has a low lying coastline which is already at risk from flooding. Increased wind speeds may also threaten coastal copses. Lancashire's existing coastal defences do not take account of climate change induced wave height and the frequency of tidal surges. The loss of mudflats and salt marshes would have major impact on the internationally significant bird feeding grounds found in the extensive bays and estuaries. Ports, harbours, resorts, coastal industries and occupations such as farming or fishing are also vulnerable to more extreme tidal events. Dredging of harbours may also need to be increased as a result of silt levels bought in by rivers and wind blown maritime silt driven by the increased speed of south westerly winds.

The uplands too could change significantly in character as a result of warmer, wetter conditions. The changes could affect soils, moorland vegetation and those upland animal and plant communities which are adapted to a relatively cold maritime climate. There will be an inward migration of new species, an outward migration of marginalised species and an increased risk of upland fires which damage the economy of upland estates and their ecological value.

Summary of Key Issues

The most significant pressures from air pollution and climate change are:

- potential loss of inter-tidal and other coastal habitats and biodiversity due to rising sea levels;
- loss of species at the edge of their range due to the impacts of species competition and migration;
- impact on sensitive species such as lichens which are particularly susceptible to air pollution;
- gradual changes in wildlife communities in response to climate change, pests and fire hazard;
- increase in tidal surges, high waves and coastal winds which will have implications for coastal defence works.

Source: Lancashire County Council (2001)

63. Within Stage 2 of the assessment process judgements are made about the landscape. Few, if any, Landscape Character Assessments have considered fully the impacts of climate change when making judgements.

64. There is potential at this stage for the judgement making process to address the possible consequences of climate change on the landscape. Subsequent decisions can be made as to whether or not intervention is required to mitigate the potential effects of climate change. As a result the preparation, for example of landscape guidelines, will consider the potential effects, good or bad, of climate change impacts leading to appropriate landscape character management. The following section presents one way in which this could be carried out.

How to Address Climate Change within Landscape Character Assessment.

65. At present there is no definitive guidance on how climate change may be incorporated into the assessment process with further work being required. A potential technique to undertake such work is suggested in **Figure 6.** and although an understanding of climate changes is desirable it is not a prerequisite. This process may be adapted to suit individual needs and circumstances, alternatively other techniques may be available. This figure suggests the development of a matrix identifying which climate change impacts may affect specific landscape characteristics. The process can lead to the identification of landscape guidelines which fully consider climate change. It is important to recognise that this is an continuous process to be reviewed and refined over time and can be adapted to meet individual requirements.

Figure 6: Flow chart indicating how climate change may be considered within a Landscape Character Assessment

PHASE 1 SCOPING

Construct Matrix
Identify landscape characteristics relevant to the study area through the preparation of a landscape character assessment.

Background Research
Identify general climate change impacts relevant to the study area e.g. from UKCIP regional and sectoral study summaries (available online at www.ukcip.org).

Identify priorities qualitatively
Based on a range of potential impacts, such as those presented in this report, qualitatively assess whether there is a particular interaction between a specific landscape character assessment feature and identified climate change impact. Indicate this by an appropriate symbol e.g. tick or star. This process will help to identify priority areas.

PHASE 2 DETAIL

Add more detail to indicate specific impacts
Define the nature of the potential impact on the landscape feature/characteristic within the identified priority area(s) e.g. using more detailed information from regional and sectoral studies. Forthcoming reports such as the ODPM study on planning and climate change and the Environment Agency/UKCIP Risk, Uncertainty and decision making report may be useful in this process.

PHASE 3 RESPONSE

Develop responses
Taking into consideration the likely climate change potential impacts identified prepare appropriate landscape strategies, guidelines etc.

PHASE 4 FEEDBACK

Review Scoping, Detail and Responses
Develop a cyclical approach to the process of incorporation in LCA, progressively refining knowledge and precision through subsequent iterations.

66. An illustration of how such as matrix may be constructed is provided in **Figure 7**. Here climate change impacts are set out on the x axis with landscape character features noted on the y axis. Using a combination of local knowledge and for example the conclusions reached in the various regional climate change impacts studies [18], the cells of the matrix can be populated in two phases: scoping to assess priority areas in phase one; and the provision of detail in phase two. Some impacts, as identified in Chapter 2, will be generic, others very difficult to gauge precisely, but the matrix serves as a means of focusing attention on key receptors and notable impacts over the short or longer term, on a small or wide range of landscape character features and over a restricted or wide geographical range.

Figure 7: Matrix for the Assessment of Climate Change Impacts in Landscape Character Assessment

Landscape Character Features		Climate Change Impacts						
		Higher temperatures			Wetter winters	Rise in sea level	Decrease in cloud cover and increased solar radiation	Change in storm tracks
		e.g. drier summers	e.g. decrease in summer soil moisture	e.g. decrease in snowfall	e.g. increased flooding	e.g. more frequent extreme sea levels		
Soils								
Vegetation	e.g. mudflat							
	e.g. raised bog							
	e.g. sand dunes							
Trees/ woodland	e.g. riverine trees							
	e.g. beech woodlands							
Land Use								
Enclosure								
Field Pattern								
Settlement Pattern								

67. An example of the potential results that can be derived from incorporating climate change within a landscape assessment is provided **Table 4**. It presents a summary of climatic variables, key receptors and the likely associated impacts. Also identified are example responses which could be employed to address such impacts. In addition there are existing or anticipated actions or decisions that will need to be climate change-proofed.

Table 4: Examples of Climate Change Drivers, Landscape Receptors, Impacts and Responses

Climatic Variable	Broad Landscape Receptors	Possible Impacts	Potential Responses
• Higher average and more extreme temperatures • Reduced and more unpredictable precipitation (rain and snow) • Greater year to year variability • Reduced seasonality • Changes in cloud cover and solar radiation • Higher relative humidity • Change in storm tracks • Reduced soil moisture	Coastal Areas	Compromising of coastal habitats under sea level rise Incursions during extreme events Marine renewable energy developments & offshore windfarms Loss of built heritage from sea level rise and flooding	Managed retreat Multifunctional land use Higher/more sea defences
	Rural Upland	Loss of niche habitats Erosion during flash floods Increased erosion Increased fire and storm damage Demands for the provision of wind energy developments Land use change e.g. if skiing and winter outdoor pursuits are prevented/reduced by lack of snow	Development of habitat management strategies Emergency planning procedures Development of strategic planning policies for windfarms Economic adaptation strategies by landowners Land-use planning policies Increased tree cover
	Rural Lowland	Summer droughts and attendant water shortages Habitat fragmentation Changes in cropping patterns Increased flood risk and pressures for development in areas beyond risk Historic landscapes increasingly difficult to maintain	Adaptation of farming methods On-farm water storage Careful choice of species in planting schemes Land-use planning policies Extension of wetland areas
	Small Islands	Lack of accessibility by sea Loss of land due to sea level rise	Strategic economic adaptation strategy Higher/more provision of sea defences Improvements to existing infra-structure
	Urban Areas	Maintenance of built heritage Damage from increased storminess Flooding impacts	Emergency planning procedures Review of conservation policy and approaches Developing alternatively cooling strategies e.g. creating open and green spaces.

RESPONDING TO CLIMATE CHANGE IMPACTS ON LANDSCAPE CHARACTER

Introduction

68. The human response to the impacts of climate change on the landscape is likely to be as complex as the effects themselves. The response of individual landowners and managers, and hence the overall effect of individual land management decisions, will determine the form and function of significant tracts of landscape. Responses will involve a blend of strategies and tactics to:

- adapt behaviour to cope with actual and predicted impacts (yielding immediate, local benefits); and
- mitigate the effect of potential impacts (which can only address the global CC issue, and will not have any pay back for 40 or so years).

69. Many responses, whilst not directed at the landscape *per se*, have implications for the landscape as the expression of human interaction with the physical environment.

Examples of Adaptation and Mitigation Strategies and Tactics

70. Little work has been done directly on responding to the effects of climate change via Landscape Character Assessments. However, appropriate adaptation and mitigation strategies developed in response to climate change can be found. These, some of which are planned others which have been implemented, tend to be applied at the site specific level rather than at the landscape scale.

71. Within the Somerset Levels and Moors there is a recognised potential for agricultural land to store flood waters as and when existing flood defences become ineffective (**Box 7**). However the consequential impacts, both good and bad, to a wide range of environmental, economic and social factors need to be carefully considered if such a strategy were to be implemented.

72. The case study on Wicken Fen is an example of how the effects of climate change leading to the loss of coastal marshes can be offset by the provision of marshland elsewhere (**Box 8**). Sherwood Energy Village (**Box 9**) is an example of how sustainable development can incorporate climate change considerations, demonstrating the benefits of adaptation to the current climate as a precursor to adaptation to future climate change.

Box 7: Flooding on The Somerset Levels and Moors

The Somerset Levels and Moors consist of 60,728 hectares of low-lying land draining to the Severn Estuary. The estuary has the second highest tidal range in the world with tidal levels up to five metres above the lowest land. Formed by the deposit of marine silts, the Levels lie just above sea level and form a barrier of higher land between the estuary and the Moors.

Lying further inland, the Moors are low-lying peat moors, overlaid in some areas by clay. They constitute the most important remaining lowland wet grassland in England. Approximately 7,200 hectares of the area is considered to be a wetland of outstanding ecological importance in a European context, mainly for over-wintering birds and invertebrates in the many ditches and rhynes draining the land.

Some 2000 individuals and families farm the land, with approximately 50% dairy. 10-12% is arable, whilst the remainder is beef and sheep farming. Other local industries include withy growing and peat extraction. Surrounding the Moors are a series of hills including the Mendips, Blackdowns, Brendons and Quantocks. Water from these high areas has to pass through the Levels and Moors on its way to the sea.

At the downstream end of most of the drainage channels is a sluice or clyce with doors on the seaward side which close automatically when sea levels rise above the freshwater level. The Rivers Parrett and Tone system being tidal to some 30 kilometres inland is an exception to this.

On high tides, there can be a period of up to four hours when the river system is "tide-locked", and during this period the river has to store run-off within its own banks.

In very wet weather the storage available in the river channel can be exceeded and overtopping of the banks in the floodplain provided by the Moors can take place. When river and tide levels allow, the Moors are then evacuated utilising Environment Agency owned pumping stations.

Climate change is predicted to result in increased sea levels and increased storminess. This will result in run-off being stored on the Moors more frequently and for longer periods. Such reductions in flood defence standards will result in the Moors being abandoned by agriculture, and eventually losing its current ecological interests. Under current policy guidance the Environment Agency cannot justify increasing expenditure to maintain existing standards of flood protection until flood events occur that demonstrate increased damages to urban property outweighing the cost of improvements. The sustainability of current land uses on the Moors is already being questioned during Water Level Management Plan consultations. Climate change can only make these issues more acute.

Eight thousand years ago this area of Somerset was an inlet of the sea. If climate change accelerates, at some point a decision will be needed on the value of maintaining defences against returning the area to the sea.

This case study was provided by the Environment Agency for the South West Climatic Challenge Conference 1999 (http://www.ex.ac.uk/ccvc/cases6_c.htm)

Box 8: Reclaiming Wetlands at Wicken Fen

At Wicken Fen in Cambridgeshire reed beds and wet grasslands have been created by the National Trust on land that had previously been drained and utilised for intensive arable farming.

The National Trust is proposing to acquire up to 3700 hectares of farmland to the south of Wicken Fen over the next 100 years thus extending the existing wetland further. The aim for the restored land is to manage it extensively using herds of grazing animals as well as growing 'green crops' such as reeds and bio fuel. The wetlands of the area would be restored by a combination of natural regeneration and the raising of water levels via a reduction in drainage pumping and the use of sluices.

It is now widely acknowledged that in some fen areas the loss of soil via erosion and peat via shrinkage has made agriculture unsustainable in its present form into the medium term. Drainage of the fens require expensive engineering works to keep the areas drained as a result of peat shrinkage. In some areas the cost of these works will not be considered economically viable in the future as income from some types of farming reduces. In addition the catchment is very dependent on summer irrigation with summer water in very short supply. The changes predicted in the climate over the coming 50 years are likely to make this situation more critical and it is possible that the cultivation of some types of crop will become unsustainable.

This is an area where land drainage and crop irrigation is potentially unsustainable in the longer term and where peat / soil loss along with water shortages will make farming uneconomic - the creation therefore of a large new wetland reserve is an ideal alternative land use.

Due to sea level rises areas of land may be inundated by the sea with many of the important wildlife areas along the East Coast eventually being lost, as the way in which cost benefit analysis is carried out for flood defence works will show building the necessary sea defences to be uneconomic. As a result nature reserves such as Cley, Titchwell, Blakeney, Holme and parts of Minsmere may not survive in their current state more than 50 - 100 years as the sea defences collapse. These sites are of international importance on account of their wildlife and therefore we need to make provision now to attempt to compensate for such losses.

Source: www.wicken.org.uk Extracts from The Wicken Fen Vision.

Box 9: Sherwood Energy Village

Sherwood Energy Village (SEV) is a major initiative for the East Midlands transforming a 91-acre former colliery in Ollerton, Nottinghamshire into an environmental enterprise comprising industry, housing, recreation and leisure. The development will be constructed on environmental, ethical and sustainable principles, with on site developments complying with the highest environmental standards.

The main aim of Sherwood Energy Village is the regeneration of the local economy, the empowering of the local community and the growing need to address environmental issues in every aspect of life.

The Energy Village concept has been developed and refined over a number of years and will incorporate a number of key environmental initiatives such as the use of wind and solar technology together with the development of a biomass power plant.

SEV will show that by using building materials from sustainable sources, together with energy saving building techniques and designs, energy requirements can be reduced.

The Energy Village development will showcase environmental features within buildings and on the site itself by incorporating sustainable design and construction; renewable energy sources and environmental technologies. The UK's largest application of Sustainable Urban Drainage systems (SUDS) has been engineered into the site as part of the infrastructure. Engineered swales have been incorporated with the capacity to stand a one-in-two-hundred year storm. Both when the colliery was active, and after it had closed, periods of heavy rain would cause flash floods to neighbouring roads. At its highest point the site contours stands at 66 ft. above sea level, at its lowest point it is 42 ft. above sea level. Since the introduction of the system of swales flooding has not occurred even in the prolonged period of rain in the latter half of 2002.

SUDS can incorporate different methods of water management dealing with collection, dispersal and retention. Methods include permeable surfaces, filter drains, swales, basins and ponds etc. These systems mean that rain water and surface run-off are controlled and managed in order to slow the flow and allow it to return to the water cycle in a more natural fashion. This aims to prevent the seasonal flooding that has become more commonplace when conventional storm drains and culverts are overwhelmed by the amount of rainwater they have to deal with.

Source: www.sev.org.uk

73. These examples illustrate a range of responses relevant to landscape character. Further adaptation and mitigation strategies could include:

- Encouragement of the development and implementation of sustainable land management strategies where multi functional uses are sought;
- Development of positive planning in flood risk zones, which includes an integrated approach to the use of land for flood water storage, steering non essential development away from flood plains and the ongoing review of flood defences;
- Review of abstraction licenses in order to prevent the drying up of streams, in turn balanced with increases in the demand for ground and river water;
- Exploration of the contribution that coastal regions, left to their natural dynamics, could make as natural buffers for storm and flooding events;
- Investigation at a landscape (and potentially national) scale, of the provision of buffer zones around protected areas such as Sites of Special Scientific Interest and National Nature Reserves, and creation of 'stepping stones' and 'ecological corridors' for species and habitats to colonise new sites and establish in new locations (both northwards and uphill); and
- Development of new approaches for the management of nature reserves that incorporate potential climate change impacts.

74. This is an emerging area with only a few case studies to draw on. It is anticipated that the range of examples will grow. It may be possible to use the site specific examples at the larger landscape level.

CONCLUSIONS

75. This topic paper begins the process of understanding more fully the potential interactions between climate change and landscape character. The UK climate has changed notably over the last century and climate models indicate that further more dramatic changes are possible. The potential impacts of climate change e.g. higher temperatures, flooding, more intense rainfall etc, could have marked effects on landscape character. In many cases the precise impact of climate change relevant to landscape character is as yet still unclear. However, we could see many subtle changes to the fabric of the landscape both through impacts on landscape elements such as trees, hedges and water bodies and through broader changes in land use. These are likely to occur over the short (such as through extreme events) and the longer term, and be geographically specific and more widespread in their effects.

76. It is possible that some of the characteristic features of valued landscapes could be compromised and in some cases new landscapes created. Such shifts in the balance of landscape character could prompt the emergence of new perceptions of what landscapes are valued and why. The future form and function of landscape could be at the centre of responses to the demands for mitigation of climate change.

77. Although within a number of Landscape Character Assessments climate change has been identified as a force for change, the issue should be considered more fully. A better understanding of the impacts on natural environment, land use and the cultural heritage can ensure the resultant outputs of an assessment (such as landscape strategies and guidelines) adequately reflect the likely influence of climate change on the landscape.

78. A suggested process for incorporating climate change impacts into the assessment process has been presented in this topic paper together with examples of potential mitigation and adaptation techniques. They should not be taken as definitive or exhaustive but act as an aid for those wishing to consider climate change within their landscape assessments, promoting further thought and discussion. It is clear that there is much work to be done in responding to the effects of climate change impacts on landscape character.

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Further Information

Share your ideas, experience, knowledge and use of landscape character assessment with others by joining the **Countryside Character Network at www.ccnetwork.org.uk**. Feedback and continued discussion on this topic paper and others can be made via the on-line discussion forum.

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SCOTTISH NATURAL HERITAGE

The full *Landscape Character Assessment: Guidance for England and Scotland* and related topic papers can be viewed and downloaded from **www.countryside.gov.uk/cci/guidance** and **www.snh.org.uk/strategy/LCA**

Free copies of the guidance are also available from:

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