Character Area Climate Change Project NE116R

Responding to the impacts of climate change on the natural environment: Dorset Downs and Cranborne Chase

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Dorset Downs and Cranborne Chase

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Cowslips and green-winged orchids in chalk grassland

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Further information
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Summary

Introduction

Natural England is working to deliver a natural environment that is healthy, enjoyed by people and used in a sustainable manner. However, the natural environment is changing as a consequence of human activities, and one of the major challenges ahead is climate change.

Even the most optimistic predictions show us locked into at least 50 years of unstable climate. Changes in temperature, rainfall, sea levels, and the magnitude and frequency of extreme weather events will have a direct impact on the natural environment. Indirect impacts will also arise as society adapts to climate change. These impacts may create both opportunities and threats to the natural environment.

Natural England and its partners therefore need to plan ahead to secure the future of the natural environment. One way in which we are doing this is through the Character Area Climate Change Project.

The project aims to identify the local responses required to safeguard the natural environment and our enjoyment of it. In the pilot phase we are focusing on four of the 159 ‘Character Areas’ in England, one of which is the Dorset Downs and Cranborne Chase. The others are the Cumbria High Fells, Shropshire Hills, and the Broads.

This report provides the detailed findings from the pilot project. The summary leaflet is also available on our website at www.naturalengland.org.uk. It:

- identifies significant natural environmental assets;
- assesses potential climate change impacts on these assets; and
- puts forward potential adaptation responses.

What we learn from the four pilot projects will be used to extend the approach across England as part of our aim to build a healthy and resilient natural environment for the future.

Although the project is primarily concerned with the natural environment, it has also considered the impacts of climate change on other areas of Natural England's remit, including access and recreation, landscape, and the historic environment.

About the project

The objective of the Character Area Climate Change Project is to ensure that when decisions on the future of places like the Dorset Downs and Cranborne Chase are made, proper account is taken of impacts on the natural world, as well as on communities and their livelihoods. It is not Natural England’s role, or intention, to take such decisions, but to initiate debate on the impacts of climate change on the natural world, so that well informed decisions about its future can be taken.

Communities and their livelihoods are vital considerations in the development of any future strategy to respond to climate change. This report does not attempt to cover these issues, not because they are unimportant, but because our role is primarily in relation to the natural environment.

Ensuring a strong, healthy, diverse and inclusive society that lives within environmental limits is the key objective of sustainable development. Natural England seeks to contribute to this through its management of the natural environment. We recognise that environmental and social solutions need to proceed in tandem. Informed by this project, we will engage with communities, other organisations and Government to find approaches that deliver successful and long-term adaptation to climate change.

Taking action to respond to climate change will also depend on the cooperation of those who own and manage the land. We do not take that cooperation for granted and are aware that many measures will require appropriate incentives. At this stage we wish to explore with others potential responses which are feasible and acceptable in principle, and have not yet considered the detailed mechanisms of change.

Significant natural assets

The Dorset Downs and Cranborne Chase Character Area is a high, rolling chalk landscape extending from Salisbury to south of Dorchester. It covers 116,500 hectare (ha). Most of the area is included in the Dorset Area of Outstanding Natural Beauty (AONB) and the Cranborne Chase and West Wiltshire Downs AONB, and contains a wide range of wildlife, historic and landscape features.

The north facing scarp, creased by steep, dry combes has substantial areas of calcareous grassland. The undulating top land mostly contains open, arable fields enclosed by fences or sparse hedges. The arable and grassland mix is important for farmland birds and arable plants. The chalk stream valleys of the Frome, Piddle, Stour, Allen and Ebble dissect land dipping to the south-east. Here, wet grassland occurs around the surviving water meadows. Broadleaved woodland and conifer plantations exist around Cranborne Chase. The area contains a wealth of archaeological features, including the remains of prehistoric, Roman and medieval settlements, field systems, and also Bronze Age barrows, hill forts, marl pits and parkland features.

The most significant biodiversity assets found in the Character Area are:

- 855 ha of internationally important ‘Natura 2000’ habitat and associated species; including chalk grassland and scrub (marsh fritillary and early gentian), mixed alder-ash wet woodlands (marsh fritillary), and yew woodlands;
- 3,460 ha of nationally important Sites of Special Scientific Interest (SSSI) and 10,250 ha of Biodiversity Action Plan (BAP) habitat; and
- iconic species including Adonis blue butterfly, Atlantic stream crayfish, grey partridge, otter, Bechstein’s bat, and the rare arable flower pheasant's eye.

Significant landscape assets include:

- rolling, chalk landscape of international importance, with dramatic scarps and steep-sided, sheltered valleys;
- north and west facing scarp slopes with species-rich grassland indented by combes and valleys;
- south and east facing dip slopes of open, mainly arable land with occasional downland on steeper valley slopes, isolated farmsteads and few trees;
- sheltered valleys, often containing chalk streams, and varied with woodlands, hedged fields, and flood meadows;
- woodlands containing ancient hazel coppice, and substantial parklands; and

- timber framed buildings, flint and clunch walling, and thatched roofing.

The Character Area is widely used for recreation and tourism, and assets include:

- 1,897 km of public rights of way;
- 7,987 ha of open access land;
- National Cycle Route 26, which runs between Dorchester and Castle Cary; and
- 4,575 ha of woodland and associated agricultural land and clean chalk rivers, which yield good quantities of fish and game.

The most significant 'ecosystem services' provided by the Dorset Downs and Cranborne Chase, from which we all benefit, include:

- clean drinking water, mainly drawn from the chalk aquifer;
- food and fibre, primarily from cereals and sheep; and
- flood protection, with water storage in the flood plains providing natural protection from fluvial flooding.

Likely impacts of climate change on the Dorset Downs and Cranborne Chase

Evidence from the UK Climate Impacts Programme (2002) shows that the climate in the Dorset Downs and Cranborne Chase over the coming century is likely to become warmer and wetter in winter, and hotter and drier in summer. In addition, rainfall intensity will probably increase. Extreme events such as heat waves and storms are predicted to increase in frequency and severity.

By 2080, if we do not reduce greenhouse gas emissions, the climate of the area may resemble that of Lisbon in Portugal. The mean temperature in January might increase by 3°C and in July by 6°C, while average rainfall may decline by 12%. Portugal has arid chalk landscapes where the impact of drought, floods, and soil erosion are already being felt, and some parts of the country experience water shortages every other year.

Biodiversity, landscape & recreation

The composition of the natural communities that are characteristic of chalk downland, woodland, streams and arable fields will change. For example, the shallow rooting beech, which is common in Dorset woods, parks and estates, does not thrive on dry soils and is likely to decline, but small-leaved lime needs warmth to set seed and will probably increase. Veteran trees of all species are more likely to be felled by storm force winds. However, in woods the impact of these storms can be positive, creating glades that species adapted to sunlight can occupy.

Diverse natural communities of plants and animals are most likely to survive on soils and in streams with low nutrient status and in large patches of habitat. Drought and lower summer rainfall is likely to result in a contraction of the chalk stream network. Freshwater species will be lost from some of the winterbournes (the chalk stream headwaters that usually flow only in winter), while some perennial streams will become seasonal winterbournes.

We can expect an increase in the popularity of woodland and streamside recreation as people seek shade in the hottest months.

Natural resources

Human beings could not survive without goods and services derived from the natural environment. For example, up to 80% of the drinking water supplied to towns and villages in this area comes from the chalk aquifer. More rain will fall in winter deluges when the ground is already saturated. This is already happening. An increase in soil erosion can also be expected, resulting in damage to historic features and more silt, nutrients and pesticides washing into rivers. These inputs come predominantly from arable farmland and already have a significant impact on water quality and freshwater biodiversity.

Indirect impacts

Changes in farming systems, the economy, population patterns and cultural values will also affect the natural environment of the Dorset Downs and Cranborne Chase. Our project does not try to assess these, although they will have significant implications for the area and any proposed adaptation measures.

Changes in the types and varieties of crops, sowing dates, irrigation, pests, diseases and soil erosion are all likely. Arable farming may expand into the floodplains and valleys in response to longer growing seasons and new crop varieties, with potentially negative impacts on grassland and wetland wildlife, landscape character, buried archaeology and access.

The imperative to reduce greenhouse gas emissions and concerns over security of energy supplies are likely to lead to an increase in renewable energy generation. Exposed sites such as the chalk plateau could be favoured for wind turbine development, eroding the character of the landscape as currently perceived and valued.

Adaptation options

Responding to the impacts of climate change requires adaptation to prevent natural environmental assets and the social and economic benefits that they provide from being lost. The following adaptation responses could be employed within the area:

Biodiversity, landscape & recreation

- Continue to improve the condition of existing habitats. Eighteen percent of nationally important habitat within the area is in unfavourable condition as a result of management neglect in woodlands, under grazing, excessive nutrients and silt in water bodies, and agricultural intensification. Rectifying this would increase the resilience of habitats and wildlife populations.
- Create or restore new areas of habitat. As part of the South West Regional Biodiversity Partnership, Natural England has helped to produce the South West Nature Map. This identifies the best areas in the region to conserve, create and connect wildlife habitats at a landscape scale, in order to enhance resilience to climate change.
- Plant locally native replacements for existing mature trees, avoiding those species susceptible to drought.
- Re-establish pollard regimes. This will reduce the susceptibility of trees to drought and storms by reducing the root to crown ratio.

- Learn from past extreme weather events that may occur more frequently as a result of climate change, such as our response to the tree damage caused by the storm of 1987.
- Identify research needs and commission appropriate studies to build adaptive capacity. For example, there is an urgent need to quantify the relative impacts of native woodland and other forms of land cover on water quantity and quality, particularly the contribution that floodplain woodland can make to mitigating large flood events.

Natural resources

- Install or restore water storage on farms, particularly dewponds.
- Re-establish chalk grassland or native woodland adjoining water courses to reduce nitrate pollution and siltation in streams and rivers.
- Employ methods on farms that protect water quality and soil resources, such as allowing vegetated field margins and avoiding bare fields in autumn and winter.
- Create more naturally functioning floodplains to allow greater water storage and the evolution of new wetland habitats. There are existing or potential floodplain restoration projects on the River Frome at Maiden Newton, the River Cerne, and the River Stour near Kingston Lacy.

Planning for an uncertain future

- Adopt a partnership approach between statutory bodies and planning authorities to maintain adequate land for the natural environment and ensure resilience to climate change at all scales.
- With 'growth points' as the priority, guide development away from sensitive environmental zones. Option appraisal should consider the value of ecosystem goods and services, so that, for example, the full impacts of building on floodplains can be assessed; and the full costs of conventional development versus development adapted to future climate can be compared.
- Install Sustainable Urban Drainage Systems (SUDS) in new developments to intercept and store water. SUDS aim to mimic as closely as possible the natural drainage of a site and will reduce the impact of urban development on flooding and the pollution of waterways.
- Ensure that renewable energy infrastructure is strategically planned. A landscape capacity study for the Character Area would help to ensure that infrastructure is sited in the best locations and would also help to develop markets, for example, by encouraging farmers to diversity into wood fuel.

Next steps

This project on how climate change is likely to affect the natural environment of the Dorset Downs and Cranborne Chase Character Area, and the adaptation responses required, is a significant first step but cannot be conclusive. It provides an indication of what may happen. However, the future impacts of climate change are still uncertain and are partly dependent on the amount of greenhouse gases that society releases and how much is released by natural feedback loops from the environment (one of our biggest unknowns).

When identifying adaptation actions, existing strategies, policies and initiatives need to be considered. Some actions defined as climate change adaptation are already occurring under a different name and it may be possible to modify existing programmes to provide a mechanism for delivering adaptation. An example of this is the planned incorporation of climate change adaptation into Natural England's Environmental Stewardship Scheme.

Natural England is now working on the following:

- An implementation plan, which may include a demonstration project. Natural England will work in partnership with local stakeholders to ensure that this builds upon and dovetails with other initiatives.
- Learning from the pilot process to assess likely climate change impacts and the required adaptation strategies for other Character Areas both regionally and nationally.

The future of the Dorset Downs and Cranborne Chase depends on the actions we all take today to reduce our greenhouse gas emissions. This, combined with decisions we make about managing our landscapes to adapt to unavoidable climate change, will determine whether we continue to have a high-quality landscape that is cherished and respected by all.

Technical report

Contents

1. Introduction

The purpose of this project is to use national and local expertise to define our response to climate change within the Dorset Downs and Cranborne Chase Character Area. A list of valued assets has been compiled and specific impacts of climate change on them have been identified. Following this, specific responses have been compiled to practically adapt assets to the identified impacts of climate change. A detailed description of the project methodology can be found in Appendix 1.

The report is structured as follows:

- Section 2: Background to Character Area – a brief description.
- Section 3: Impacts – identification of direct and indirect climate change impacts based on bioclimatic data.
- Section 4: Adaptation – identification of responses and assessment against 'good adaptation' principles.
- Section 5: References.
- Appendix 1: Project methodology.
- Appendix 2: Briefing on socio-economic scenarios.
- Appendix 3: Tables accompanying narrative.

2. Background to Character Area

Box 2.1 Key features of the Dorset Downs and Cranborne Chase Character Area

- The Character Area is approximately 116,500 ha in extent.
- 855 ha (0.7per cent) of internationally important 'Natura 2000' habitat and associated species; chalk grassland and scrub (marsh fritillary and early gentian), wet and dry heaths and mires (southern damselfly, nightjar, woodlark, Dartford warbler, hen harrier and merlin), mixed alder-ash wet woodlands (marsh fritillary), and yew woodlands.
- 3,460 ha (3 per cent) of SSSI (Sites of Special Scientific Interest) and 10,250 ha (9 per cent) of BAP (Biodiversity Action Plan) habitat.
- Iconic species include Adonis blue butterfly, Atlantic stream crayfish, grey partridge, otter, Bechstein's bat, and the rare arable flower pheasant's eye.
- 1,897 km of Public Rights of Way.
- 7,987 ha (6.8 per cent) of open access land.
- National cycle route 26 running between Dorchester and Castle Cary.
- 4,575 ha (3.9 per cent) of woodland and associated agricultural land and clean chalk rivers, both yielding good densities of fish and game for hunting and fishing.
- Internationally important example of chalk landscape.
- Cultural and natural processes have combined to create a distinctive character.
- Rolling, chalk landscape with dramatic scarps and steep-sided, sheltered valleys.
- North and west facing scarp slopes with species-rich grassland are indented by complex combes and valleys.
- South and east facing dip slopes are open, mainly arable with occasional downland on steeper valley slopes and contain isolated farmsteads and few trees.
- Sheltered valleys, often containing chalk streams, are varied with woodlands, hedged fields, and flood meadows.
- Woodlands containing ancient hazel coppice, and substantial parklands.
- Timber framing, flint and clunch walling, and thatched roofing are all common characteristics.
- Arable cropland occupies 50 per cent of the land surface, with permanent grassland 26 per cent and temporary grassland 9 per cent. Sheep comprise 39 per cent of the total livestock, pigs 36 per cent and cattle 25 per cent.
- Flood plains provide natural protection from fluvial flooding.

2.1 Location

The Dorset Downs and Cranborne Chase Character Area is a rolling chalk landscape that forms part of the extensive belt of chalk which stretches across southern England. The Wardour and Blackmoor Vales lie to the north-west below the steep scarp slopes of the chalk and the Dorset Heaths lie to the south-east at the foot of the rolling dip slope. The chalk landscape extends to the north-east into the West Wiltshire Downs and Salisbury Plain Character Area (see Figure 2.1).

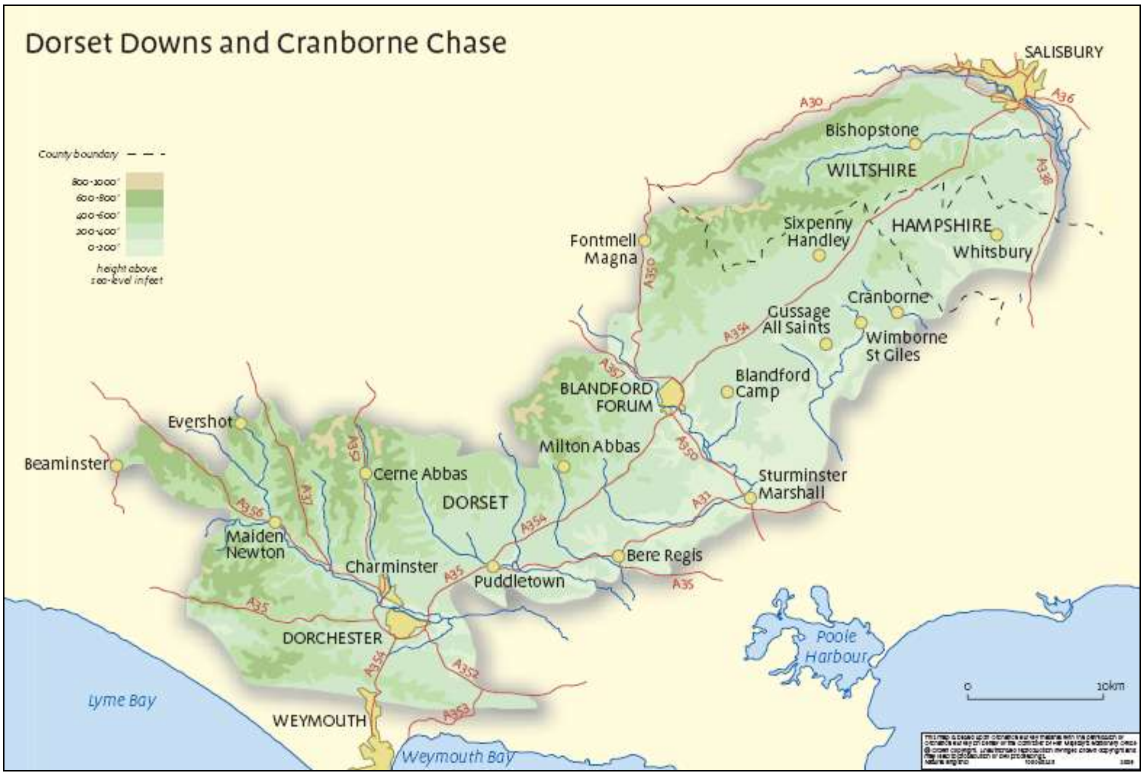

Figure 2.1 Context of Dorset Downs and Cranborne Chase Character Area

2.3 Significant natural environmental assets

2.3.1 Biodiversity and geodiversity

Internationally important assets

There are six Special Areas of Conservation covering 855 ha (0.7 per cent of the Character Area); Cerne and Sydling Downs (369ha); part West Dorset Alder Woods (80ha); part Dorset Heaths (91ha); Great Yews (29ha); Prescombe Down (76ha); and Fontmell and Melbury Downs (147ha). There is part (91 ha) of one Special Protection Area, the Dorset Heathlands, in the Character Area. Together, these sites are internationally important for the following habitats and associated species; chalk grassland (see Figure 2.3) and scrub (marsh fritillary and early gentian); wet and dry heaths and mires (southern damselfly, nightjar, woodlark, Dartford warbler, hen harrier and merlin); and mixed alder-ash wet woodlands (marsh fritillary), and yew woodlands.

Picture 2.1 Chalk tops

Picture 2.2 Chalk scarp slopes from Win Green Hill

Nationally important assets
There are 3,460 ha of Sites of Special Scientific Interest (SSSI) and 10,250 ha of Biodiversity Action Plan (BAP) habitat within the Character Area (see Figure 2.4). Priority BAP habitat includes cereal field margins, ancient and/or species-rich hedgerows, lowland calcareous grassland and scrub, lowland dry acid grassland, lowland meadows, chalk streams, purple moor grass and rush pasture, lowland heath, lowland wood pasture and parkland, lowland beech, yew and wet woodland, and fens.

Nationally important species include Duke of Burgundy and Adonis blue butterflies, Atlantic stream crayfish, otter, water vole, Bechstein's and Barbastelle bats, dormouse, and the rare arable flowers pheasant's eye, red hemp nettle and dense-flowered fumitory.

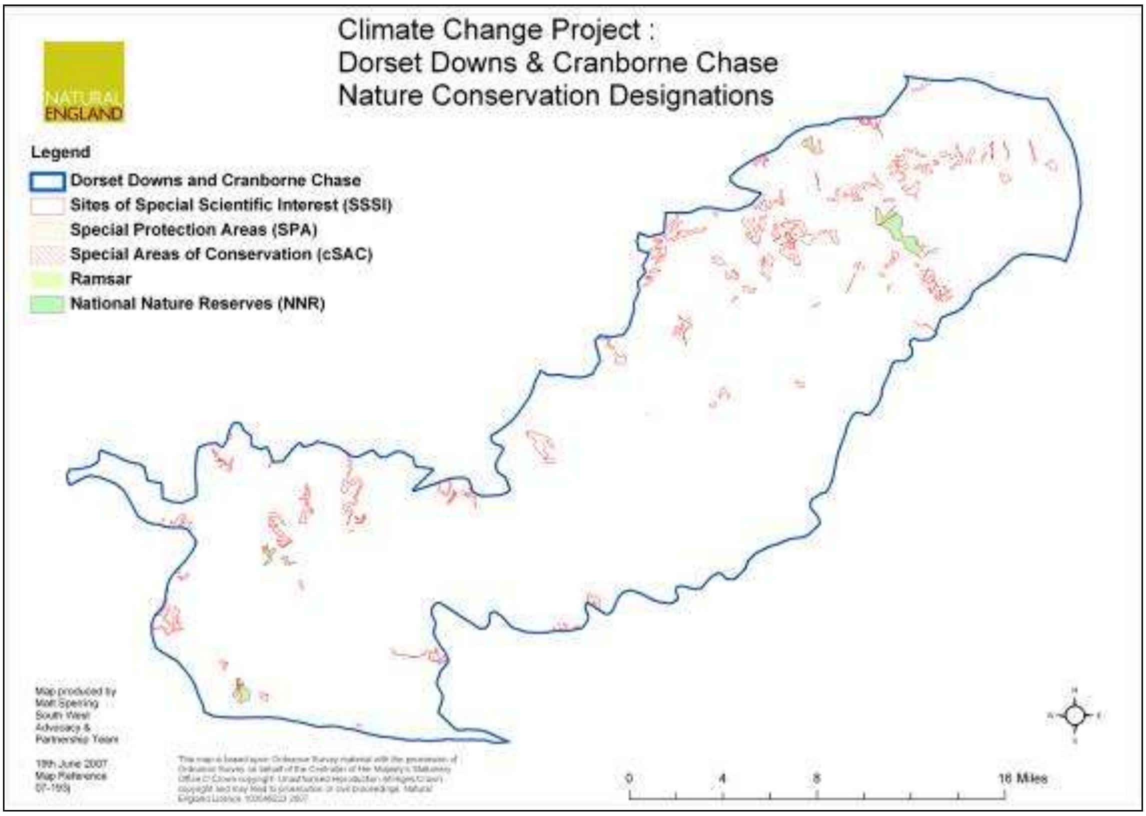

Figure 2.2 Designated biodiversity and geodiversity sites

The current condition of the environment is very important in determining how it will be impacted by climate change. Eighty two per cent of SSSI by area is in favourable or unfavourable recovering condition (see Figure 2.3). The reasons for adverse condition are shown in Table 2.1 below. Inappropriate forestry and woodland management, inappropriate scrub control and undergrazing are the main cause of adverse condition.

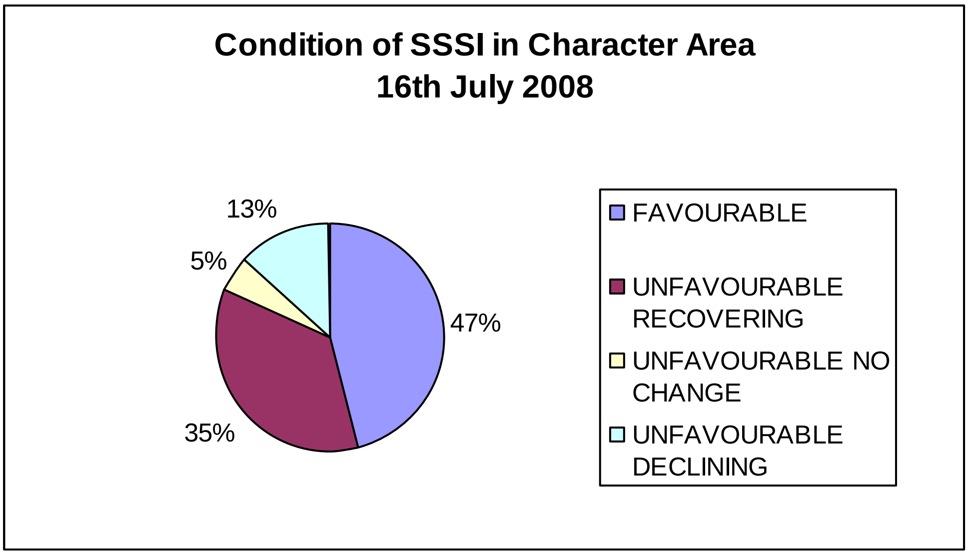

Figure 2.3 Condition of SSSI in Character Area

Table 2.1 Reasons for adverse condition of SSSI in the Character Area

Adverse condition description	Area (ha)
Forestry and woodland management	306.90
Inappropriate scrub control	186.88
Undergrazing	166.71
Inappropriate weed control	65.54
Game management - pheasant rearing	47.28
Overgrazing	46.65
Water pollution - agriculture/run off	35.10
Inland flood defence works	23.27
Inappropriate weirs dams and other structures	23.07
Invasive freshwater species	23.07
Siltation	23.07
Water pollution - discharge	23.07
Agriculture - other	12.26
Inappropriate agri-environment agreement prescription	8.28
Inappropriate pest control	3.91
Other	2.50
Deer grazing/browsing	2.45
Drainage	2.45
Earth science feature obstructed	1.40

The solid geology of the area is dominated by Upper Cretaceous chalk, a very pure and soft form of limestone deposited on the tropical sea floor around 90 million years ago. Below the chalk are Lower Cretaceous and Upper Jurassic limestones and sandstones. Folds in the rocks are thought to be related to the forces that created the Alps between 65 and 2 million years ago. Over time, the uplifted chalk was weathered in some areas to form clay-with-flints, and this gives rise to the soils most likely to support woodland. 'Silcretes' (sandstones with a hard silica cement) also formed as a result of weathering in sandy soils. During the ice-age permafrost, these deposits were broken up into Sarsen stones and carried down slope by water. This debris-charged water was very erosive and created the dramatic 'Karst' landscape of dry valleys and swallow holes seen today. SSSIs have been designated to protect all of these features within the Character Area.

The majority of soils in the Character Area are shallow lime rich soils over chalk or limestone and freely draining slightly acid loamy soils with some freely draining lime rich soils. Figure 2.4 shows the distribution of the main soil types.

Locally important assets
Locally important habitats in the Dorset BAP, in addition to those cited above, include ponds and veteran trees.

Species of local importance include great crested newt, Pipistrelle bat and the arable flowers prickly poppy, corn parsley, and narrow-fruited corn salad**.**

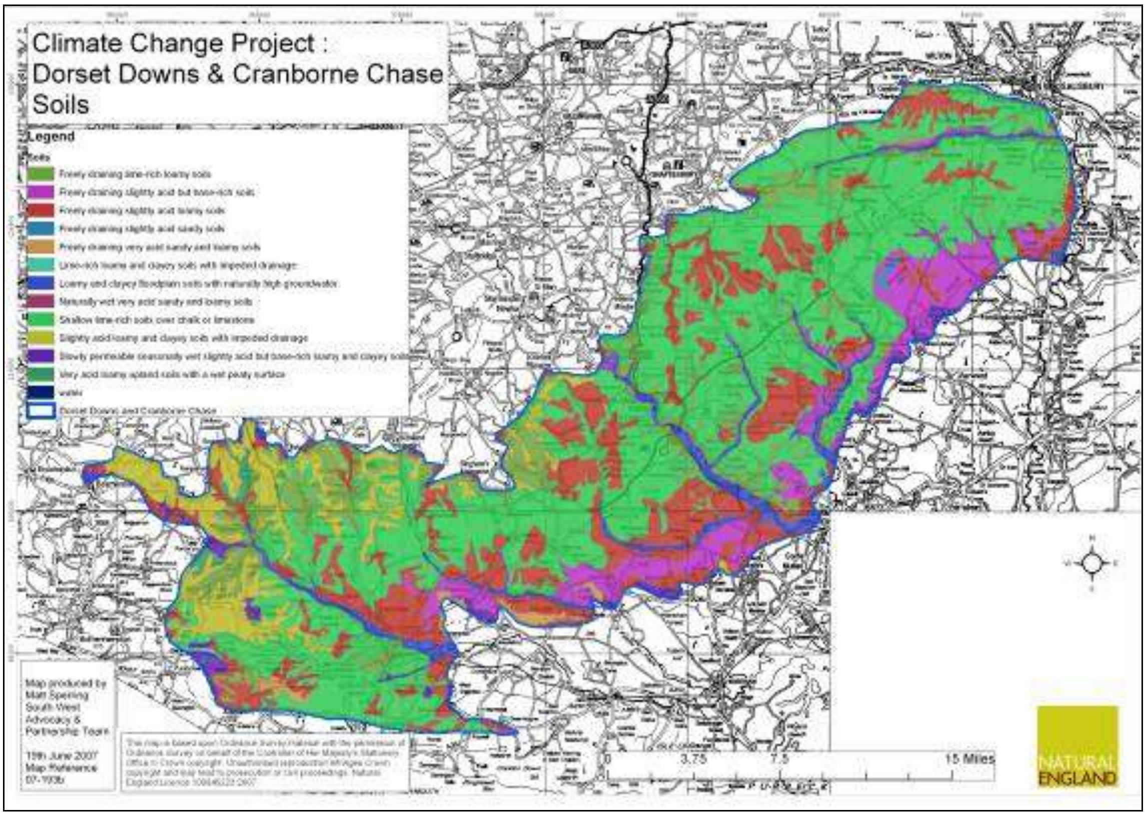

Figure 2.4 Soils in the Character Area

2.3.2 Access and recreation
There are 1,897 km of Public Rights of Way in the area, of which 15 km is National Trail (see Figure 2.5). The Monmouth Way and Macmillan Way are heritage trails which cross the area and other long distance paths include the Ridgeway Trail, Three Valleys Way and the Jubilee Trail.

There are 3,413 ha (2.9 per cent) of Countryside and Rights of Way Act (CROW) Open Access land, concentrated to the west of Dorchester. In addition, Forestry Commission "Woods for People" access land totals 2,429 ha (2.1 per cent). The National Trust and

Natural England provide a further 1,344 ha (1.1 per cent) of land which is open to the public.

Cycling is a popular activity in the area and National cycle route 26 runs between Dorchester and Castle Cary.

Hunting, fishing and shooting are also popular activities**.** Angling is a significant activity on the chalk streams that run through the area including the Stour, Allen and Tarrant.

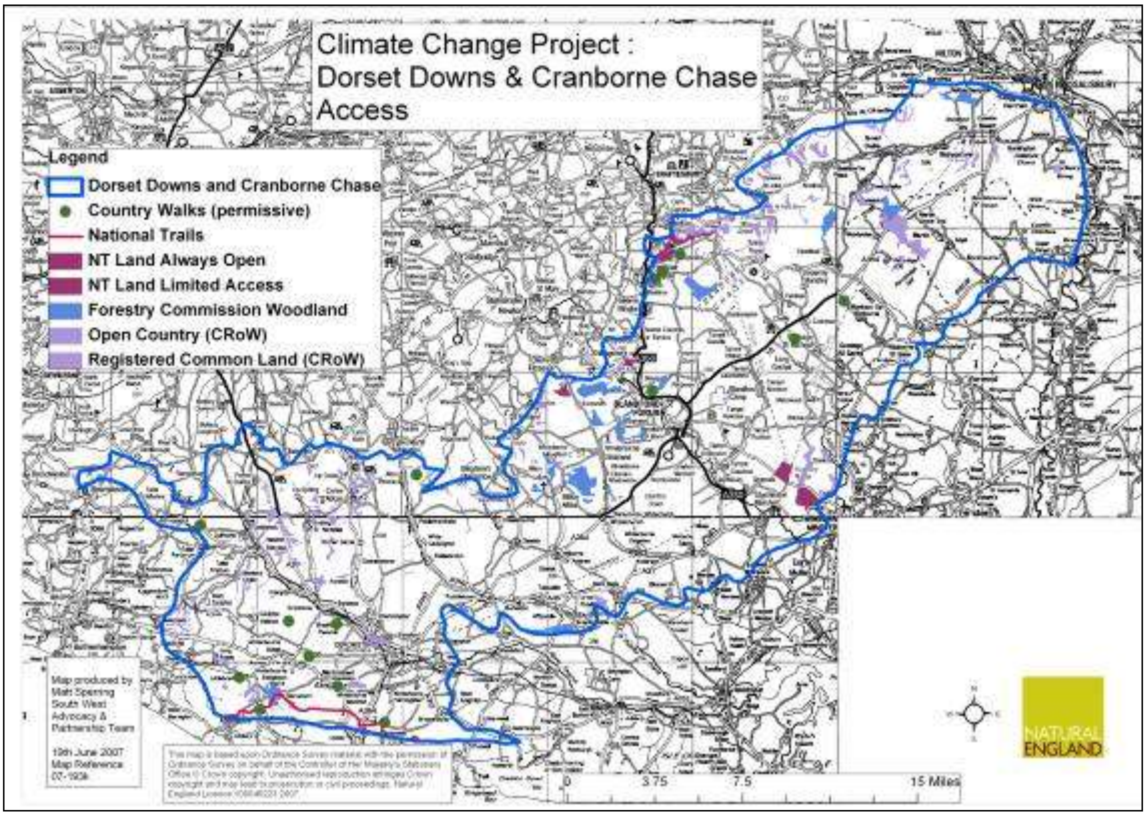

Figure 2.5 Access in the Character Area

2.3.3 Landscape

87 per cent of the area is agricultural land, 9 per cent is woodland and 2 per cent is urban.

The Dorset Downs and Cranborne Chase is a nationally and internationally important example of chalk landscape, largely designated as AONB and part of the UK family of protected landscapes. About 80 per cent of the area falls within the Dorset and the Cranborne Chase and West Wiltshire Downs AONBs. It is a particularly good example of an International Union for Conservation of Nature (IUCN) Category V protected landscape where the interaction of people and nature over time has created a distinctive character.

The Dorset Downs is a rolling, chalk landscape with dramatic scarps and steep-sided, sheltered valleys. The north and west facing scarp slopes (see Figure 2.2) with species-rich grassland are indented by complex combes and valleys; they also offer spectacular views and contain prominent hillforts and other prehistoric features. The south and east facing dip slopes are open, mainly arable with occasional downland on steeper valley slopes and contain isolated farmsteads and few trees. The sheltered valleys, often containing chalk streams, are varied with woodlands, hedged fields, flood meadows and villages in flint and thatch. Larger deciduous and conifer woodlands are found in the Cranborne Chase area along with the more significant historic parklands and deer parks, notably at Tollard Royal and Rushmore.

The area is crossed by numerous chalk rivers and streams. There are also scattered dew ponds throughout and water meadows alongside the Rivers Frome and Piddle and at Broad Chalke.

This landscape has been shaped by people over millennia. Archaeology in the Character Area includes ceremonial/ritual remains dating from the Neolithic (c.2500 BC) and Bronze Age (c.1500 BC), such as the Dorset Cursus, causewayed camps (Maumbury Rings) and numerous barrow cemeteries to the monumental Iron Age hillforts (c.700 BC) of Maiden Castle and Hambledon Hill. See Figure 2.7 for location of Scheduled Ancient Monuments in the Character Area.

Cranborne was a royal hunting ground from the 12th to 17th centuries, it is still characterised by woodlands containing ancient hazel coppice and substantial parklands created from the 17th century onwards. The Downs in the 17th century became dominated by sheep rearing, and an elaborate system of water meadows developed in the valleys to promote this industry. Water meadows were used to produce early spring grass for sheep by running water from the chalk streams over the meadow for a period of three days. Being derived from the ground, the stream water is at a relatively constant 11^{o}C.

In terms of buildings, timber framing, flint and clunch walling, and thatched roofing are all common characteristics.

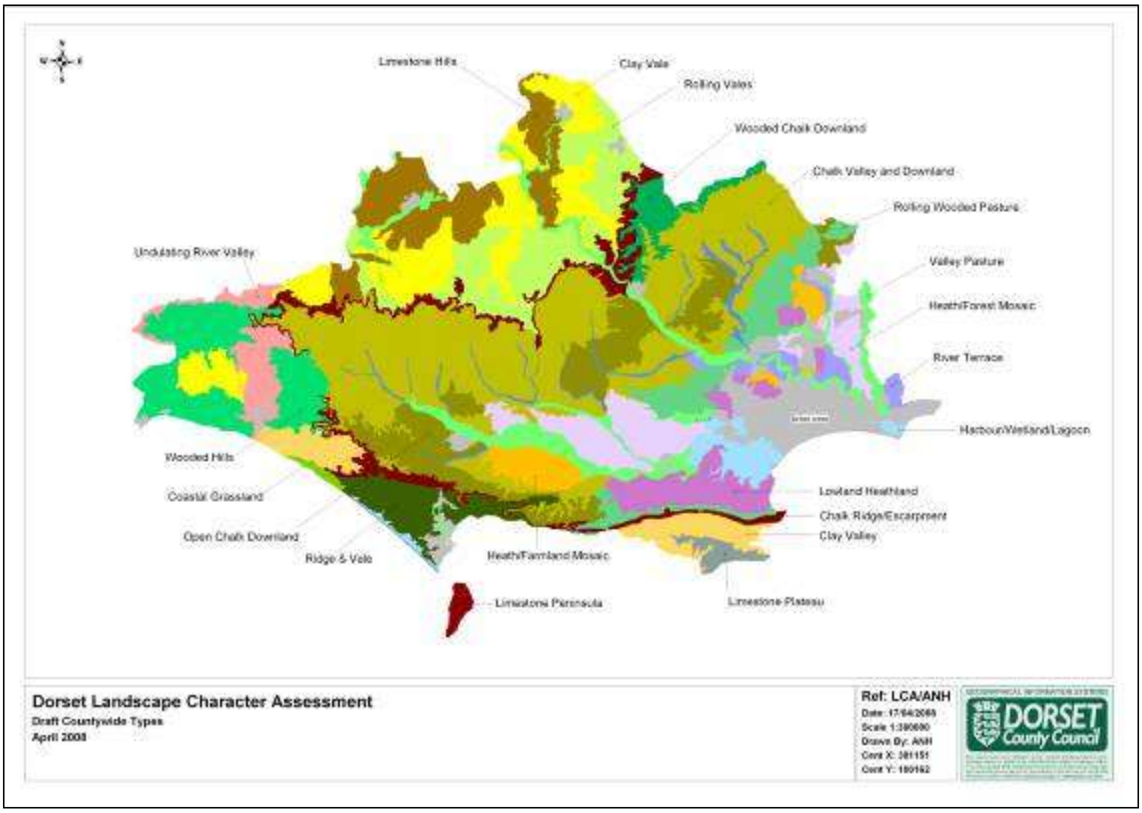

Figure 2.6a Dorset Landscape Character

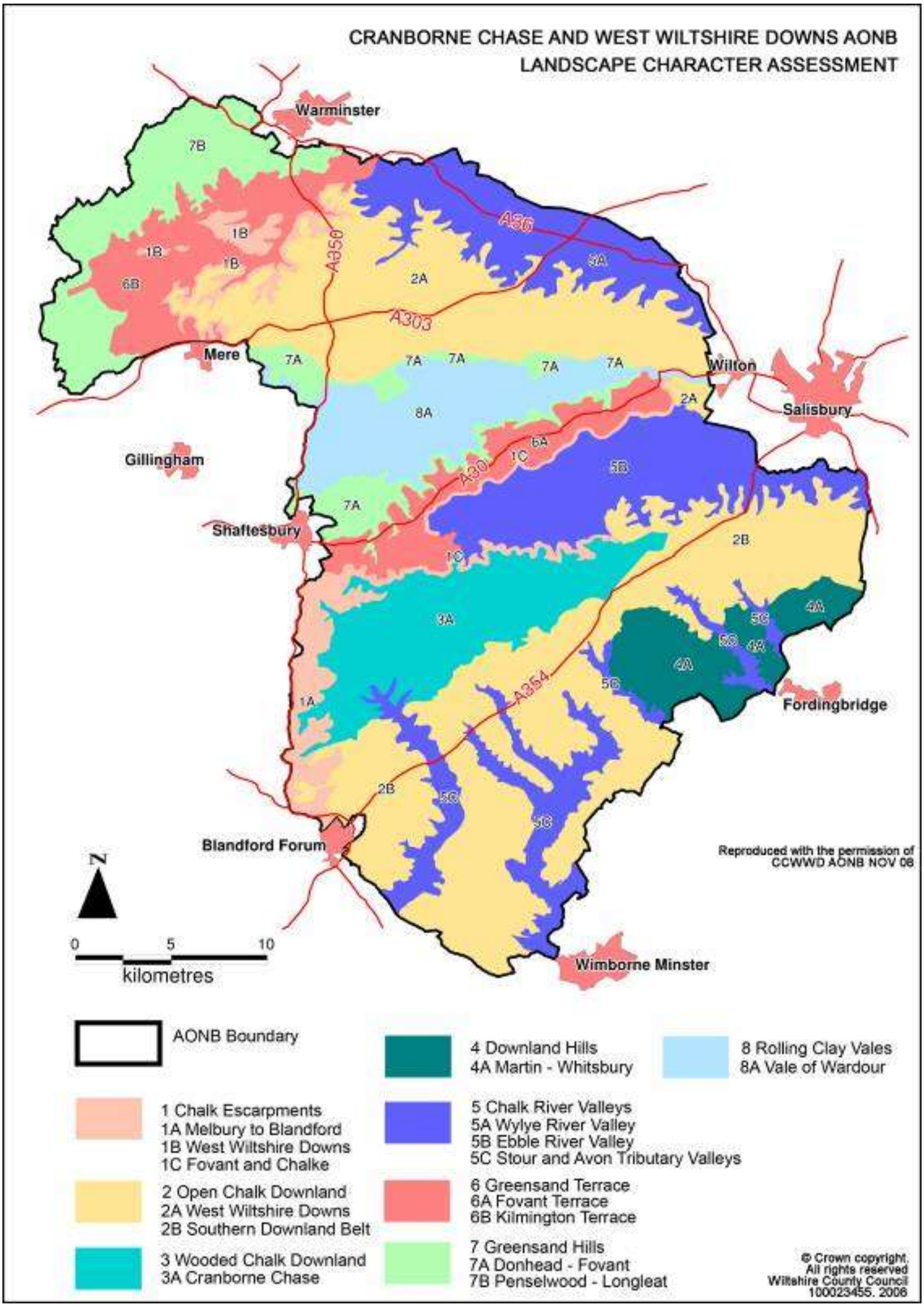

Figure 2.6b Cranborne Chase & West Wiltshire Downs Landscape Character

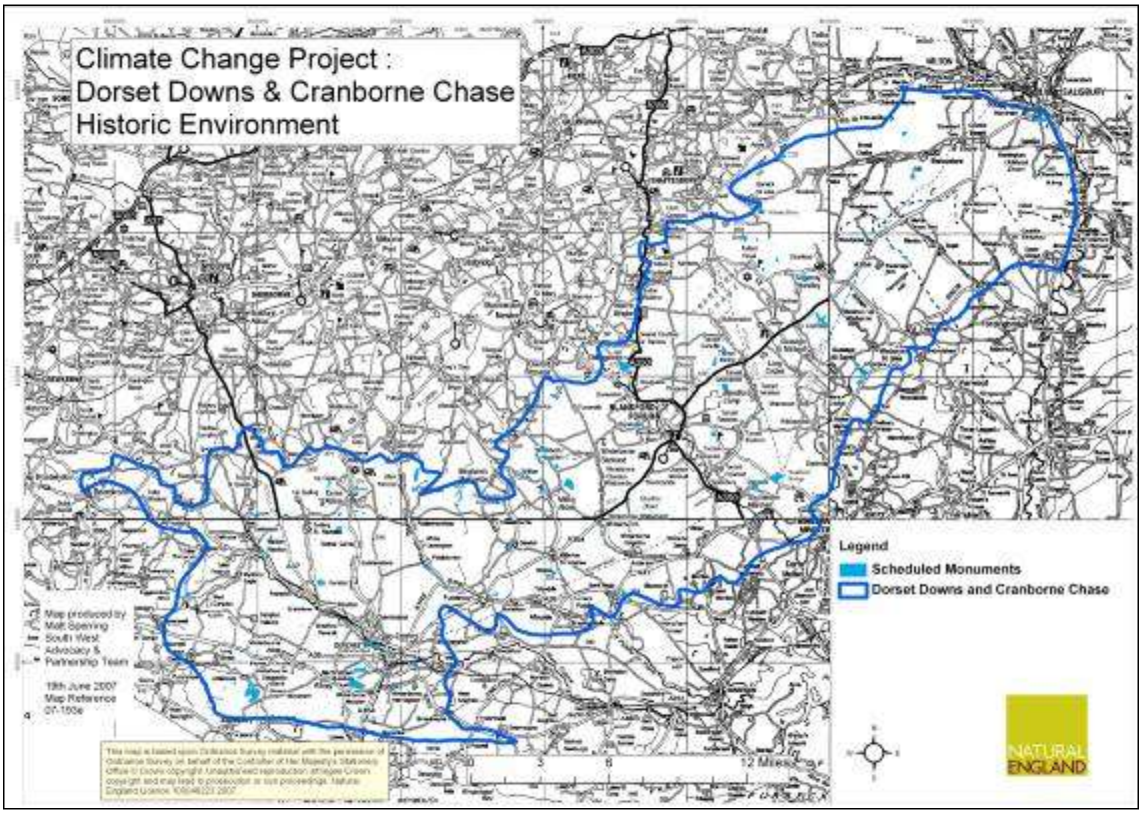

Figure 2.7 Scheduled Ancient Monuments

2.3.4 Ecosystem Services

Human beings benefit from processes or structures within ecosystems that give rise to a range of goods and services called 'ecosystem services' (POST 2006). The Millennium Ecosystem Assessment 2005 grouped ecosystem services into four broad categories:

- Supporting services - such as nutrient cycling, oxygen production and soil formation. These underpin the provision of the other 'service' categories.
- Provisioning services - such as food, fibre, fuel and water.
- Regulating services - such as climate regulation, water purification and flood protection.
- Cultural services - such as education, recreation, and aesthetic value.

Arable cropland occupies 50 per cent of the land surface, with permanent grassland 26 per cent and temporary grassland 9 per cent. Sheep comprise 39 per cent of the total livestock, pigs 36 per cent and cattle 25 per cent. Almost all of the agricultural land in the Character Area is classified as Grade 3 (good or moderate). The arable crops sown in 2007 comprised wheat (40 per cent), oilseed rape (17 per cent), spring barley (16 per cent), winter barley (8 per cent), oats and maize (5 per cent each), with other crops making up the remainder. Grade 4 land is found in the river floodplains.

Shooting, hunting and fishing are important in the Character Area. The fish population on the Stour is dominated by coarse species such as roach. The Allen and Tarrant are important spawning grounds for migratory salmonids. Spawning areas tend to be located in the tributaries where water quality is good. Brown trout are present in the

Stour between Spetisbury and Wimborne. The highest densities tend to be found in the chalk streams, particularly the Allen.

Woodlands in the Character Area provide multiple services. A number of plantations of non-native trees are located throughout the Character Area. The Forestry Commission own a number of sites including Vernditch Chase, Stonedown Wood, Blandford Forest, and Black Down (Hardy's Monument), which are a recreational resource. Woodlands can be managed for timber but also as a source of wood fuel. They also have a role to play in flood risk reduction through interception and storage of rainfall and climate regulation through carbon sequestration.

Flood plains in the Character Area provide natural protection from fluvial flooding. The Environment Agency has chosen to increase the risk of flooding for the chalklands and the River Frome (except Dorchester). Increasing flood risk in specific areas will help to reduce the risk in vulnerable places while creating the opportunity to restore floodplain and provide environmental benefits such as habitat creation.

The chalk aquifer and streams provide water for people. The principal aquifer is the un-confined chalk and it supplies the majority of the groundwater abstractions. It also provides summer baseflow to the Rivers Stour, Frome and associated tributaries as they drain Cranborne Chase and the Dorset Downs. In terms of consumptive use, the largest abstraction by volume is for public water supply (up to 80 per cent) with other uses such as spray irrigation, schools, hospitals and industry making up the remainder. Fish farming and hydropower abstract large quantities of water but this is generally returned to the water course.

The Character Area provides people with enjoyment, learning opportunities, recreation and tranquillity. This is an attractive area for tourists, see Section 2.3.3. Many of the recreation and tourism assets also have value as an educational resource. There are a number of field study and visitor centres in the Character Area. The natural beauty of the area also gives a strong sense of place and local distinction and the landscape has a spiritual quality for many people. The tranquillity map produced by the Council for the Protection of Rural England (Figure 2.8) shows how, away from main roads and towns, the area is very tranquil.

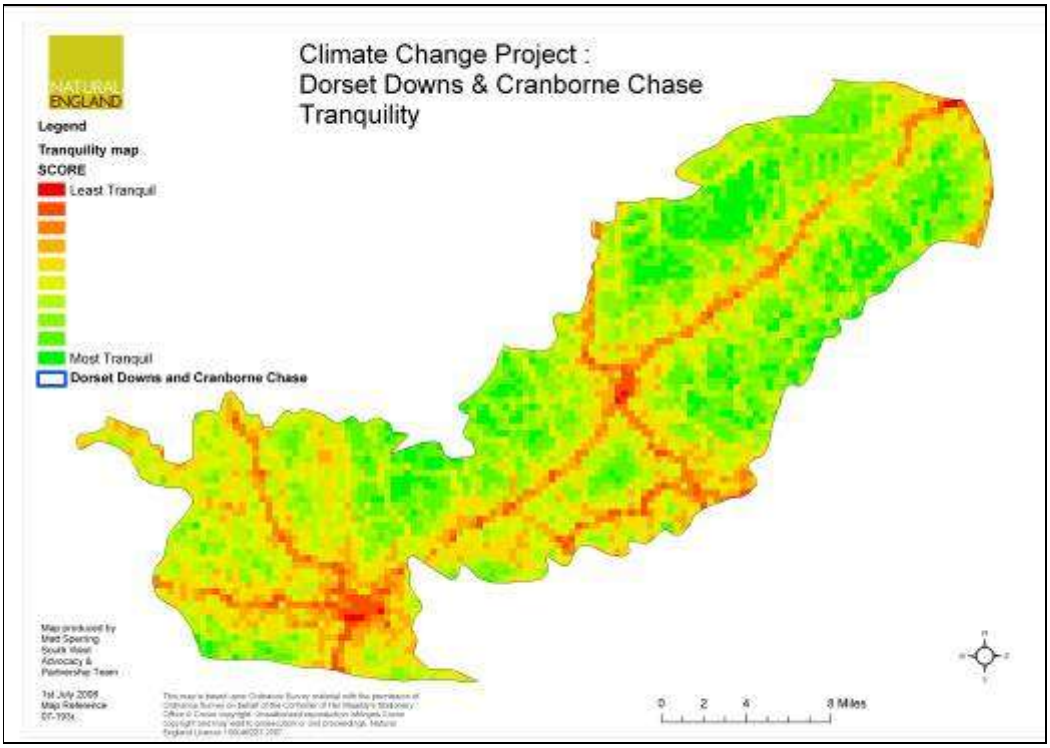

Figure 2.8 Tranquillity map of the Character Area

Table 2.2 Significant natural environmental assets in the Character Area

Type of asset	Assets
Biodiversity and geodiversity	Chalk grassland and scrub and associated insect communities Wet and dry heaths and mires and associated insect and bird communities Dry acid grassland Meadows Chalk streams Fens Purple moor grass and rush pasture Beech, yew, mixed deciduous and wet woodland Wood pasture and parkland Arable farmland Ancient and/or species-rich hedgerows Upper Cretaceous chalk and associated landform; plateau, scarp and dip slopes Lower Cretaceous and Upper Jurassic limestone and sandstone and associated features i.e. spring lines Ice-age features; clay-with-flints, flint screes, acid drift, dry valleys, swallow holes Shallow lime rich soils and freely draining slightly acid loamy soils
Access and Recreation	Public Rights of Way network Open access land Forestry Commission, National Trust and Natural England land Cycle tracks Angling Market towns and urban areas Historic sites
Landscape	Rolling chalk upland with long views Chalk scarp slopes Sheltered pastoral combes Chalk streams and rivers Continuity of open downland Open arable farmland Valley pastures, flood and water meadows, wetlands Wood pasture Ancient field boundary hedges Valley-side broadleaf woodlands Shelterbelts and copses Prehistoric earthworks - hillforts, barrows, lynchets, etc. Medieval field patterns Traditional farmsteads Historic parklands and ancient deer parks Secluded tranquil villages
Ecosystem services	Water resources and quality Flood protection Climate regulation Provision of food, fibre and fuel – farming, fishing and forestry Recreation Tourism Education Tranquillity

3. Impacts

Box 3.1 Key impacts of climate change on the Dorset Downs and Cranborne Chase Character Area

- Change in species and communities that make up a habitat - some species may only survive if they can colonise and survive in different places.
- In the headwaters, ephemeral sections will become largely devoid of aquatic species.
- A decrease in summer rainfall may lead to more frequent droughts and higher soil moisture deficit which could severely affect beech woodland and veteran trees.
- The ability of species and habitats to recover from repeated seasonal drought and flood events may be compromised.
- Veteran trees and isolated parkland trees are at particular risk of high winds associated with storms. However, storms can have a positive impact on woodland biodiversity but an increasing frequency of storm events may reduce their ability to recover.
- Differences in the ability of woodland species to adapt to a longer growing season will be another cause of community composition change.
- An increase in winter rainfall will increase soil erosion, resulting in silt and nutrients being washed into chalk streams and rivers.
- Air quality may decline with negative impacts on biodiversity.
- Changes in agricultural practices may have a greater impact on biodiversity than direct biophysical impacts from climate change.
- A decrease in water availability in summer and an increase in flood risk in winter could affect the amount, distribution and type of access and recreation in the Character Area.
- The hazardous season for outdoor recreation could shift to the summer and more people may need to be rescued due to heat stroke and heat exhaustion. A further consequence of warmer temperatures in water environments is an increase in pests such as midges and mosquitoes.
- Woodland recreation is likely to increase in popularity as people seek shade in the hottest months.
- An increase in visitor numbers would have negative impacts on wildlife and landscape and must be carefully managed to avoid damage.
- Potentially, the landscape of the Character Area could be significantly impacted by climate change and it is possible that by the end of the 21st century, the area will resemble that of the southern Mediterranean at present.

Box 3.1 Continued

- Many historical features that are exposed to weathering will be affected by a combination of heavy rainfall, scrub encroachment, burrowing animals and increased numbers of visitors. However, a decline in the incidence of frost would reduce rates of erosion.

- Longer, drier summers increase the chance of fire, putting thatched and timber-framed buildings at greater risk.

- Many of the processes that contribute to the deterioration of important geological sites will be accelerated, such as vegetation growth, increased rates of erosion and mass movements.

- Arable farming may expand into the floodplains and valleys, changing the appearance of the landscape.

- Exposed sites are preferred for locating on-shore wind farms; hence the chalk plateau of the Character Area could be favoured for wind turbine development.

- Reduced annual rainfall will affect the availability of water resources for human consumption, agriculture, fisheries and habitats but the magnitude of the impact will depend on the return period of droughts.

- Changes to the types and varieties of crops, sowing dates, irrigation, pests, diseases and soil erosion are all likely; current crops may not be able to persist under hotter, drier conditions but new, drought tolerant crops will thrive.

- An increasing oil price and concerns over security of energy supply may lead to an increase in renewable energy generation, putting pressure on the landscape of the Character Area as currently perceived and valued.

- The location of the Character Area in one of the most heavily populated parts of the UK means it is likely to experience development pressure.

- A change in species and community composition may have an effect on the delivery of current conservation targets.

3.1 Bioclimatic Data

3.1.1 Observed climate

In anticipation of the next set of UKCIP scenarios of climate change for the UK, due to be published at the end of 2008, a report detailing observed climate for the UK for two 30 year periods 1961 – 1990 and 1971 – 2000 has been issued. This report presents detailed observed data on the climate variables to be included in the UKCIP08 scenarios (Jenkins *et al*., 2007). The observed climate between 1961 – 2000 for the Dorset Downs and Cranborne Chase geographical area can be seen in Table 3.1.

Between 1961 and 2000 some warming has been observed in the Dorset Downs and Cranborne Chase Character Area. Warming is particularly marked in the winter records with an annual average increase of 0.4 to 0.5°C. This is consistent with the UKCIP02 projections which forecast warmer summers and winters. The observed precipitation record shows less variability between the two thirty year periods although there has been an increase in autumn rainfall.

Table 3.1 Observed climate of the Dorset Downs and Cranborne Chase Character Area (Jenkins *et. al*. 2007)

Climate variable		Observed climate 1961 - 1990	Observed climate 1971 - 2000	Change 1961-1990 to 1971-2000
Temperature	Annual mean	8 - 12°C	10 - 12°C	0.2 – 0.3°C
	Spring mean	6 - 10°C	8 - 10°C	0.3 – 0.4°C
	Summer mean	14 - 16°C	14 - 16°C	0.2 – 0.3°C
	Autumn mean	19 - 12°C	10 - 12°C	-0.1 to 0.1°C
	Winter mean	4 - 6°C	4 - 6°C	0.4 – 0.5°C
Precipitation	Annual mean	700 - 1000mm	700 - 1000mm	2 to 5%
	Spring mean	180 - 260mm	180 - 260mm	-5 to 5%
	Summer mean	100 - 180mm	100 – 180mm	-5 to 5%
	Autumn mean	260 - 350mm	260 - 350mm	5 to 10%
	Winter mean	260 – 350mm	260 - 350mm	-5 to 10%
Wind speed	Annual mean	No data	7 – 14 knots	NA
	Spring mean	No data	7 – 10 knots	NA
	Summer mean	No data	2 – 10 knots	NA
	Autumn mean	No data	1 – 10 knots	NA
	Winter mean	No data	7 – 14 knots	NA
Relative humidity	Annual mean	82 – 85 %	79 – 85 %	-0.9 to -0.3 %
	Spring mean	79 – 82 %	76 – 82 %	-0.9 to -0.3 %
	Summer mean	76 – 82 %	76 – 82 %	-0.9 to -0.6 %
	Autumn mean	82 – 85 %	82 – 85 %	-0.9 to -0.6 %
	Winter mean	85 - 88%	85 – 88 %	-0.3 to 0.3 %

The UKCIP02 scenarios forecast the impacts of climate change under a range of emissions scenarios for the UK (Hulme *et al*., 2002). Scenarios for three different time slices are presented, representing the average climate over 30 year periods centred on the 2020s, 2050s and 2080s. The climate changes projected to the 2020s are similar across all scenarios; this is because changes in the short term are dictated by past greenhouse gas emissions in recent decades. Climate changes beyond the next few decades depend on future emissions, but even the low emissions scenario represents an acceleration of climate change when compared to changes that have occurred in the 20th century. The scenarios are based on a UK Met Office General Circulation Model (GCM), coupled to a Regional Climate Model (RCM) which allows impacts to be projected on a local to regional scale.

The bioclimatic data used in this project is taken from the HADRM3 model, a regional climate model with a 50km^2 resolution, driven by different emissions scenarios; high and low emissions, based on the Intergovernmental Panel on Climate Chang (IPCC) Special Report on Emissions Scenarios (SRES). The UKCIP02 high emissions scenario corresponds to the A1 SRES emission scenario (see Appendix 2 for further explanation of socio-economic scenarios). Table 3.2 gives the bioclimatic data for the Dorset Downs and Cranborne Chase Character Area.

Changes in mean temperature or total rainfall as presented in Table 3.2 are not the only changes we can expect. It is likely that there will also be change in extreme temperatures and rainfall events (for example an increase in heat waves and storms). It is important to note changes in extremes as they are likely to have a big impact on the natural environment.

Table 3.2 Bioclimatic variables for Dorset Downs and Cranborne Chase Character Area

Climatic Variable	Annual average value for Dorset Downs and Cranborne Chase Character Area					
	2020s		2050s		2080s	
	High	Low	High	Low	High	Low
Change in absolute maximum temperature	1.71 ºC	1.44 ºC	4.08 ºC	2.57 ºC	7.06 ºC	3.64 ºC
Change in absolute minimum temperature	0.76 ºC	0.64 ºC	1.81 ºC	1.14 ºC	3.14 ºC	1.62 ºC
Change in minimum temperature expected over 20 years	1.05 ºC	0.88 ºC	2.50 ºC	1.57 ºC	4.35 ºC	2.23 ºC
Change in growing degree days >5ºC	374	314	896	563	1555	800
Change in mean temperature of the coldest month	No data	0.64 ºC	1.80 ºC	1.14 ºC	3.12 ºC	1.61 ºC
Change in mean temperature of the warmest month	No data	1.15 ºC	3.41 ºC	2.09 ºC	6.02 ºC	3.03 ºC
Change in total potential evapotranspiration	No data	28.1%	82.2%	51.3%	153.8%	74.3%
Percentage change in moisture	-46.4%	-38.8%	-114.1%	-70.5%	-206.5%	-101.4%

Climatic Variable	Annual average value for Dorset Downs and Cranborne Chase Character Area					
	2020s		2050s		2080s	
	High	Low	High	Low	High	Low
availability						
Change in total precipitation	-2.9%	-2.4%	-6.9%	-4.3%	-11.9%	-6.1%

A visual summary of the major changes in rainfall and temperature expected in England is provided in Figure 3.1.

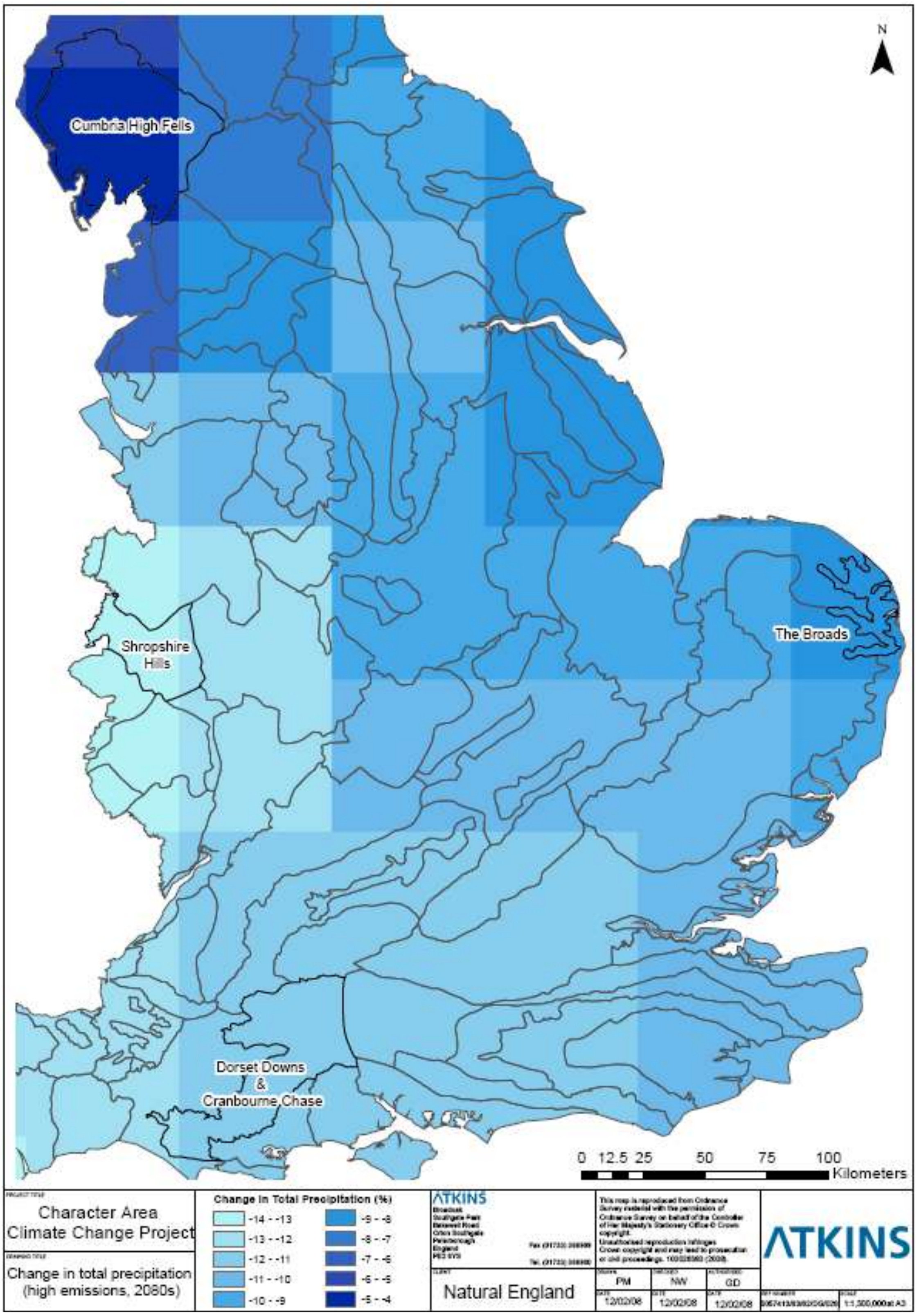

Figure 3.1a UKCIP02 scenarios (2080s high emissions) - total precipitation

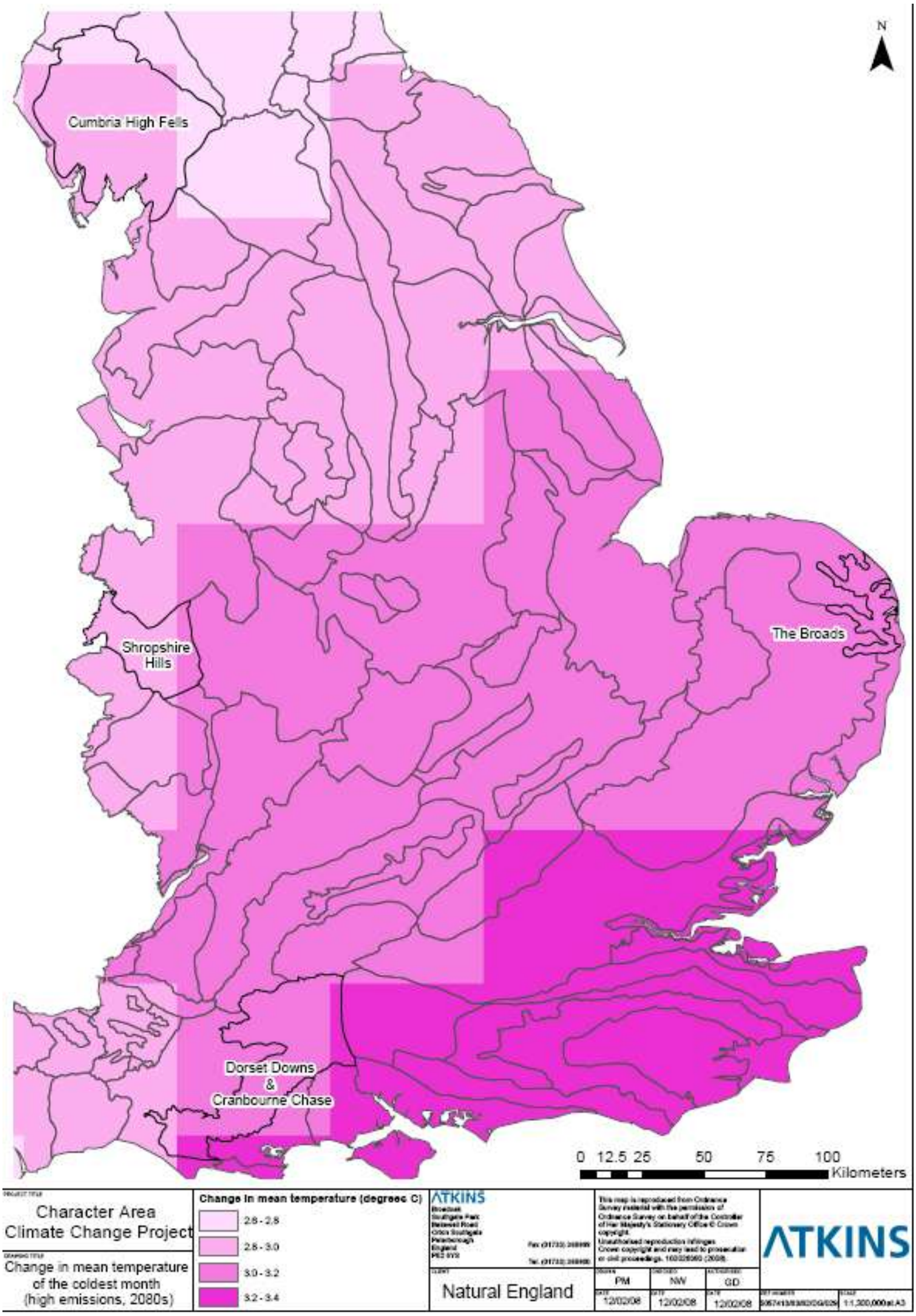

Figure 3.1b UKCIP02 scenarios (2080s high emissions) - change in mean temperature of the coldest month

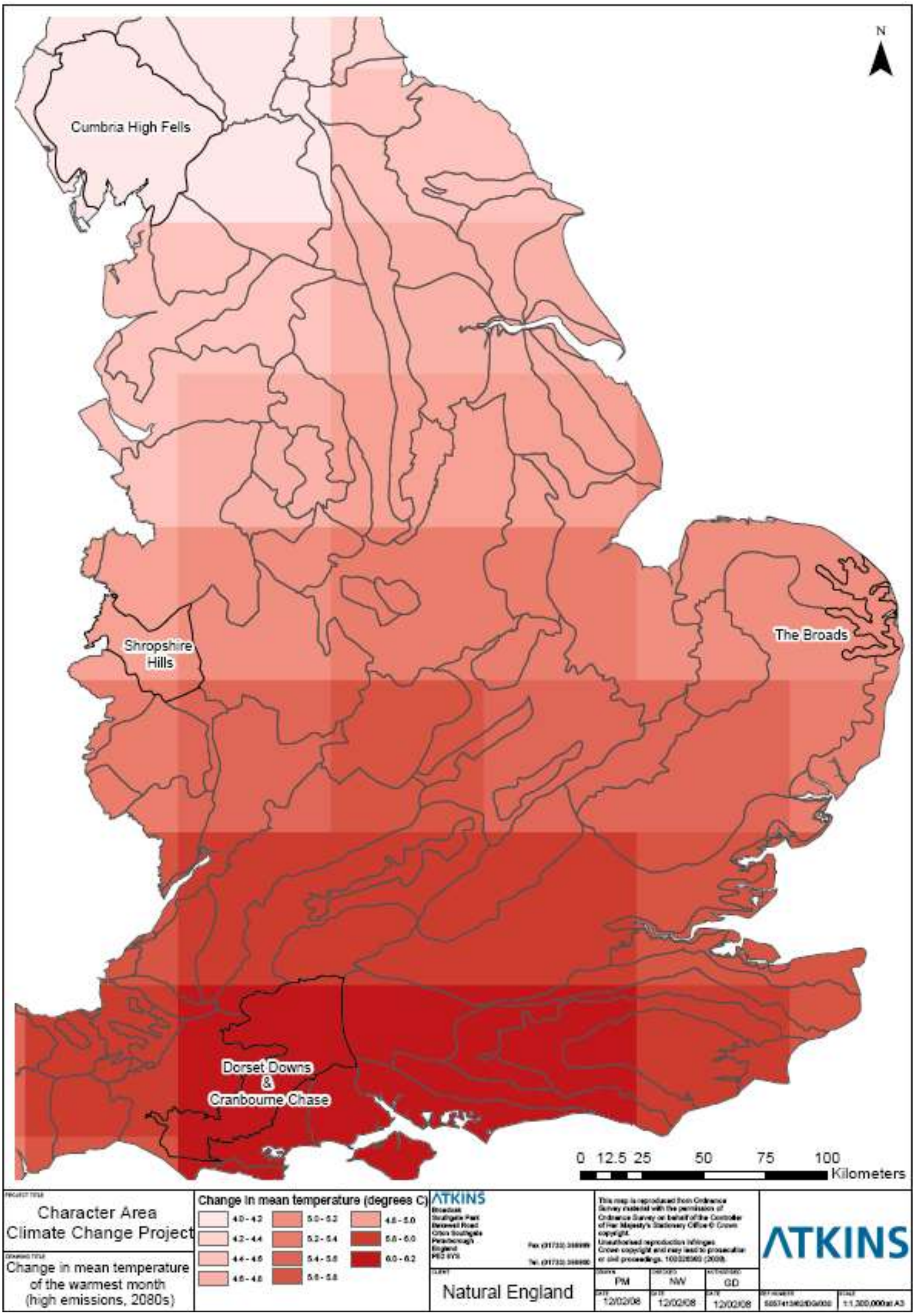

Figure 3.1c UKCIP02 scenarios (2080s high emissions) - change in temperature of the warmest month

3.2 Types of impact

Climate change will not be the only pressure on natural environments in the future and other impacts will be felt through socio-economic change. The Dorset Downs and Cranborne Chase Character Area is influenced by agriculture and changes in agricultural practices are likely to have a significant impact on species, habitats and landscapes. Changes in agriculture could be driven by climate change, such as crop switching to more drought tolerant plants or conversion of grazing land to arable. These would be classified as indirect impacts of climate change on the Character Area. This project focuses mainly on the direct biophysical impacts of climate change on the assets valuable to Natural England. Where significant indirect impacts have been identified (such as those related to agricultural change in the face of climate change) these have been documented.

The interaction of climate change and socio-economic pressures adds another source of uncertainty to predictions of future impacts. However, the direct impacts of climate change are also subject to uncertainty due to socio-economic change. The impacts of climate change will be mediated by the socio-economic scenario that prevails at the time; changes in attitudes and behaviour towards the natural environment and conservation will alter the nature of the impacts.

We have assumed that the socio-economic scenario that prevails in future will be broadly similar to that which we currently experience. In identifying climate change impacts, only one emissions scenario (high) for the 2080's has been used to indicate a direction of travel. For further information about socio-economic scenarios, see Appendix 2.

3.3 Impacts on significant natural environmental assets in the Character Area

The UKCIP02 climate change projections, the bioclimatic data given in Table 3.2 and expert judgement was used to identify impacts on the significant natural environmental assets identified in the Character Area in Chapter 2. Table A3.1 in Appendix 3 identifies the climatic changes pertinent to the significant environmental assets and the likely impacts, which are discussed further below.

One of the most important factors in determining habitat resilience to climate change is the condition of the habitat. Natural England's goal is to achieve favourable condition on 95 per cent of SSSIs by 2010.

3.3.1 Impacts on biodiversity and geodiversity assets

Direct Impacts

The main biophysical impact of climate change is likely to be a change in species and communities that make up a habitat. Results from the Monarch study (Walmsley *et al.* 2007) indicate that certain species will gain suitable climatic space in the north and west whilst losing it in the south. Broadly speaking some species may only survive if they can move and survive in different places. Changes in climate will alter the competitive balance between species thus changing where individual species can colonise and survive (see Box 3.2). However, climate is not the only factor determining colonisation; the means of dispersal, competition and presence of suitable habitat will all determine if species move.

Table A3.1 in Appendix 3 contains details of species composition changes for each habitat but broadly speaking climate change will encourage species to move upwards and across valleys to north facing slopes (see Box 3.2). Some likely changes are:

- In chalk grassland, upright brome *Bromopsis erect)* may be at a competitive disadvantage under future climatic conditions whilst tor grass *Brachypodium pinnatum* may increase in dominance and expand its range.
- Reducing occurrence of beech *Fagus sylvatica*.
- Increase in lime *Tilia cordata* in woodlands.
- Change in woodland ground flora.
- Loss of specialists associated with veteran trees (primarily fungi, saproxylic invertebrates and lichens).
- Loss of riverine species from areas where water temperatures move outside the range required for the species to compete effectively.

Box 3.2 Change in suitable climate space
As air rises, the pressure it experiences decreases and it expands. As it expands, energy is released and consequently the temperature of the air falls. As a rule of thumb, for every 100m air rises, its temperature drops by 1ºC; this is the dry adiabatic lapse rate (see Figure 3.2). As a result of increasing temperatures at ground level, species will move upwards, if they are able, in order to find the temperature to which they are adapted. There is already observational evidence of this effect occurring; Hickling *et al*. (2006) report that a wide variety of vertebrate and invertebrate species have moved northwards and uphill in Britain over approximately 25 years. This phenomenon is more pronounced in the Alps with certain species observed to be moving 23.9m upwards per decade (Parolo and Rossi 2007). In addition to moving upwards, species will move across valleys to north facing slopes as the temperature on south facing slopes exceeds that which they can tolerate. There is also evidence of species moving in response to topographic influence on micro-climate; Davies *et al*. (2006) report the changing slope and aspect preferences of silver-spotted skipper in response to climate change.

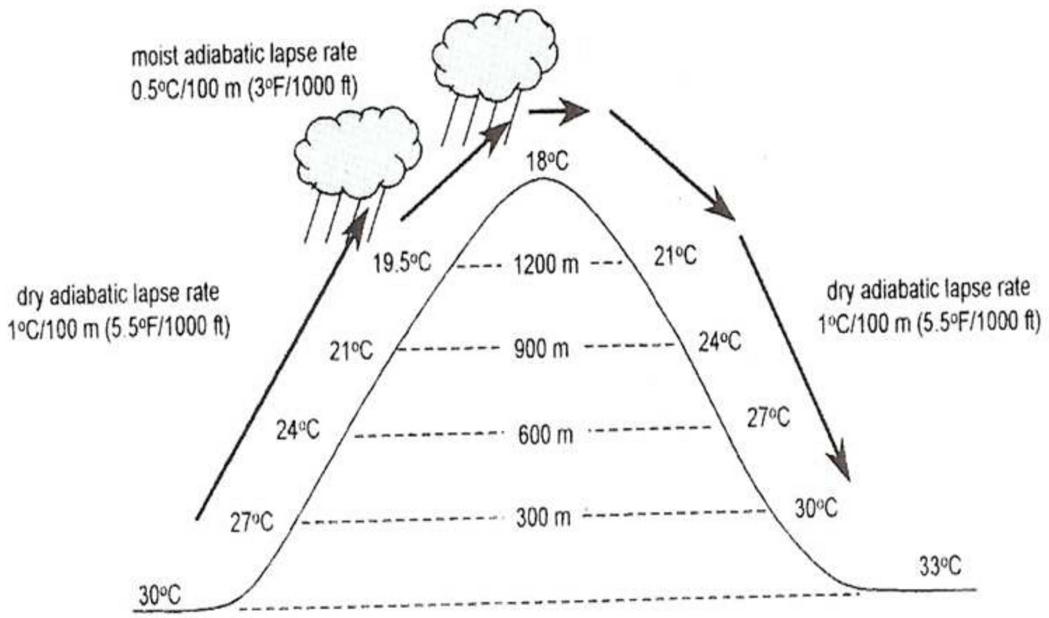

Figure 3.2 Adiabatic lapse rate
Source: Hopkins, from Bonan 2002

As some species are likely to lose climate space, others will gain it. Not all the species gaining climate space are welcome; climate change may increase the number of non-native and invasive species. Examples identified from the Dorset Downs and Cranborne Chase include:

- Loss of regional differences and/or native distinctiveness in invertebrate assemblages.
- Potential invasion of woodland species from further south in Europe for example Mediterranean pines and Holm oak *Quercus ilex*.

Changes in temperature will have phenological effects which are also likely to affect community composition. For example, it is predicted that temperature changes may cause certain lowland hay meadow species to flower or set seed earlier in the season. Phenological changes are already being observed in the UK; earlier arrival of birds and butterflies in the spring have been recorded (Sparks *et al*., 2001) and tree leaf appearance in Surrey has been found to be 10 days earlier in the 1990s than the 1980s (Sparks *et al*., 2001). Changes in phenology are another cause of compositional change as changes in the relative timing of events has knock on effects for other species in the community.

Increasing temperatures will exacerbate algal blooms and problems associated with excess nutrients in water courses. Algal blooms are responsible for fish kills which could increase in frequency. This is an existing problem due to the amount of intensive arable farming in the Character Area but it is likely to be exacerbated by climate change.

As well as temperature changes, climate change will alter rainfall patterns which will impact on biodiversity. More extreme periods of low river-flows will result in lower water levels, reduced dissolved oxygen levels and poorer flushing of contaminants. As a result, riverine species adapted to flowing water conditions will decline. This problem is compounded by higher water temperatures and enhanced nutrient and fine sediment delivery during summer. In headwaters, ephemeral sections will become largely devoid of aquatic species, whilst perennial sections will become ephemeral, thus resulting in a further loss of riverine habitat. There is however some uncertainty over the impact of climate change on chalk streams.

Wessex Water has investigated the Middle Stour catchment to determine whether there is an adverse effect of abstraction for public water supply on the ecology of the rivers and streams (Hyder Consulting (UK) Ltd, 2008). It was not possible to isolate the influence of abstraction on the ecological communities of the Stour. However, studies confirmed that the North Winterborne supports varied macroinvertebrate and macrophyte communities, including a number of winterbourne specialist species and rare or notable taxa. Monitoring data indicated that winterbourne macrophyte community types and macroinvertebrate specialists occurred further downstream after consecutive dry winters, for example in 2006. In dry years the North Winterborne was dry for between 2.5 months and 8 months. It was predicted to be dry for an additional 21 days as a consequence of abstraction.

A decrease in summer rainfall may lead to more frequent droughts and higher soil moisture deficit which could severely affect beech woodland and veteran trees. This in turn would lead to a reduction in associated species and a loss of landscape character. This is a significant impact for the Dorset Downs and Cranborne Chase as scattered and parkland trees are an important component of the landscape. The loss of veteran trees would also result in a loss of bat roosts, unless dead trees can be left standing to provide cracks and holes for roosting bats. Conversely, wetter winters could threaten the integrity of flood meadows as the plants are more prone to increasing wetness than to summer drought.

A further impact of climate change may be greater variation between seasons. Whilst habitats may be able to recover from individual flood or drought events, a seasonal cycle of flooding and drought is likely to put significant pressure on habitats. Shallow rooted plants are particularly vulnerable to extremes of drought and flood. The ability of species and habitats to recover from repeated seasonal drought and flood events may be compromised.

Veteran trees and isolated parkland trees are at particular risk of high winds associated with storms. An increasing frequency of storm events might also threaten populations of rare species which rely on mature trees. However, storms can have a positive impact on woodland biodiversity by creating gaps for pioneer species, structural variety for shrub species and dead wood for insects and fungi. Flash floods associated with storms can also damage vegetation and cause soil erosion.

An increase in temperature and growing degree days will lengthen the growing season. This may be beneficial to some species which can adapt to a longer growing season, for example oak, but detrimental to those that cannot for example ash. Differences in the ability of woodland species to adapt to a longer growing season will be another cause of community composition change. Overall, it is likely that an increase in the length of the growing season will be beneficial for trees.

Climate change may increase the rate of physical processes such as soil erosion in the Character Area. An increase in winter rainfall or storm events may increase erosion, resulting in more nutrients and sediment being washed into rivers. Roads and tracks have been found to be particularly effective at providing a route for run-off and sediment to water courses. The Catchment Sensitive Farming projects operating in the area have traced sediment and nutrients to arable farmland and this is already a significant impact on aquatic wildlife, likely to be exacerbated by climate change.

Air quality can be impacted by climate change and there may be consequent impacts on biodiversity. Concentrations of low level ozone are predicted to increase as temperatures warm. Ozone pollution can affect biodiversity; beech and birch are sensitive to ozone and studies of ozone effects on grassland communities have reported changes in community composition (Morrissey *et al*. 2007). Other habitats, such as wetlands, heaths, montane and inland rock habitats are poorly studied although there is some evidence that montane habitats and bogs are sensitive to ozone (Morrissey *et al*. 2007).

There will be an impact on finite geological features. Many of the processes that contribute to the deterioration of important geological sites will be accelerated, such as vegetation growth, increased rates of erosion and mass movements. More frequent vegetation clearance will be necessary to maintain the visibility or rock exposures.

Indirect impacts

Changes in agricultural practices as a result of climate change may have a greater impact on biodiversity than direct biophysical impacts.

An increase in the area of cultivation and scrub clearance as a response to longer growing seasons and the development of new crops may negatively impact on the habitats of the Character Area. Expansion of arable farming as a response to longer growing seasons and new viable crops may result in the conversion of valleys and floodplains to arable fields. Arable farming will concentrate in the valleys and plateau, as steep scarp slopes cannot be ploughed. This would result in a loss of grassland and wetland habitats and associated species.

Increasing intensification of agriculture would further impact on freshwater habitats as the amount of nutrients and sediment washed in would increase, exacerbating eutrophication and algal blooms.

Agriculture also affects the permeability of the landscape for the more mobile plants and animals. Creation and extension of habitat networks will be constrained by the presence of agricultural land uses hostile to species. These indirect impacts of climate change will be mediated by the prevailing socio-economic scenario in the future (see Appendix 2) and the state of agricultural economics is hard to predict.

In addition to agriculture, recreation is a significant driver of change in the Character Area. The potential impacts of an increase in tourism and recreation on biodiversity in the Character Area are identified in Section 3.3.2. Grassland plants are susceptible to trampling by visitors and freshwater habitats are at risk from an increase in water based recreation. The increase in tourism in the spring in response to warmer temperatures may have a negative impact on ground nesting birds.

3.3.2 Impacts on access and recreation assets

Direct Impacts

A decrease in water availability in summer and an increase in flood risk in winter could affect access and recreation in the Character Area. Currently, fishing in the chalk streams and rivers is a popular recreation activity which could be threatened if water levels drop in summer and fish can no longer survive.

In winter, flooding of winterbornes becomes an issue for fishing and other forms of recreation near water including walking and cycling. There is potential for disruption to the rights of way network and other visitor attractions (including urban areas) due to flooding. An increase in standing water on footpaths and other rights of way may also lead to more rapid erosion. Overall though this is likely to be a sporadic, short term impact that is unlikely to lead to long term closure or inaccessibility of areas. The Character Area has few riverside paths and therefore is not highly vulnerable to this impact.

Increased temperatures may lead to additional maintenance costs for paved rights of way. Melting and pot holing of surfaces will become more frequent due to climate change and an increase in usage due to more visitors may increase the amount of maintenance required.

Warmer, drier summers may increase the fire risk in the Character Area. Whilst fires are not currently common in the Character Area due to accidents or used as a management technique, climate change will increase the risk of fire occurring. Should a fire occur, there is the potential for severe damage to recreation assets such as historic sites and valued landscapes. The greatest risk will be associated with areas of heathland and grassland. During a fire, smoke may collect in valley bottoms, becoming a health and safety risk for visitors.

Hotter, drier summers may also lead to more incidences of heatstroke and other heat related illnesses. Currently, winter is seen as the high risk season for recreation. Under conditions of climate change, the hazardous season for outdoor recreation could shift to the summer and more people may need to be rescued due to heat stroke and heat exhaustion.

A further consequence of warmer temperatures in water environments is an increase in pests such as midges. This could reduce the attractiveness of the area to visitors. Possibly more serious is the potential for the re-introduction of vector borne diseases such as malaria. The Health Protection Agency (HPA) has mapped malaria suitability under recent climate and a range of future climate scenarios illustrating the number of months introduced mosquitoes could persist in the UK. Under the 2080s medium-high emissions scenario, the risk of malaria transmission is predicted to increase in the South West (HPA, 2008).

Woodland based recreation is also likely to increase in popularity as people seek shade in the hottest months and there will be an opportunity to develop visitor facilities at woodland sites. However, climate change may pose health and safety risks in woodland areas; woodlands susceptible to windblow from storms may become hazardous due to falling branches. In addition, tick-borne diseases such as Lyme disease may become more prevalent in woodland areas as warmer temperatures allow rapid development between tick stages (HPA, 2008). However, there is no simple correlation between temperature and incidence of Lyme disease, other factors such as agricultural and wildlife management practices and increased exposure may be responsible for an increase in cases (HPA, 2008).

Hunting and shooting are unlikely to be significantly impacted by climate change but there may be potential for new species to be reared in the Character Area. However, hunting during wetter winters may lead to increased erosion from vehicles and horses hooves.

There may be opportunities for new activities as climate becomes warmer and drier in summer including paragliding and hot air ballooning.

Indirect Impacts

The in-direct impacts of climate change on recreation assets in the Character Area are due to an assumed increase in visitor numbers as a response to an increase in temperature. Visitor numbers may also increase as UK-based holidays become more popular than overseas destinations which “carbon pricing” may make too expensive or where temperature rises have made the local climate too uncomfortable. Whilst this assumption may be valid under the current socio-economic scenario, this may not be the case under alternative scenarios where people have different attitudes towards the environment and nature conservation has different objectives. The assumption that visitor numbers would increase has been made in this report and in Table A3.1 in Appendix 3.

A rise in temperature and the consequent rise in visitor numbers can be seen as an opportunity or a threat for the Character Area. In terms of recreation and enjoyment of the natural environment, climate change may present an opportunity. The impact of climate change may be to extend the tourist season as the autumn and spring months become popular. It is anticipated that the greatest increase in visitor numbers will be in the shoulder months. This may benefit the tourism industry which traditionally is very seasonal. However, an increase in visitor numbers may have negative impacts on wildlife and landscape and the opportunity must be carefully managed to prevent it becoming a threat. An increase in visitor numbers due to a more favourable climate could further increase the number of people visiting the Character Area. A number of potential negative impacts of an increase in visitor numbers can be identified including:

- Even greater congestion at ‘honeypot’ sites or on popular rights of way leading to a reduction in visitor experience and wilderness quality.
- Increase in litter, noise and pollution.
- Increased use of water bodies and navigable waterways causing congestion and increased erosion.
- Greater pressure on water resources and sewage treatment works.
- Increased demand for visitor infrastructure for example accommodation and resources.
- Congestion on transport infrastructure for example roads, car parks, trains.
- Footpath erosion leading to increased run-off and sedimentation of rivers.
- Increased disturbance to sensitive wildlife due to trampling.

As well as the natural environment, the historic and cultural landscape of the Character Area is an important visitor attraction. Many trips are focused on one of the market towns that act as gateways to the Character Area. Negative impacts of an increase in visitor numbers are likely to be felt in these areas as well as in the natural environment. An increase in visitors may cause an increase in traffic, pollution, litter and put increasing pressure on resources such as water. Demand for services and infrastructure such as car parks and public toilets will increase.

Changes in agriculture as a result of climate change may have an impact on access and recreation. Increasing intensification may reduce permissive access to the valleys as farmers seek to avoid damage to crops. The resulting change in landscape character may also affect the perception of Character Area to tourists, potentially making it less attractive. An increase in visitor numbers may also reduce the wilderness quality associated with the Character Area, making it less attractive to tourists and visitors.

3.3.3 Impact on landscape

Direct Impacts

Potentially, the landscape of the Dorset Downs and Cranborne Chase Character Area could be significantly impacted by climate change and it is possible that by the end of the 21st century, the area will resemble that of the southern Mediterranean at present. Warmer, drier conditions could lead to a landscape dominated by drought resistant species. Current chalk grassland species are unlikely to survive drier, warmer conditions, particularly on south facing slopes. The character of north facing slopes is likely to change and remnants of chalk grassland may be found here.

Bracken, scrub and gorse are likely to grow faster under climate change and, without management, will dominate the landscape more than they do at present.

Veteran trees, scattered trees and orchards may be particularly at risk of drought due to climate change and this is a feature that may be lost from the landscape. This is likely to be a significant impact for the Dorset Downs and Cranborne Chase as scattered trees are an important component of the landscape in this Character Area. Parklands are also important and an increase in stormy weather and the arrival of new pests and diseases makes historically authentic tree plantings difficult to conserve.

The headwaters of chalk streams and dew ponds may dry out, potentially being lost from the landscape.

Slope stability could be reduced by climate change. An increase in winter rainfall may lead to more mass movement. Drying of clay soils in summer may also lead to cracking and subsidence.

Climate change is likely to have direct impacts on the historic environment. There are a significant number of known and visible archaeological features, including prehistoric earthworks such as settlement remains, ritual/burial sites, medieval settlements and field patterns, deer parks, historic parklands and traditional farm buildings. Many of these features that are exposed to weathering will be affected by a combination of heavy rainfall, scrub encroachment, burrowing animals and increased numbers of visitors. However, a decline in the incidence of frost would reduce rates of erosion. Buried organic remains in river valleys could be affected by drought. Accelerated growth of bracken and scrub may also obscure archaeological remains and historic landscapes.

Climate change may also threaten buildings. Short, sharp rainfall events can cause erosion on monuments and longer, drier summers create fire-risk, putting thatched and timber-framed buildings at greater risk. There is a risk of storm and pest damage to buildings in a warming climate and a repeated cycle of wetting and drying can also damage the foundations of historic buildings. However, as above, a decline in the incidence of frost would reduce rates of erosion.

Table 3.3 Climate change potential impacts on landscape of Dorset Downs and Cranborne Chase

Landscape feature	Potential impacts of climate change
Rolling chalk upland with long views	Longer growing seasons leading to increased growth of scrub e.g. alongside droves thereby reducing visibility.
Chalk scarp slopes	Increased summer drought leading to parching on south-facing slopes, thinning of grass sward and increasing the vulnerability of soil to erosion from grazing, wind and foot traffic.
Sheltered pastoral combes	As above plus lowering of water table, leading to (as above) on steep slopes, less lush grazing, perhaps increased scrub on neglected grasslands.
Chalk streams and rivers	Lower river flows and increased siltation resulting from more frequent heavy rainfall events, leading to loss of surface chalk stream headwaters due to lower water table. Loss of ponds, including dew ponds reliant on surface drainage.
Continuity of open downland	Increased summer drought. Longer growing season. Localised parching of downland turf swards depending on aspect potentially causing bare earth and changes in species composition, leading to changes in vegetation texture and seasonal colour. May include faster growing, tall scrub.
Open arable farmland	Warming. Increased summer drought. Change in arable crops to more drought tolerant types (sunflowers, beans, lupins). Possible increased encroachment of arable into more pastoral landscapes due to increased profitability of arable and marginalization of livestock.
Valley pastures, flood meadows and wetlands	Increased summer drought. More extreme rainfall conditions. Drier low-flow periods. Increased abstraction periods - Potential need for water collection/storage structures (reservoirs) in the landscape. Increased erosion and instability of river banks.

Landscape feature	Potential impacts of climate change
	Drying up of wet pastures and wetlands in the landscape.
Wood pasture	Increased summer drought. Die-back and loss of veteran, ancient and mature trees (e.g. Beech). Parching of grass swards due to loss of shade/tree canopy.
Ancient field boundary hedges	Warming. Longer growing season. Extreme weather conditions. Gradual changes in shrub species composition with dominance of more adaptable, faster growing species. Potential dieback due to lower water table and possible difficulties with new hedge establishment .Wind throw of boundary trees.
Valley-side broadleaf woodlands	Increased summer drought. Warming, lack of frosts. Changed rainfall patterns. Gradual loss of/stress to certain species, e.g. characteristic Beech (surface rooting) vulnerable to drought and wind throw. Change in species composition of woodlands, e.g. more Holm Oak and other drought resistant species. Need for mixed woodland - more robust, rather than single species.
Shelterbelts and copses	Increased summer drought. Warming, lack of frosts. Changed rainfall patterns. Increased windiness. Impacts as above. Also potential increased need for woodlands with appropriate species to shelter crops and wildlife habitat from desiccating winds.
Prehistoric earthworks - hillforts, barrows, lynchets, etc.	Increased summer drought. Warming. Changed rainfall patterns. Increased windiness. Earthworks ideally benefit from a protective cover of permanent grassland. Potential parching of sward and exposure of soil to heavy rain, wind and livestock/pedestrian erosion will make these sites increasingly vulnerable to degradation. Scrub encroachment and warm environment can attract burrowing animals to earthworks. Warmer weather over a longer period may increase recreation activity on many of these sites with increased erosion.
Medieval field patterns	Warming. Longer growing season. Extreme weather conditions As above for ancient field boundaries. Also, small-scale, irregular pattern may be vulnerable to potentially more intensive farming and pressure to locally modify field boundaries (perhaps not on the scale of recent decades, but such change can be an insidious process).
Traditional farmsteads	Extreme weather conditions. Traditional farm buildings that are not maintained and kept weather proof may become more vulnerable to decay due to frequent, heavy rainfall and damp conditions, though a decline in frosts would counteract some of these negative impacts.
Historic parklands and ancient deer parks	Warming. Longer growing season. Extreme weather conditions. These are often complex landscapes including a wide range of wildlife, historic and landscape features. Adverse effects on the key components of grassland, woodland/wood pasture and water bodies, together with changes in grazing management, could cause potential degradation of the value of these important cultural landscapes.
Secluded tranquil villages	More severe summer drought episodes. Extreme weather conditions. Wetter, warmer winters. The spring line farmsteads and villages that occur alongside the chalk streams in combe bottoms are key features in this landscape. Periods of low

Landscape feature	Potential impacts of climate change
	water levels and intermittent flooding will affect these communities in the landscape. Warmer seasons may attract more visitors and create opportunities for enjoyment of the landscape along with physical impacts associated with transport and access.

Indirect Impacts

The main impact of climate change on the landscape of the Character Area may be through changes to agricultural practice. For example, re-intensification of agriculture due to improved growing conditions and newly viable crops may result in increased field size and a monoculture landscape at the expense of woodland and grassland networks. Arable farming may expand into the floodplains and valleys, changing the appearance of the landscape. Expansion into the floodplains would also affect the historic landscape, restricting access to historic features and potentially disturbing buried archaeology.

Climate change mitigation policy may have impacts on the landscape of the Character Area. Currently, UK climate and energy policy supports the development of wind power in response to climate change. Exposed, upland sites such as near Gillingham and Purbeck are preferred for locating on-shore wind farms; hence the Character Area could be favoured for wind turbine development. This is likely to have significant landscape impacts although siting of turbines on the dip slope may be preferable to the scarp slope where there are significant biodiversity and landscape assets. Mitigation policy also favours the growth of energy crops. The implications of this on landscape are uncertain, but could lead to re-intensification of some areas, in valleys and flood plains. An increase in the growth of maize or *Miscanthus* will have an impact on the appearance of the landscape.

The Character Area exhibits characteristics of a landscape moderately robust to climate change (see Box 3.3). The Character Area has medium to low permeability, in that 10-22 per cent of it is covered with functional habitat network (Catchpole, 2007 and see Figure 3.2). However, it has significant topographical variation and twelve different soil types. Land cover is not particularly heterogeneous with large swathes of arable on lighter soils, and generally linear areas of fragmented downland and patches of woodland concentrated on the scarp slopes. Within the larger habitat networks, the vegetation is diverse and structurally varied due to variations in soil, topography and grazing regime. Water regimes are moderately diverse; winterbournes respond to variations in rainfall but natural flooding in the plains is limited by land drainage and control structures. In most cases, water meadows are no longer used. In summary, the resilience of the landscape to climate change varies from low on the dip slopes/plateaux of the chalk downland and in the floodplains, to high on the chalk scarp slopes.

Box 3.3 Resilience and robustness to climate change

When evaluating the impacts of climate change on landscapes, the terms robust and resilient are potentially useful. However, there are subtle differences between the terms. Resilience is defined in the climate change literature as '*the ability of a system to recover from the effect of an extreme load that may have caused harm*' (UKCIP 2003) whilst robustness is defined as '*the ability of a system to continue to perform satisfactorily under load'* (UKCIP 2003). In terms of climate change and the natural environment, a resilient landscape can be thought of as one that can recover following an extreme climate event (such as a storm or flood) although recovery may not be to the same condition as it was in prior to the event. Recovering from climate change will involve a shift in state; recovery to the status quo will not be sustainable in the long term.

A robust landscape can be thought of as one that continues to function under the stresses caused by prolonged changes in temperature and rainfall. In order to continue functioning a robust landscape must posses the ability to change in response to climate change e.g. species need to be able to move. A robust landscape is likely to possess extensive, permeable habitat networks and exhibit heterogeneity within and between habitats. Landscapes resilient to climate change are likely to possess the following features (Hopkins *et al*. 2007):

- high permeability;
- variation in topography – slope, aspect and height;
- soil diversity;
- numerous land cover types;
- diverse and structurally varied vegetation; and
- diverse water regimes.

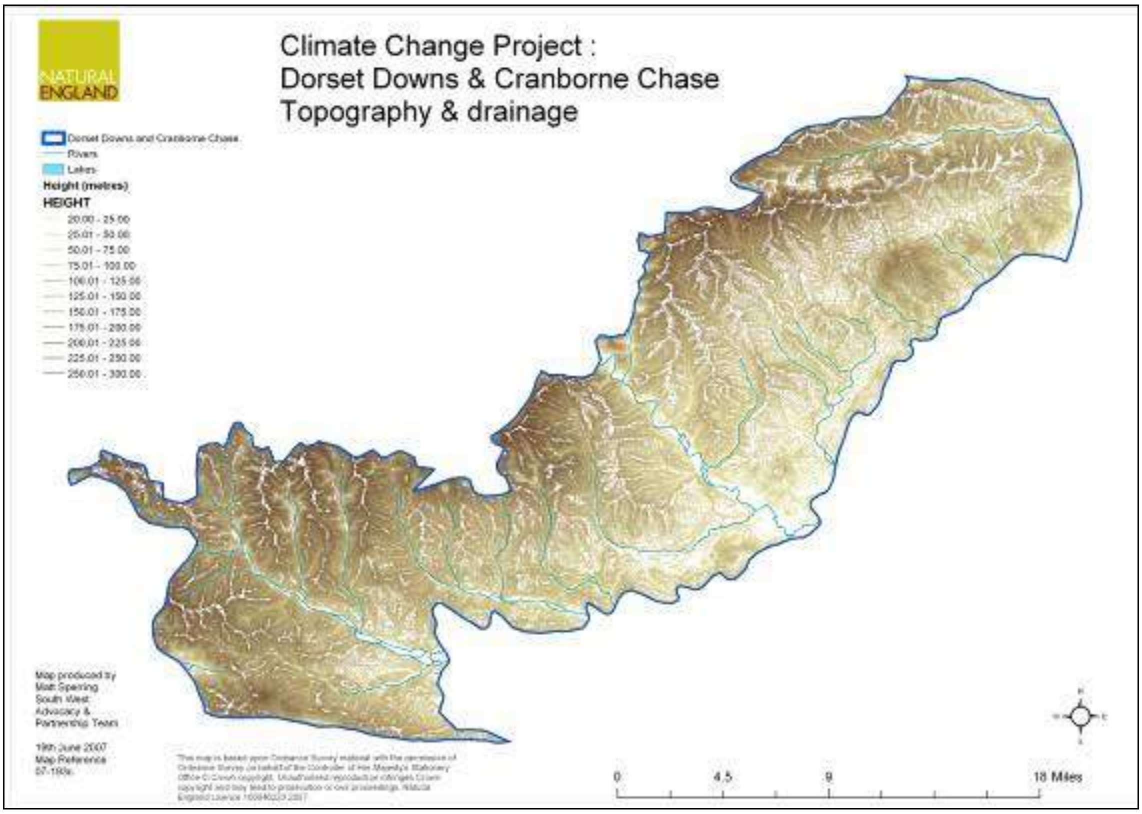

Figure 3.3 Topography and drainage in the Character Area

3.3.4 Impact on ecosystem services

Direct Impacts

Table A3.4 in Appendix 3 identifies the significant ecosystem services offered by the Character Area. Reduced annual rainfall will affect the availability of water resources for human consumption, agriculture, fisheries and habitats but the magnitude of the impact will depend on the return period of droughts. Increased demand as a result of hotter, drier conditions and population growth in the area will compound this issue, potentially resulting in a supply-demand deficit. Wessex Water expects the availability of water from existing sources to fall by about 2 per cent by the 2020s, using existing models. The calculation will be run again in the spring using the new UKCIP08 probabilistic models. More stormy rainfall means that water is more likely to run off the land rather than seeping underground into the aquifers used for public water supply. This problem would be exacerbated by long dry spells.

Agriculture will be indirectly affected by climate change through reduced water resources but it also faces direct impacts. Climate change presents an opportunity for agriculture; longer growing seasons may increase productivity but farmers may need to be willing to switch to alternative crops. Changes to the types and varieties of crops, sowing dates, irrigation, pests, diseases and soil erosion are all likely; current crops may not be able to persist under hotter, drier conditions but new, drought tolerant crops will thrive. For example, there may be an opportunity for vineyards on the slopes of the area as the climate becomes warmer and drier.

However, climate change may also threaten agriculture in the Character Area. Summer drought may affect productivity and more irrigation may be required. Lower water levels in chalk streams and rivers may impact on the water cress industry in the Character Area. It is also likely that new pests and diseases will be present in the Character Area as a result of warmer conditions.

Forestry may be impacted by an increase in storms and diseases. Increased wind throw of trees and more prevalent pests and diseases such as the processionary moth may reduce the commercial viability of forestry.

An increase in the occurrence of wildfires may have an impact on water quality. This is a particular concern for water companies as it increases their processing costs. Wildfires can also lead to more rapid soil erosion.

An increase in soil erosion and loss of biomass as a result of climate change may impact on the climate regulation function of ecosystems.

Indirect Impacts

Indirect impacts of climate change will also be felt by ecosystem services. As well as an increase in recreation and tourism, the use of the Character Area for outdoor education is likely to increase as conditions become warmer and drier. Trampling and footpath erosion are likely consequences of an increase in visitors. An increase in visitors may negatively affect the attractiveness of the Character Area for recreation and tourism. A further indirect impact of an increase in visitor numbers is increased pressure on water resources and infrastructure, exacerbating direct climate impacts (see Section 3.3.2 above).

3.3.5 Socio-economic impacts

The socio-economic changes in agriculture and recreation will have an impact on the environmental assets of the Character Area. Changes in these sectors are hard to predict (see Appendix 2). This project has not adopted a formal scenario based approach, nor does it provide an integrated assessment as these are highly complex. Instead, it is assumed that conventional development (mainly World Markets with aspects of other scenarios) will prevail.

Table A3.5 in Appendix 3 provides some examples of socio-economic impacts which could affect the environmental assets of the Character Area. This is based on knowledge of socio-economic changes, informed by current trends and drivers (e.g. the Water Framework Directive; European and UK Climate Change Programmes) and the futures literature (e.g. Evans *et al*. 2004; LUC *et al*. 2006; OST, 2002; UKCIP, 2001).

Potential changes in the agricultural sector are likely to have the most significant impact on the Character Area. One important socio-economic change may be a shift in consumer demand towards more organic and local produce. This growth is already being seen and is likely to continue in future as people become more concerned with where their food comes from and how it is produced. This socio-economic change could have benefits for biodiversity; a reduction in pesticide use may increase invertebrate populations which will have a beneficial impact on bird species. In addition, a reduction in the use of artificial fertilisers will have benefits for water quality.

Changes in the water industry such as an increase in water metering or the introduction of variable tariffs could also have benefits for the natural environment. Wessex Water intends to introduce variable metered tariffs to encourage conservation, particularly in the summer (Wessex Water Services Ltd, 2008). Through managing demand for potable water, these initiatives could lead to greater water availability for non-potable uses such as wetland habitat creation and restoration.

Whilst climate change policy could drive an increase in energy generated from renewable sources such as wind and biomass, socio-economic changes could have a similar effect. An increasing oil price and concerns over security of energy supply may lead to an increase in renewable energy generation, putting pressure on the landscape of the Character Area as currently perceived and valued. Alternatively, increased use of wood fuel could, if well managed, lead to landscape and biodiversity gains e.g. increased woodland cover, increased coppice, and more incentive for controlling deer. A further potential source of renewable energy is micro-hydro power and some farmers are already considering installing micro-hydro systems on the Upper Stour.

The location of the Character Area in one of the most heavily populated parts of the UK means it is likely to experience development pressure. Growth in population in South West England would put further pressure on the area as demand for housing, transport and other infrastructure would increase. This would also increase pressure on recreation assets as the number of people living in close proximity to the Character Area would rise. The area may be further fragmented by development and is likely to become more congested and disturbed. Traditionally, development has occurred along river valleys in the Character Area. Future development should avoid floodplains for flood risk reasons but development on the slopes would have an impact on landscape.

In summary, climate change is not the only, or necessarily most important, driver of change in the Character Area. The impacts of climate change are likely to exacerbate existing pressures. It is possible that the combined effects of climate change and other pressures will exceed the ability of the natural environment to adapt.

3.3.6 Policy implications

A change in species and community composition may have an effect on the delivery of current conservation targets. Under current, static definitions of ‘favourable condition’, species and community compositional changes may make it more difficult to meet targets as climate changes. Habitats with species compositions currently occurring outside the Character Area may well become the norm within the Character Area. In addition, a potential increase in non-native and invasive species may threaten the delivery of conservation targets.

4. Adaptation

Box 4.1 Key adaptation responses

- When defining adaptation actions, existing schemes should be considered.
- The most important drive within the Character Area will be to improve the condition of existing habitats by addressing other sources of pressure.
- In order for species to take advantage of local changes in microclimate, maintain and create variety in habitats and the landscape.
- Apply learning from past extreme weather events that may occur more frequently as a result of climate change.
- Extend the existing habitat network.
- The provision of shade and drinking water at tourist attractions.
- Tiered fire warning system.
- Implement a two pronged approach to fire prevention; hazard management (for example vegetation management) and risk management (for example education, enforcement and access restrictions).
- In areas of public access, monitor tree health and carry out tree surgery to reduce the risk of trees or branches falling.
- Link recreation and biodiversity networks in rural and urban areas; habitat creation which is designed with access and recreation in mind helps to prevent people causing damage to sensitive biodiversity and gives a higher quality experience.
- Plant locally native replacements for existing mature trees, avoiding those susceptible to drought.
- Re-establish pollard regimes to reduce susceptibility to storm damage and provide wood fuel.
- Regularly monitor and manage important geological sites to ensure that rock exposures remain visible
- Holistic catchment management.
- Employ farming methods that protect water and soil resources e.g. vegetated buffers around fields and not leaving fields bare in autumn/winter.
- Install Sustainable Urban Drainage Systems to intercept and store water through the spatial planning system.

Box 4.1 (continued)

- Nature conservation policy needs to adapt to the likelihood of species and community compositional changes.
- Identifying research needs and commissioning appropriate studies can be seen as an early step towards building adaptive capacity that should increase the effectiveness of strategies when implemented.
- Rural payments may need to be tied to the provision of ecosystem services.
- Use the spatial planning system to maintain adequate land for the natural environment.

Based on the impacts identified in Section 3, a list of adaptation responses for the Dorset Downs and Cranborne Chase has been complied (see Table A3.2, Appendix 3). These have been informed by Hopkins *et al*. (2007), who present guidelines for conserving biodiversity in a changing climate (see Box 4.2).

The adaptation responses have been tested against more generic criteria of effectiveness (see Section 4.3).

When defining adaptation actions, existing schemes should be considered. Some actions defined as climate change adaptation may already be occurring under a different name or it may be possible to modify an existing programme to deliver adaptation. Good partnerships already exist to increase the resilience of the Character Area through projects such as Pastures New, Woodlink and the Dorset Winterbournes Project. Existing Natural England plans and policies such as Higher Level Stewardship and SSSI monitoring need to routinely allow for climate change.

Reviewing best practice in conservation and protection of environmental assets in countries with similar climates to those which can be expected in the Dorset Downs and Cranborne Chase will also help in designing adaptation.

It should be recognised that there may be policy, economic or other constraints to delivery of some actions; these are identified in Table A3.2. Additionally, some of the actions identified may not have a delivery mechanism at present. At this stage, all potential adaptive actions are included despite known constraints.

4.1 Adaptation Response in Dorset Downs and Cranborne Chase Character Area

4.1.1 Biodiversity responses

Direct Impacts

The impacts of climate change will be felt most in habitats which are already degraded or in poor condition**. The most important drive within the Character Area will be to improve the condition of existing habitats.** For example, restoration of wetland habitats in valleys would increase their resilience to climate change. This would also deliver multiple benefits in terms of water quality, landscape and could provide a source of reeds for local thatched roofs.

Box 4.2 Guidelines for conserving biodiversity in a changing climate (Hopkins *et.al.,* 2007)

- Conserve existing biodiversity:
    - Conserve protected areas and other high quality habitats.
    - Conserve range and ecological variability of habitats and species.

- Reduce sources of harm not linked to climate.

- Develop ecologically resilient and varied landscapes:
    - Conserve and enhance local variation within sites and habitats.
    - Make space for the natural development of rivers and coasts.

- Establish ecological networks through habitat protection, restoration and creation.

- Make sound decisions based on analysis:
    - Thoroughly analyse causes of change.
    - Respond to changing conservation priorities.

- Integrate adaptation and mitigation measures into conservation management, planning and practice.

A vital response is to maintain the quality of existing habitat (Hopkins *et al*., 2007). A number of management practices are suggested in Table A3.2 that aim to enhance significant natural environmental assets in the Character Area, for example:

- restoration of wetlands and reedbeds in river valleys;
- restoration of riparian shading by trees; and
- maintain existing grassland habitat through appropriate grazing regimes.

An important concept is ‘adaptive management’. This is where existing management practices are modified to cope with uncertainty, in this case due to climate change and monitoring the results to ensure the response is effective. Examples of adaptive management in the Character Area include:

- Altering stocking rates on grazed grasslands to respond to an increase in biomass productivity in winter or spring.
- Varying the timing of the hay cut and/or duration of aftermath grazing to take account of earlier ripening.

Adaptive management has a number of advantages over more radical adaptation options. It is relatively inexpensive and flexible, assuming the change is gradual rather than a series of large shifts. Adaptive management is useful in dealing with those impacts which are uncertain as the response can be altered on an iterative basis depending on the results.

In order for species to take advantage of local changes in microclimate, variety in habitats and the landscape needs to be maintained and created. Responses such as planting an appropriate mixture of woodland trees and increasing riparian shading by planting trees would be good examples of how to increase heterogeneity within habitats and the landscape.

Another response applicable across all habitats is to apply learning from past extreme weather events that may occur more frequently as a result of climate change, such as storms or the emergence of new pests and diseases. This response requires ongoing monitoring of species and habitats at the same time as preparing contingency plans. The storm of 1987 and Dutch elm disease taught us that removing fallen or standing ‘dead’ trees may sometimes do more harm than just letting nature recover. We can also look to other locations with similar climates to that which England may experience in future to identify potential threats and opportunities.

Freshwater habitats can be improved by reducing the flow of silt and nutrient into rivers through catchment sensitive farming methods. For example, maintaining vegetated buffer strips around fields can reduce run-off and soil erosion. Removing in-channel river structures to re-establish habitat will also increase their resilience to climate change, as would conversion of poplar plantations to new native woodland in floodplains and replacement of elms lost through Dutch elm disease.

In addition to maintaining existing habitats, a number of responses (see Table A3.2) advocate the extension of existing habitats and the creation of new areas. This is the fourth of the Hopkins *et al.* (2007) guidelines (see Box 4.2). The extent to which plants and animals can move in order to adapt to the effects of climate change will be an important factor in their continued persistence at specific locations (Catchpole 2007), thus increasing the area of suitable habitat is likely to aid the conservation of species. In order to maintain the same degree of biodiversity in the face of climate change, more habitat is required. One way to do this is to extend the existing habitat network in the Character Area (see Box 4.3).

Box 4.3 Extending habitat networks

The England Habitat Network (EHN) illustrates the existing networks of woodland, grassland, heathland and mires and bogs present in England. A habitat network is made up of current statutory sites and sites listed on habitat inventories and surrounding land that is potentially permeable to the species present in the habitat of interest. Different types of land use, in-between patches of semi-natural habitat, will have different levels of permeability for different species (Catchpole 2007); the network joins up those sites which are separated by potentially permeable habitat or land use.

To maintain the same degree of biodiversity in the face of climate change, more habitat is required. With regard to the EHN there is a need to prioritise habitat creation action (highest priority action at the top):

- Subject to 'ground truthing', aim to maintain the existing mapped EHN for its value as an aggregated area of existing habitat patches;
- Consider extensions/additions to the habitat patches, including the expansion of pinch-points, within the EHN;
- Expanding existing habitat patches in networks outside the EHN;
- Expand small isolated patches in 'hostile' environments.

To date, habitat network maps have been created for four habitat groups present within the Character Area: woodlands; grasslands; heath; and mire/fen/bog (see Figure 4.1). Currently, the woodland networks are the most extensive in the Character Area. This is one interpretation of a potential woodland network for the Character Area. A slightly different network would result depending on which species or function is considered and what assumptions are fed into the model.

Habitat networks can be extended through maintenance of existing high quality habitats, habitat restoration and re-creation. New areas of habitat should then be protected with buffers area on their boundaries. For woodland habitat this could be scrub and for grasslands it may be arable margin strips. This will ensure the new habitat patches do not become fragmented and that connectivity is maximised.

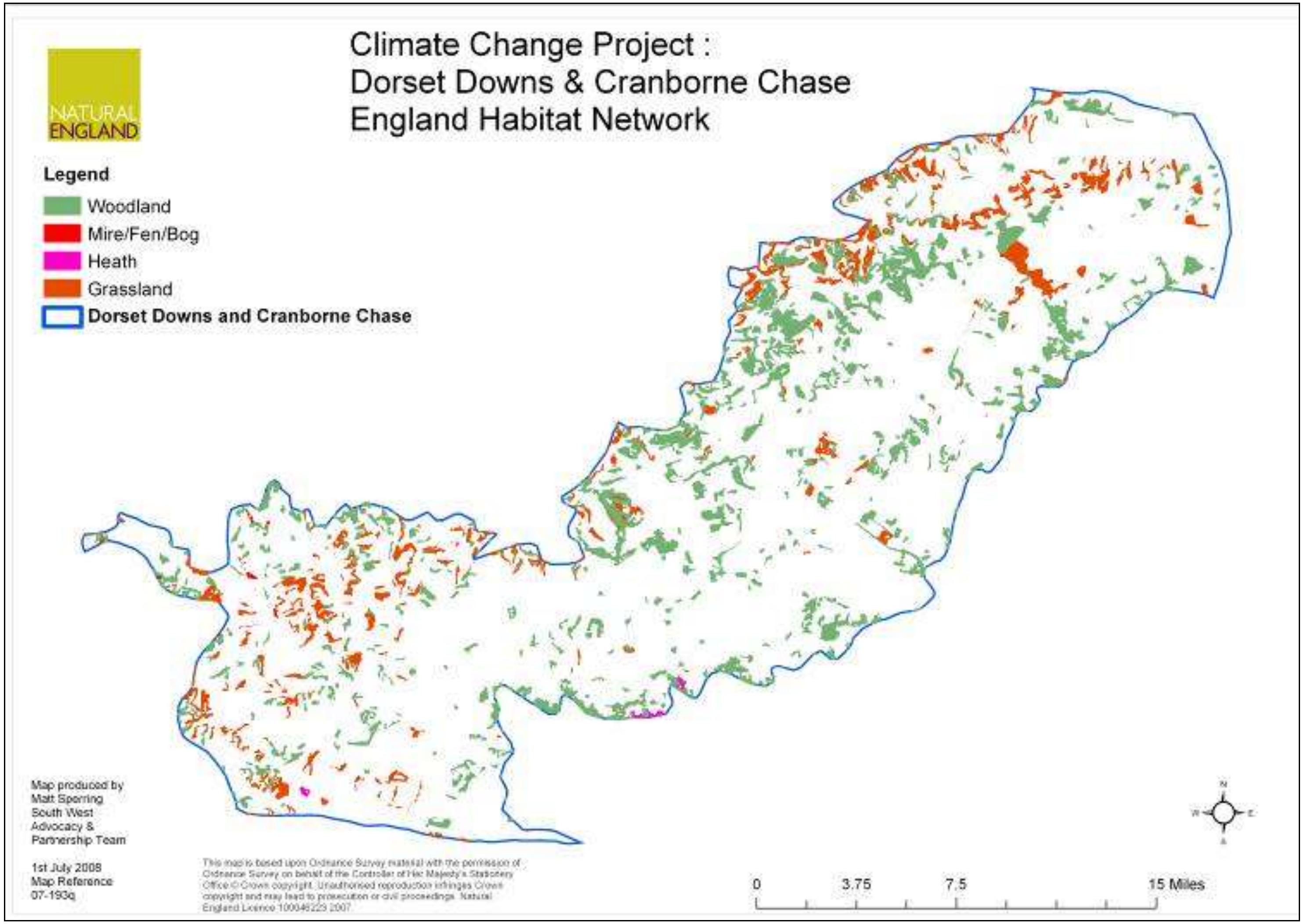

Figure 4.1 Habitat networks in the Character Area

It is important to remember when restoring and creating new areas of habitat that species and habitats extant today may not survive in future. In this respect we have to accept a move from certainty over what we have (and value) now to uncertainty over what habitat will look like in future. Any habitat creation must proceed under the assumption that what will be created will be of uncertain value. However, one way of reducing uncertainty is to use areas which are currently sub-optimal for the species and habitats in question but are likely to become more favourable due to climate change. An example of this in the Dorset Downs and Cranborne Chase is habitat creation of mixed broadleaf woodlands with some beech on north facing slopes. Whilst, currently, north facing slopes have a microclimate which is too cool for beech, in future this is unlikely to be the case (although the vulnerability of beech to drought may still prevent it establishing on north facing slopes). This strategy would also be applicable to chalk grassland habitats within the Character Area.

Creation of ecological networks cannot prevent biodiversity loss due to climate change, it can only reduce it and there is a danger of spending resources re-creating habitats that will not be sustainable under a changed climate. Similarly, habitat re-creation targeted at specific species may not be an effective response if the species is likely to be lost as a result of climate change. An example from the Dorset Downs and Cranborne Chase is beech. There is some uncertainty from models that beech will be able to survive in Britain; one model suggests that warmer winters may result in less bud initiation however others suggest the whole of the British Isles will remain suitable.

It may not be an efficient use of resources to create suitable habitat for beech as this will not be sufficient to prevent its decline. Physical constraints to habitat creation may also exist, e.g. a lack of suitable soil conditions on which to recreate lowland calcareous grassland, and we do not yet know enough about how to recreate chalk grasslands successfully.

Indirect impacts

The most important drive within the Character Area will be to improve the condition of existing habitats by addressing other sources of pressure. This is the Hopkins *et al*. (2007) second guiding principle for adaptation to climate change. Reducing sources of pressure other than climate change is particularly important for freshwater habitats and a number of the proposed responses in this section of Table A3.2 address these, including: reducing abstraction for potable water where they are affecting hydrologically sensitive wildlife sites; reducing the amount of nutrients and sediments washed into watercourses; and increasing infiltration rates. Examples of other pressures to be managed in the Dorset Downs and Cranborne Chase include:

- management neglect in woodlands;
- undergrazing;
- excessive nutrients and silt in water bodies; and
- agricultural intensification.

The main tool to address these pressures will be agri-environment schemes. A number of responses identified in Table A3.2 and A3.3 can be delivered through environmental stewardship agreements.

4.1.2 Access and recreation responses

Direct impacts

An increase in summer heat related illnesses may be significant and the area should ensure that is has an up-to-date heat wave contingency plan. The provision of shade and drinking water at tourist attractions will be important.

An increase in fire risk could be caused directly by hotter drier summers but is also influenced by visitor behaviour. Whilst the baseline fire risk is low, the risk will increase as summers become warmer and drier. There is uncertainty over the best way to respond to an increased fire risk in areas frequented by visitors. Whilst excluding people from an area can reduce the risk of a fire occurring the counter argument is that by closing areas, fire is less likely to be detected if it does occur.

There are a number of potential strategies for responding to the risk posed to recreation by fire, mainly focusing on raising awareness and fire prevention including a tiered warning system. This will raise people's awareness of the level of fire risk and encourage them to adjust their behaviour accordingly. Natural England already uses a Fire Severity Index (FSI) provided by the Met Office. This works on 10km square grids across England and Wales to facilitate restrictions on open access land. The possibility of extending this scheme to cover all land in Character Areas at risk of wildfires could be investigated. Whilst the Met Office is improving the FSI by using the latest higher resolution forecast models, Natural England has set up soil moisture monitoring sites in some of their National Nature Reserves, to help verify the accuracy of the FSI. Land managers may be able to learn lessons from other places which use a similar system including National Parks in Australia and the south of France. Knowledge about communicating risk may also be available from the Environment Agency's experience with its tiered flood warning system.

A tiered fire risk warning system on its own will not prevent fires. The majority of wildfires in this country are either started accidentally or maliciously by people or result from controlled burns getting out of control. Fire 'prevention' therefore needs to take a two pronged approach; hazard management (for example vegetation management) and risk management (for example education, enforcement and access restrictions).

Whilst preventing fires occurring is the primary objective of a fire risk reduction strategy, limiting the damage caused by fire when it does occur is also important. It is important that the response to fire outbreaks is quick, appropriately equipped and co-ordinated. There is now an England Wildfire Forum which looks at this issue (members include the Fire Service, Forestry Commission and Natural England). There is existing good practice in this area including the Peak District National Park Fire Operations Group which co-ordinates a fire plan (including communication protocols, lists of contacts and who has the key for locked moorland gates) which enables quick mobilisation of personnel and off road equipment including that belonging to private land owners and managers. Training is also run through the fire operations group, including working with helicopters. This example has been copied on Dartmoor too.

Education will play an important role across the country if hotter drier summers become the norm. The Countryside Code might need revising and direct communication with local communities should also be pursued. For example, the Dorset Urban Heaths Partnership continue to work with Dorset Fire and Rescue

Services and local people to raise awareness of the dangers and impact of wild fires. Arson Awareness sessions have taken place including courtroom drama scenarios with information on courts and prison sentences.

Flooding is another direct impact of climate change on recreational assets. Although, this can impact on recreational access for relatively short periods of time, damage can lead to long-term closures and significant expense as witnessed in the summer of 2007 in Gloucestershire. The process by which highway authorities close paths for public safety is well rehearsed, although the extent to which the public respect such closures varies. Re-instatement then becomes a matter of resources versus priorities. Footpath erosion may be exacerbated by increased rainfall in winter. Silt traps could be installed to catch eroded material and return it to the footpath. This would prevent additional sediment reaching water courses.

Woodland areas are likely to become increasingly popular for recreation as temperatures warm. In the Dorset Downs and Cranborne Chase there may be potential to create woodlands on dip slopes where there is likely to be less conflict with existing biodiversity and landscape assets. Trees may pose a health and safety risk if they become affected by drought. In public places, monitoring tree health and carrying out tree surgery to reduce the risk of trees or branches falling may gain importance. It may also be necessary to educate people about the risks of tick borne diseases which may become more prevalent in woodlands.

Indirect impacts

The most significant impact of climate change on access and recreation could be an increase in visitor numbers. Currently the trend toward leisure visits to the countryside is downward and while this may reverse if summers become hotter and drier, the impact may be greatest along the coast and inland waters.

Warmer summers might present new opportunities for recreation and rural tourism. There may be opportunities to develop new forms of tourism such as vineyard tourism or offer new activities such as paragliding or hot air ballooning. However, if more people choose to enjoy the countryside this opportunity may present risks to valued assets if it is not managed correctly. The suggested responses to an increase in visitor numbers are thus aimed at reducing negative impacts and ensuring recreation and tourism can continue within the Character Area in a way that is sustainable.

A key part of any visitor management strategy must be an assessment of the likely increase in visitor numbers and identification of areas in the Character Area most at risk from the negative impacts of recreation. Modelling of visitor numbers and temperatures could be undertaken to indicate the likely scale and timing of visitor number increases due to climate change. Once an indication of visitor numbers has been obtained, they can be theoretically allocated to visitor attractions based on previous experience, relying on the assumption that the factors attracting visitors remain constant over time (see note on socio-economic scenarios in Appendix 2). With this information, a risk assessment of those areas most at risk of footpath erosion, congestion and trampling can be made and adaptive management techniques deployed accordingly. This initial research is crucial to effective visitor management and allows a tailored approach to be undertaken at vulnerable sites.

A major principal of visitor management is dispersal, or spreading the impact of an increase in visitor numbers across the Character Area. Burden sharing is a generic adaptation to climate change which can be applied to recreational assets in a natural environment. Currently, certain elements of the Dorset Downs and Cranborne Chase are considered most desirable to visitors and there is a high demand for access and recreational services. These ‘honeypots’ include Win Green Hill, Fontmell Down and Melbury Hill and popular rights of way such as the Wessex Ridgeway and Ox Drove Byway Open to All Traffic. As demand for recreation increases it is likely that these sites and routes will reach or exceed their carrying capacity. In response to this, it is suggested in Table A3.2 that alternative sites and routes are publicised in an attempt to spread demand throughout the Character Area. Rights of Way can be linked to disperse visitors. To be effective such an initiative would need to be undertaken with reference to relevant Rights of Way Improvement Plans (ROWIPs).

However, dispersal of visitors may create more problems than it solves, particularly in terms of biodiversity impact. It may be better to concentrate visitors at honeypot sites with existing visitor facilities. The need for quiet refuges for sensitive wildlife will need to be maintained. Strategies designed to widen access should be accompanied by a risk assessment to ensure sensitive habitats are not being put at risk.

It will be important to link recreation and biodiversity networks in rural and urban areas. An advertising campaign based in the urban areas which serve as a gateway for visitors, may help to promote attractions closer to centres of population and reduce the number of people in sensitive areas for biodiversity. The concept of ‘sustainable tourism’ should be promoted to visitors through interpretive signs and access and recreation promotion. Provision of access and recreation should be linked to planning policies to increase green infrastructure. A local example of this is heathland creation on the outskirts of Bournemouth with access and recreation designed to prevent people impacting on the sensitive habitat.

In addition to dispersing visitors across the existing right of way network, new paths could be created to maximise the recreation opportunity created by climate change. One suggestion is to create a recreation network, based on the notion of habitat networks. The idea would be to map existing rights of way and open access land and identify where it would be possible to open further land or rights of way for recreation, taking into account sensitive habitats and land uses. For this to be effective it would need to mirror public demand which again should have been identified through ROWIPs.

Action to increase areas of semi natural habitat, proposed under biodiversity responses above, will provide more space for wildlife to disperse into. To some extent this will mitigate the impacts of increased visitor numbers on the existing biodiversity resource. Recreation networks can be linked to biodiversity networks. Habitat creation which is designed with access and recreation in mind helps to prevent people causing damage to sensitive biodiversity and gives a higher quality experience. Habitat creation in the South West Forest includes access and recreation provision in combination with extending the woodland habitat network. This approach could be taken in the Dorset Downs and Cranborne Chase to maximise benefits for biodiversity and access and recreation.

Habitat creation may come into conflict with recreation. Tree planting on the top of slopes can restrict views and riparian planting can interfere with fly fishing.

In order to avoid congestion, pollution and other negative impacts of an increase in vehicle movements within the Character Area, it is felt that improvements to public transport facilities will be needed. Public transport initiatives within the Character Area need to be integrated with other modes of transport, including the railways serving gateway destinations to the Character Area.

Visitor attractions can be retrofitted with a number of features to make them more sustainable. For example, in order to save water resources, attractions can be fitted with greywater recycling systems which collect water and use it for toilet flushing. There is an environmental education centre at Fontwell Magna which uses a reedbed for drainage.

4.1.3 Landscape response

The significance of the landscape impact can only be determined by understanding the context in which changes have occurred. The Countryside Quality Counts project (CQC, 2007) provides a systematic assessment of how the countryside is changing. It identifies where change is occurring and whether this change matters to people, by reference to the Character Area descriptive profile (Countryside Agency, 1999). Tools such as Landscape Character Assessment (Countryside Agency, 2002) can be used to consider the significance of impacts and actions to adapt to them.

The CQC analysis advocates creation of new woodlands and occasional, appropriately placed clumps of trees on ridgetops and summits as well as better management of existing woodland and parkland trees within the Dorset Downs and Cranborne Chase Character Area (CQC, 2007), thus it could be expected that an increase in small areas of woodland as a response to climate change would also be viewed favourably. Grassland and heathland creation can also be undertaken with woodland creation and the Forestry Commission in Dorset has experience of creating heathland areas within woodlands.

The assessment also includes a vision to restore the historic open, rolling grasslands for which the chalklands have traditionally been known (CQC, 2007) which is consistent with the response to climate change suggested in Table A3.2. There is also agreement over the need to promote appropriate management of arable farmland to create a wildlife-rich habitat supporting farmland birds.

Most recently, Dorset AONB have produced detailed management guidelines for the different landscape types with the Character Area (Harman, 2008).

Trees have been identified as a landscape feature that may be impacted by climate change. In response it will be necessary to plant locally native replacements for existing mature trees, avoiding those susceptible to drought. One practical action to respond to changing species composition of woodland habitats may be to trial different traditional varieties or new varieties to ascertain which varieties might grow successfully in future. It could also be possible to start a programme of selectively breeding from existing varieties to develop better adapted varieties. Species susceptible to drought should be avoided. This will also help to increase the heterogeneity of the landscape, increasing its robustness to climate change.

Mature trees are at particular risk from an increase in the frequency and intensity of storms. It may be necessary to manage the succession of planted trees to ensure that a storm event does not clear all trees from the landscape. Another response would be to re-establish pollard regimes to reduce susceptibility to storm damage and provide wood fuel. Hedgerow trees in particular require active management through pollarding. Pollarding will also increase the resilience of trees to drought by reducing the root to crown ratio.

In order to maintain chalk grassland it may be necessary to remove scrub. Scrub removal is expensive but the relative cost could decline if it is used as wood fuel. Removing bracken and gorse from the landscape would have additional benefits for historic environment and geodiversity assets as it would allow access to these features to be maintained.

It may be possible to re-instate old technologies for energy generation which would have benefits for the historic environment and other landscape assets. For example, water mills could be restored and used to provide a local source of energy. There is an opportunity to link this to renewable energy generation (see reference to micro-hydro power in Section 3.3.5). However, this response may conflict with re-naturalisation of rivers which has also been suggested as a biodiversity and landscape response.

The significance and integrity of important historic assets can be threatened by poorly designed adaptation and mitigation responses. An integrated approach is therefore required when assessing potential adaptation within this Character Area. For example:

- Planting of wet woodlands on floodplain. These areas are characterised by water meadow systems, which may be damaged by such planting. However, they represent a good way of controlling and storing water and it might be better for the historic environment, the historic landscape, the overall landscape character and climate change adaptation, if we looked to restoring these features.
- Planting of beech on the north slopes – need to take account here of other environmental assets that may be damaged from such planting, including historic environment and landscape character.
- Altering the number of grazing animals in response to increased grass growth can lead to poaching and erosion of archaeological remains.

Conserving and managing the geodiversity of the Dorset Downs and Cranborne Chase will need to include regular monitoring and management of important geological sites to ensure that exposures remain visible. Space should be allowed for natural physical processes and for active landforms to change and migrate.

4.1.4 Ecosystem services responses

Climate change will impact on the ecosystem services offered by the Character Area and effective responses must be employed to protect them. Table A3.4 suggests potential responses to impacts on ecosystem services in the Character Area. Many of the responses described under biodiversity, access and recreation, and landscape will have multiple benefits in preserving ecosystem services.

In addressing impacts on water resources and water quality it will be necessary to manage catchments in a more holistic manner. In response to reduced water availability it would be beneficial to increase water storage capacity within the catchment and to reduce the amount of overland flow. This can be achieved through planting of wet woodland on floodplains and reducing the area of bare ground. This also has benefits for flood protection as water takes longer to reach the channel, thus avoiding high peak flows. Habitat restoration and creation as a response to climate change impacts on biodiversity will be beneficial in enhancing water resources in the Character Area as it increases the vegetated area in the catchment, which in turn governs the rates of water absorption into and release from the aquifer.

In response to water shortages, farmers may need to increase their capacity for on-farm water storage. Farming methods should be employed that protect water and soil resources for example vegetated buffers around fields and not leaving fields bare in autumn/winter. Planting wet woodland in valleys may also retain water resources and reduce flood risk although this would conflict with biodiversity and landscape objectives. Precision farming methods using Geographic Information Systems to target irrigation may also help reduce the water demand of agriculture.

Catchment sensitive farming methods designed to protect water resources will have benefits for soil retention. Figure 4.3 shows the location of catchment sensitive farming project areas in the Character Area. Vegetated buffer strips around fields and maintaining vegetation cover in winter can protect the soil resource from erosion. The Environment Agency has published a Strategy for Soil Protection which should be used to deliver climate change adaptation. Hedgerow planting is another way to minimise soil erosion and intercept rainfall. Planting hedgerows would have additional benefits for landscape.

Sustainable Urban Drainage Systems (SUDS) can be used to intercept and store water. This has multiple benefits in terms of water resources and flood risk reduction as water reaches rivers more slowly, reducing the risk of flash floods. Maintaining water levels in valleys will have multiple benefits for water resources, landscape and the historic environment.

There may be opportunities in the Character Area to grow new crops such as grapes. Livestock will be impacted by climate change and farmers may have to adapt their practices. For example, shade can be provided by trees which would have a beneficial impact on landscape. Awareness of changing pests and diseases will be important in the agricultural sector (see Section 4.1.1).

Climate change may provide an opportunity for forestry outside prime biodiversity areas. Climate change is likely to improve the growing conditions for commercial tree species. The market for wood fuel will also increase as people switch to low carbon sources of energy. Short rotation coppice could be planted in valley bottoms, complementing access and recreation and other ecosystem service responses. Increasing tree cover will have multiple benefits for soil retention, water quality, provision of shade and reduction of flood risk.

Responses to an increase in tourism and recreation are addressed in Section 4.1.2.

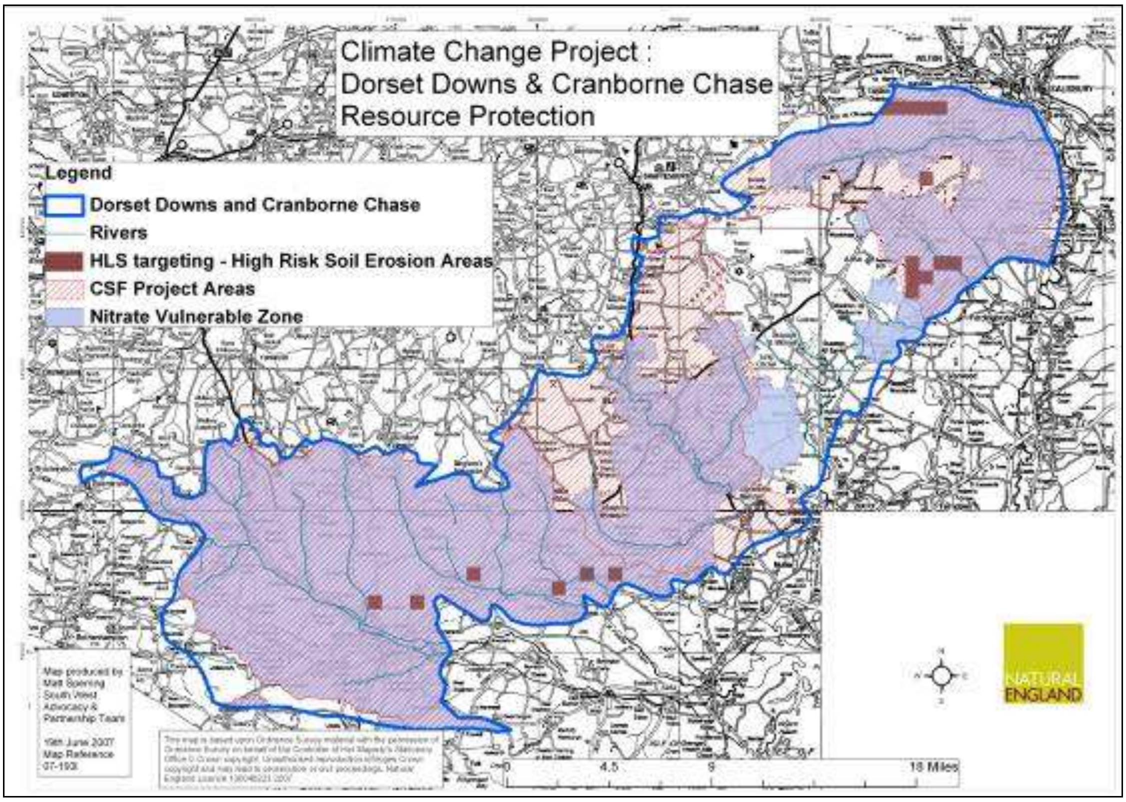

Figure 4.2 Areas important for resource protection in the Character Area

4.1.5 Responses to other socio-economic impacts

Table A3.5 in Appendix 3 sets out responses to the likely socio-economic impacts.

Climate change may be the ‘tipping point’ that prevents the Character Area from recovering from the combined effects of all sources of pressure. In addition, the legacy of past sources of pressure on the natural environment may restrict the ability of the Character Area to adapt to climate change. For example, the ability of the woodland network to respond to climate change has been reduced through loss of historic parkland and fragmentation due to arable farming and intense grazing.

Habitat restoration and creation will be required to address these multiple sources of pressure. In addition to responding to the direct impact of climate change, this will allow other issues such as habitat fragmentation due to agricultural intensification and development to be addressed. The greater the area of good quality habitat, the more robust wildlife will be to the impacts of climate change and other pressures.

It is possible that there will be conflicts over land use in future optimal areas. North facing slopes have already been identified as potential sites for habitat creation but there will also be pressure from agriculture which may no longer be viable on warmer, drier south facing slopes. Decision making over future land use will be influenced by the prevailing socio-economic scenario and attitudes towards the natural environment.

As many of the socio-economic impacts will be felt through an increase in development pressure (for housing, transport, wind turbines etc) the main response is to use the spatial planning system to maintain adequate land for the natural environment. Whilst there is no certainty over what the natural environment will look like under conditions of climate change, it is certain that more land will be required. Planning Policy Statement 9 and the biodiversity duties in Local Development Frameworks should be used to achieve this goal.

Some of the socio-economic changes identified in Table A1.5 may have beneficial impacts on the Character Area. These opportunities must be recognised and acted upon in order for the natural environment to derive maximum benefit form changes occurring in other sectors. An example is the potential for habitat creation and network extension in conjunction with organic farming.

4.1.6 Policy response

Nature conservation policy needs to adapt to the likelihood of species and community compositional changes. Under current legislation and static definitions of 'habitat quality', species and community compositional changes may prevent Natural England from meeting targets. Currently, species such as sycamore and holly are seen as negative invaders which reduce the available space for more highly valued native species. However, if native species are less viable under conditions of climate change, attitudes towards non-natives may have to change. Is it possible that species currently considered of low conservation value in the UK, along with invasives, may become so rare in their native habitat that the UK has a responsibility to conserve them? Changing conservation objectives may require a radical shift in the current paradigms of conservation; non-native species may have to be favoured and the attitude towards alien and invasive species may have to change.

Many of the responses described above rely on changes to farming practice. These changes may be brought about through existing schemes such as Higher Level Stewardship and rural payments. To maintain ecosystem services in the face of climate change it will be necessary to link rural payments to the delivery of projects to improve water quality, soil retention and flood risk reduction. It may also be necessary to strengthen Environmental Impact Assessment regulations to deliver climate change adaptation.

Responding effectively to the impacts of climate change may be hindered by incomplete information. For example, in order to respond to the impact of climate change on freshwater habitats, better research about the geomorphological and hydrological effects of re-naturalising floodplains and habitat re-creation techniques is needed. Replacing woodland with a mixture of species as a response to species loss is suggested in Table A1.2 but it has been identified as a risky option that needs further research to ensure it is effective. The fifth Hopkins *et al*. (2007) guideline for adaptation states that sound decisions should be based on analysis. Identifying research needs and commissioning appropriate studies can be seen as an early step towards building adaptive capacity that should increase the effectiveness of strategies when implemented.

4.2 Assessment of responses against ‘good adaptation principles’

UKCIP (2007) has published a set of guidelines to inform effective adaptation which can be used to assess responses to climate change (see Box 4.4). In addition, the Hopkins *et al*. (2007) guidelines (see Box 4.2) for conserving biodiversity in a changing climate provide a more tailored approach to adaptation in the natural environment.

Box 4.4 UKCIP (2007) guidelines for effective adaptation

- Work in partnership.
- Provide a balanced approach to climate and non-climate risks.
- Manage priority climate risks.
- Address risks associated with today’s climate variability and extremes.
- Use adaptive management to cope with uncertainty.
- Recognise the value of no/low regrets and win-win adaptation options.
- Avoid actions that foreclose or limit future adaptation.
- Avoid actions that conflict with mitigation objectives.

Good adaptation requires collaborative working with stakeholders. Table A3.2 highlights the potential partners required to successfully deliver the specified adaptation action.

One of the frequently stated reasons for inaction on climate change adaptation is uncertainty over the impacts. However, decisions in business and politics are often taken in the face of uncertainty but risk management is adopted. Adaptive management is one way of addressing uncertainty. It involves phased action, initially addressing today’s risks. The outcomes of actions can be monitored and altered to take account of new information, people’s values and aspirations or increased understanding of vulnerabilities.

Addressing risks associated with today’s climate variability and extremes can be seen as a starting point towards taking further action. Understanding the impacts of current weather and climate can also provide evidence of vulnerabilities within organisations which is necessary to guide future adaptation.

No-regret options deliver net-benefits regardless of the extent of future climate change. Low-regret options deliver benefits larger than the associated costs. Identifying no and low-regret options is important as both types of action are capable of delivering maximum return on investment with low associated risk. Win-win options are those which are effective at adapting to an identified climate risk but also deliver other socio-economic or environmental benefits.

It is important that actions taken today will not limit or prevent adaptation in the future. Delivering actions incrementally through adaptive management reduces the risk associated with being wrong. Adaptation is about periodically reassessing chosen responses.

It is also important that adaptation does not conflict with mitigation i.e. reducing greenhouse gas emissions.

From Table A3.3 a number of effective response strategies can be identified. These responses are flexible, no or low regret and do not conflict with mitigation. In addition they offer opportunities for partnership working, deal with climate and non-climate risks and offer solutions for current climate risks. The particularly effective responses for wildlife in the Dorset Downs and Cranborne Chase are:

- Maintain existing habitats through adaptive management.
- Change conservation objectives.
- Increase the ability of catchments to retain rainfall and reduce artificially enhanced surface run-off.
- Aquifer protection from over-abstraction and pollution.
- Model increase in visitor numbers and identify areas most at risk of damage from an increase in visitor pressure.
- Dispersal of visitors.

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Appendix 1 Background and project methodology

There is little doubt that climate change is a reality and that it will pervade all areas of life. While there are impacts that are no longer avoidable, there is still time to develop adaptation techniques to cope with a changing climate, and mitigation strategies to limit further damage in the 21st century.

The Earth's climate is dynamic; the planet alternates between periods of glacial (cold) and interglacial (warm) conditions as part of its natural cycle (IPCC, 2001). While this is often altered by such events as large volcanic eruptions, the cycle is consistent. For the past 10,000 years the Earth has been in an interglacial period, which has provided a comfortable 15°C average surface temperature for mankind. However, there is substantial evidence that the impact of human activities has caused, and will continue to cause, a steady but significant increase in this average surface temperature.

The Earth is kept warm by certain gases in its atmosphere; gases such as water vapour, carbon dioxide (CO_2) and methane absorb outgoing radiation and re-emit it back to the Earth's surface. This has been described as the 'greenhouse effect', without which the Earth's surface would be approximately 33°C colder. Since the industrial revolution, mankind has consistently been adding to the greenhouse gases already in the atmosphere. Through burning of fossil fuels and changes in land use, the volume of greenhouse gases has increased from 270 parts per million volume (ppmv) in pre-industrial times to 379 ppmv in 2005 (IPCC, 2007). This far exceeds the natural range of the past 650,000 years (180 to 300 ppmv) as determined by ice cores (IPCC, 2007). This has caused an intensification of the greenhouse effect and a gradual warming of the Earth.

Addressing the challenges associated with climate change requires a 'two-pronged' approach; mitigation to limit the magnitude and rate of change and adaptation to deal with the residual impacts and opportunities. However, irrespective of the success of mitigation efforts, there will still be some degree of unavoidable climate change due to historic emissions of greenhouse gases (GHGs). Responding to the impacts of climate change requires adaptation. With respect to climate change, adaptation is thought of as 'an adjustment in natural or human systems to actual or expected climatic stimuli (variability, extremes and changes) or their effects, which moderates harm or exploits beneficial opportunities' (UKCIP, 2007). Adaptation requires effective measures directed at enhancing our capacity to adapt and at minimising, adjusting to and taking advantage of the consequences of climatic change.

The purpose of Natural England is to conserve, enhance and manage the natural environment for the benefit of current and future generations. In doing so, Natural England works towards the delivery of four strategic outcomes:

- A healthy natural environment: England's natural environment will be conserved and enhanced;
- Enjoyment of the natural environment: more people enjoying, understanding and acting to improve, the natural environment, more often;
- Sustainable use of the natural environment: the use and management of the natural environment is more sustainable;

- A secure environmental future: decisions which collectively secure the future of the natural environment.

Dealing with the specifics of climate change, as opposed to the generalities, is very challenging but Natural England believe it important to start working towards comprehensive, geographically specific assessments of the possible impact of climate change on the heritage of wildlife, landscapes and our enjoyment of them. Such assessments would then allow us to start identifying responses which would reduce the adverse impacts identified. Character Areas have been chosen as there is systematic comprehensive coverage of England and they are at a manageable sub-regional scale. The four pilot Character Areas are the start of the journey. The pilots aim to translate the emerging principles of climate change adaptation into specific actions.

The 4 pilots were chosen to illustrate a range of projected climate impacts:

- Cumbria High Fells (montane impacts).
- Shropshire Hills (typical fragmented landscape).
- Dorset Downs and Cranborne Chase (drought).
- The Broads (wetland, sea level rise).

The purpose of the project is to create climate change response strategies for each of the selected Character Areas based on national and local expertise. In each Character Area an initial list of the more significant natural environmental assets has been complied; other valued assets may exist, but this exercise attempted to select some of the most important. Based on this list, Character Area specific impacts of climate change have been identified. Subsequently, Character Area specific response strategies have been complied that aim to practically adapt the habitats and landscapes in question, to the identified impacts of climate change.

Project methodology

The basic methodology has been to:

1. Identify significant environmental assets in the Character Area;
2. Assess the projected nature of climate change by looking at biologically significant parameters such as precipitation;
3. Assess the impacts of the projected climate changes on the environmental assets;
4. Propose actions to minimise the adverse impacts.

The climate change responses are the result of dialogue between national experts and local staff within each Character Area. Figure A1.1 illustrates the method behind each Character Area report. Initially, national experts (in habitat types, species, landscape, access and recreation and geodiversity) were asked to fill in templates to identify the impacts of climate change on significant natural environmental assets.

The templates asked the National Experts to identify climate risks, as expressed by projected climate change. The nature of the effects generated by the risk were then identified; for example for arctic alpines the risk is an increase in temperature and the nature of the effect is that species are forced to higher altitude or north facing sites. The extent of the effect, both in terms of geographical variation and magnitude of change was then identified. The projected impacts column identified the biophysical impact of the risk on the asset in question, so for arctic alpines the impact is that species move upwards or are lost. Following identification of impacts, the national experts were asked to suggest practical action that could be taken to adapt to climate change. Any key assumptions made in the impact assessment or useful references are listed in the final column. Table A1.2 shows a worked example of the process for arctic alpine flora.

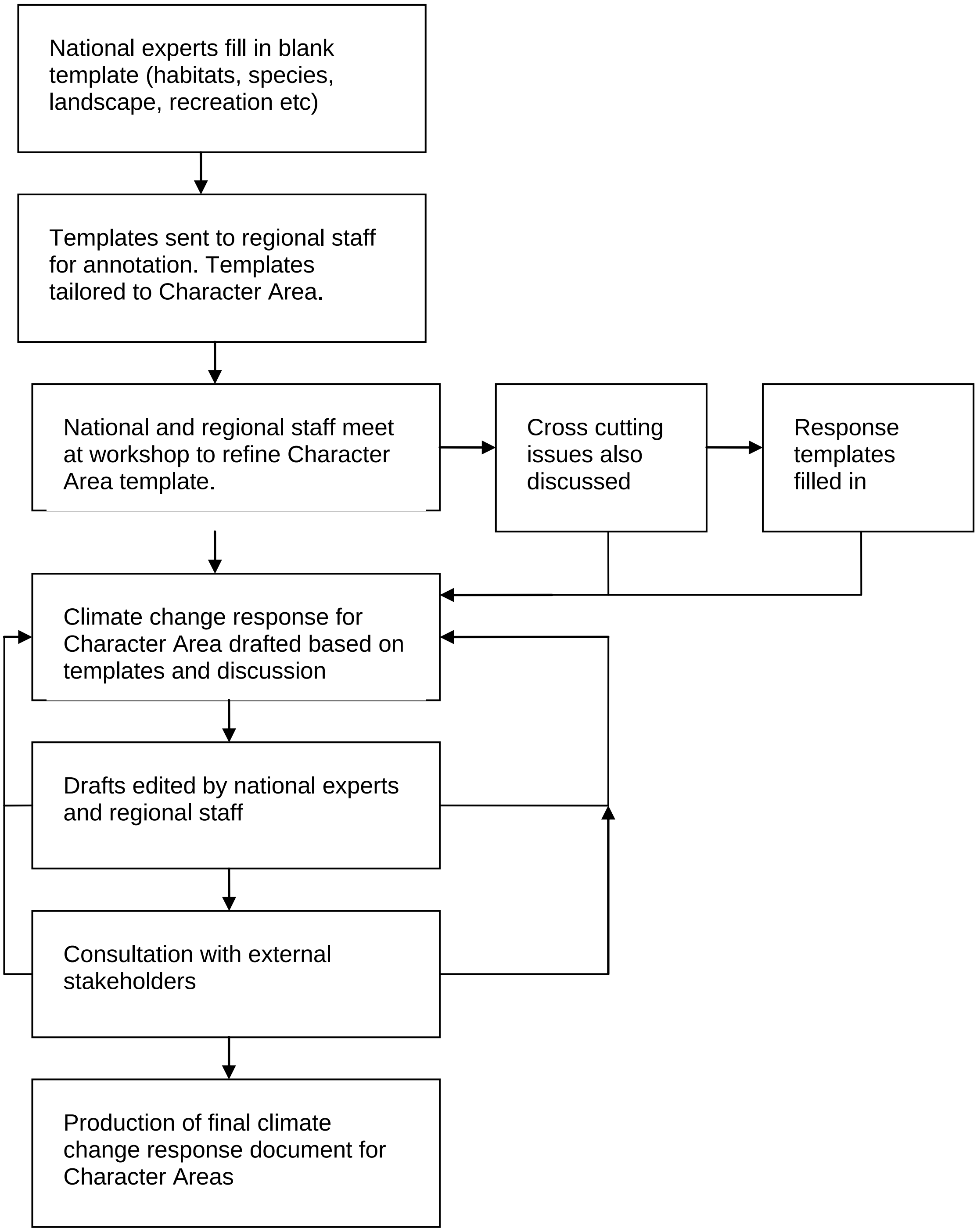


Figure A1.1 Flowchart showing project methodology

Table A1.2 Worked example of national expert template

Valued asset	Risk	Nature of effects	Extent of effects	Projected impacts	Proposed responses	Key assumptions
Arctic alpine plants	Increasing temperature	Forces them to higher altitude/north facing slopes	Amount of temperature increase from bioclimatic data	Retreat to higher altitude or loss	Improve condition of existing habitat to maintain as long as possible	

These master templates were then sent to the regional offices containing each of the chosen Character Areas. Regional staff were then asked to collate the assets pertinent to the Character Area in question and construct a Character Area specific version of the template. At this point regional staff reviewed the information provided by the national experts and updated it to reflect the specificities of their Character Area. One Character Area held an internal workshop to complete this part of the process.

Once a draft Character Area template had been assembled, national experts and regional staff met at a workshop to discuss and refine them further. The output of the workshops were annotated CA templates to reflect discussion held and a second template detailing practical response strategies for adapting to climate change. In addition, cross cutting issues such as landscape and ecosystem services were discussed at the workshops.

The outputs form the Character Area workshops form the basis of the climate change response reports. Around these templates, a narrative has been written which captures discussions held during and after the workshops.

The detail of any action – by who, when, cost, feasibility etc is not covered at this stage – that would be for subsequent implementation plans, which will involve working with regional partners.

The concept of connectivity, and how fragmented landscapes might be adapted to be more resilient in the face of climate change, has been the subject of a separate, specialist workshop with external bodies. This is a potentially important element in the response strategies.

Subsequently, after the pilot project, consideration will be given to:

- Assessing, broadly, the cost of the responses advocated;
- Assessing the contribution to locking up carbon (mitigation) which the response strategies would deliver;
- Rolling out the production of the response strategies to further Character Areas deemed to be at risk from climate change.

Appendix 2 Note on indirect climate change and socio-economic impacts

Socio-economic scenarios

Climate change will not be the only pressure on natural environments in the future. Other impacts will be felt through socio-economic change. Berkhout *et al*. (1999) identify five dimensions of socio-economic change:

1. Demography and settlement patterns
2. The composition and rate of economic growth
3. The rate and direction of technological change
4. The nature of governance
5. Social and political values

Given the deep level of uncertainty, traditional forecasting techniques are inappropriate. Instead, *scenarios* of socio-economic change are developed. Scenarios can be defined as:

> 'plausible, challenging and relevant sets of stories about how the future might unfold. They are generally developed to help decision-makers understand the wide range of possible futures, confront uncertainties and understand how decisions made now may play out in the future' (UNEP, 2005)

Scenarios attempt to capture the dimensions of change described above; however, the last two dimensions are somewhat less tangible than the first three. The nature of governance concerns the degree to which governance is at a global or local scale. Governance can be international and strongly integrated or local and highly autonomous. Social and political values refer to the degree of individualism and consumerism that prevails, as opposed to communism and conservation. A continuum exists between the two extremes of each dimension and these can be used to form a matrix in which potential future socio-economic scenarios sit (see Figure A2.1). Other dimensions of change are then applied within this framework.

A number of socio-economic scenario sets have been constructed by a number of organisations for a range of purposes. Figure A2.1 includes socio-economic scenarios constructed by UKCIP (2001), for use alongside climate change impact and adaptation assessments, and the scenarios from the Millennium Ecosystem Assessment (MEA) (UNEP, 2005). Both scenario sets consider the impacts on biodiversity, which are summarised in Table A2.1.

Table A2.1 Socio-economic scenarios related to biodiversity

Global Orchestration • Conservation sites maintained and slowly expanded but designed for access • *Large-scale farming, GM crops* • *Urban sprawl and demand for 'managed landscapes'*	**Techno-Garden** • High priority to protection • Pressures from growing demand • *Low input farming and sustainable landscape management* • *Tight planning controls* • *Control of industrial pollution*
Order-from-Strength • Policy not strong enough to restrict development pressures • Little public concern about biodiversity • *Intensified farming, larger farms* • *Environmental pollution*	**Adaptive-Mosaic** • Strenuous efforts to preserve wildlife • Access demands • *Extensive and more diverse agricultural* • *Development controls*

Adapted from UKCIP (2001) with scenario names from UNEP (2005). Indirect socio-economic impacts i.e. socio-economic impacts on other sectors but with implications for biodiversity are shown *in italics*.

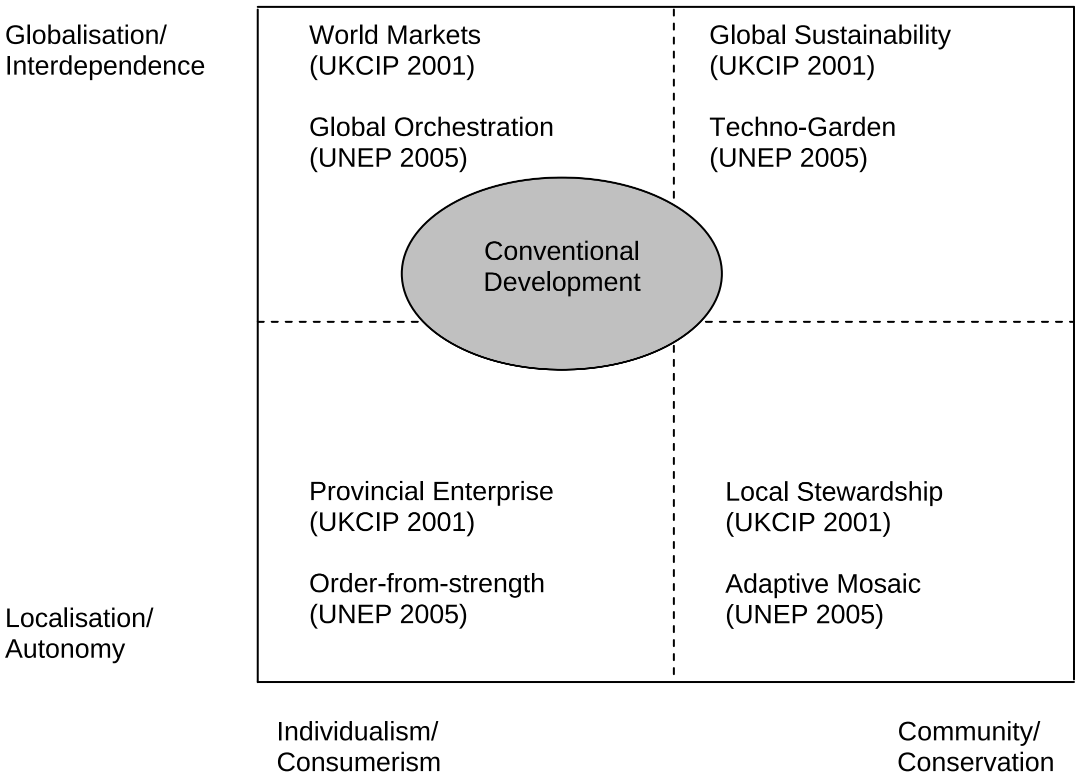
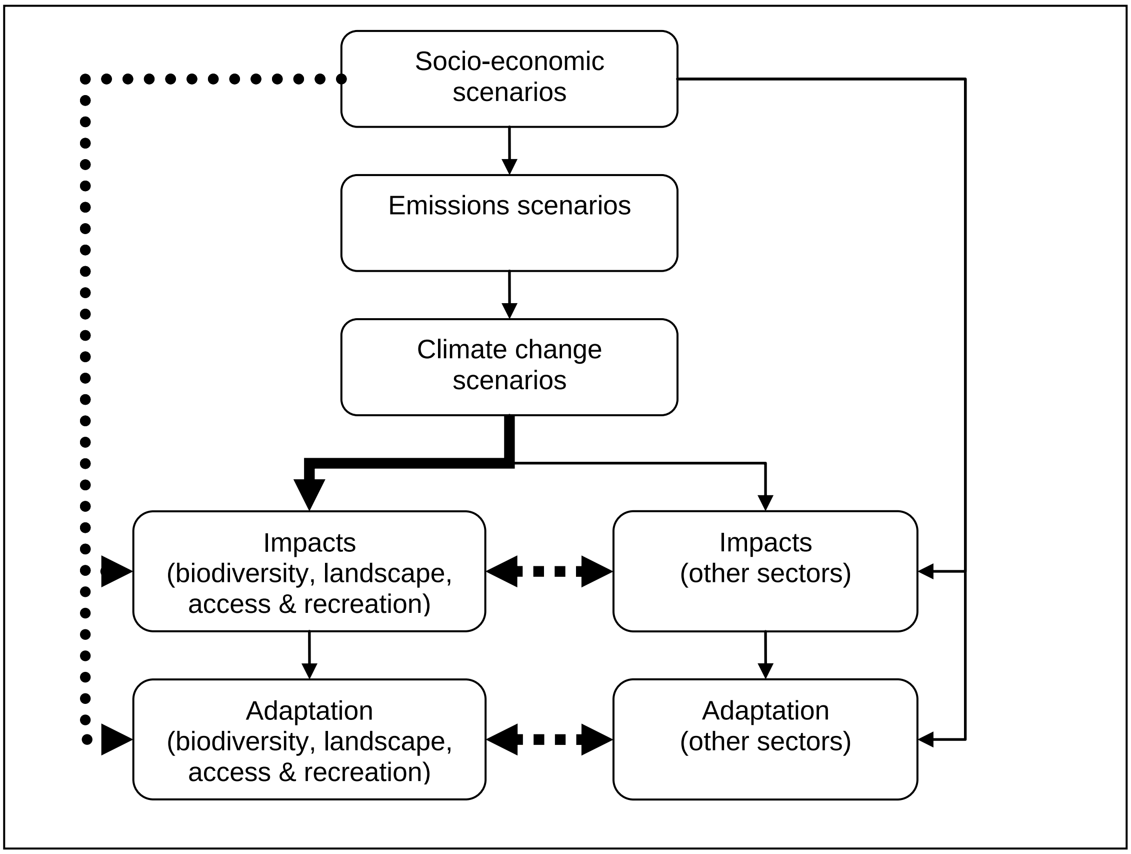


Figure A2.1 Socio-economic scenarios

Socio economic scenarios in climate change impact and adaptation assessment

We are increasingly used to working with climate change scenarios (such as those produced by UKCIP) to identify the direct and indirect impacts of climate change on assets of interest. These scenarios are informed by emissions scenarios (e.g. IPCC, 2000) which are in turn driven by socio-economic scenarios (see Figure A2.2). Therefore the socio-economic scenarios not only directly and indirectly affect natural environmental assets; they also condition the climate change scenarios and resulting impacts. For this reason, socio-economic and climate change scenarios are often linked e.g. World Markets with High Emissions, although alternative 'cross-over' scenarios can be employed.



Thick solid line = direct climate change impact on biodiversity etc; dashed line = indirect climate change and socio-economic impact on biodiversity etc; dotted line = socio-economic impact on biodiversity etc.

Figure A2.2 Role of socio-economic scenarios in climate change impact and adaptation assessment

Significance of socio-economic scenarios for the Character Area project

Climate change will directly affect valued assets in the Character Areas. The significance of the impacts of climate change will be mediated by the socio-economic scenario that prevails at the time; changes in attitudes and behaviour towards the natural environment and conservation will alter the nature of the impacts. For example, the priority attached to dealing with species loss will be dependent on what we perceive as 'valuable' in the natural environment.

In addition to direct impacts, climate change will also have an indirect impact through interaction of assets with other sectors. For example, many Character Areas are heavily influenced by agriculture. Changes in agriculture could be driven by climate change, such as crop switching to more drought tolerant plants or increasing intensification due to the failure of harvests in other parts of the world. These would be classified as indirect impacts of climate change on the Character Area. These indirect impacts will also be mediated by the prevailing socio-economic scenario at the time.

However, shifts in agriculture may occur regardless of climate change for example, driven by fluctuations in crop prices or shifts in consumer demand for certain products. Such changes would be classified as socio-economic impacts. These changes, whether climate induced or not, would significantly impact on the Character Areas.

Table A2.2 Examples of direct, in-direct and socio-economic impacts

Type of impact	Examples
Direct climate change impact	• Increased stress due to drought • Phenological changes • Carbon dioxide fertilisation effect
In-direct climate change impact	• Increased visitor numbers in Character Area (due to an increase in temperature) • Reduction in water available for habitats (due to an increase in potable water demand)
Socio-economic impact	• Increase in invertebrate and bird species due to a shift towards organic farming • Development pressure in Character Area due to population increase

In reality direct, indirect and socio-economic impacts are closely related. The Character Area project focuses on the direct biophysical impacts of climate change on the significant natural environmental assets of the Character Area (and is noting the downstream policy impacts where they arise). Where significant indirect impacts have been identified (such as those related to agricultural change in the face of climate change) these have been included and classified as indirect.

Table A2.3 Indirect impacts of climate change on significant natural environmental assets

Sector primarily impacted	Impact of climate change	How it might affect natural environment
Agriculture, horticulture and forestry	Crop switching to more drought resistant crops Re-intensification due to failure of harvests elsewhere Increase in irrigation requirements	Landscape change Landscape change, reduced access to the natural environment, increase in diffuse pollution, species compositional change, reduction of network size Reduction in water available for habitats
Flood management	Reduction in condition of existing defences and risk of subsidence Increased risk of breach and overtopping of defences	Potential for habitat creation Increased risk of inundation of sites
Water resources	Increase in demand, reduction in supply Increased storage requirements	Reduction in water available for habitats Potential for habitat creation
Buildings	Risk of subsidence Risk of overheating	Increase in running costs of buildings

Sector primarily impacted	Impact of climate change	How it might affect natural environment
Transport	Subsidence Damage to infrastructure	Reduced access to natural environment
Retail	Increased opportunity for outdoor retail	Increase in recreation potential
Leisure and tourism	Increase in visitor numbers	Increase in recreation opportunity Risk of overcrowding leading to loss of visitor experience, damage to footpaths, increased pressure on resources and infrastructure
Health	Increase in heat related illnesses	Reduced outdoor recreation in summer

The Character Area project has not adopted a formal scenario based approach, nor does it provide an integrated assessment as these are highly complex. Instead, it is assumed that conventional development (mainly World Markets with aspects of other scenarios) will prevail.

Table A2.4 provides some examples of socio-economic impacts, which could affect the species, habitats, landscapes and recreational function of the Character Areas. This is based on knowledge of socio-economic changes, informed by current trends and drivers (e.g. the Water Framework Directive; European and UK Climate Change Programmes) and the futures literature (e.g. Evans *et al*. 2004; LUC *et al*. 2006; OST, 2002; UKCIP, 2001).

Table A2.4 Socio-economic changes with potential to affect natural environment

Sector	Socio economic change	How it might affect natural environment
Agriculture, horticulture and forestry	Increase in demand for organic produce Changes in payments and subsidies	Increase in invertebrate and bird species Reduction in diffuse pollution Improve countryside stewardship Reduce monoculture
Flood management	Preference for ‘soft defences’ e.g. managed realignment Changes in flood defence budget (decrease) Changes in flood defences (increase)	Increase in inter-tidal and floodplain habitat creation potential Greater risk of inundation of valued assets – positive for some and negative for others Reduced risk of inundation of valued assets – positive for some and negative for others
Water resources	Increase in water metering Introduction of variable tariffs Increased pressure on water resources in growth areas due to population increase	Potential increase in water available for habitats as potable consumption reduces Potential decrease in water available for habitats in growth areas

Sector	Socio economic change	How it might affect natural environment
Energy	Increase in oil price resulting in switch to renewables Switch to nuclear energy	Negative landscape impact of wind turbines Risk of diffuse pollution, landscape impact
Buildings	Increase in new build rates to meet demand from population growth – urban expansion Demand for waterside locations	Pressure on land Diffuse pollution
Transport	Demand for new infrastructure – roads, railways, runways etc to meet growing demand	Habitat fragmentation, landscape impact. Positive impact on access to countryside
Manufacturing and industry	Shift of heavy industry to other parts of the world	Reduction in diffuse pollution, increase in sites available for habitat restoration and creation
Financial services	Demand for ethical investment increases	Increased financial support
Retail	Movement of retail out-of-town Increase in ethical shopping	Pressure on land Increased awareness of value of natural environment
Leisure and tourism	Increased demand for extreme sports Increased demand for eco-tourism	Increase in visitor numbers and demand for facilities and infrastructure Reverse some of the negative effects of previous tourism
Health	Increase in obesity	Increased potential to market the countryside as part of a healthy lifestyle
Defence	Terrorism	Heightened security measure required

Mitigation

Addressing the challenges associated with climate change requires a ‘two-pronged’ approach: mitigation to limit the magnitude and rate of change and adaptation to deal with the residual impacts and opportunities. In climate change literature, mitigation refers specifically to the reduction in greenhouse gas emissions (UKCIP 2003). Mitigation is often driven by policy e.g. the UK Climate Change Programme. In addition to direct and indirect impacts of climate change, assets can be impacted by mitigation policy. Table A2.5 illustrates some potential impacts of mitigation policy on the significant natural environmental assets. Note that other mitigation actions e.g. individual, corporate or market-based may also affect assets, although they are likely to be of a similar type.

Table A2.5 Mitigation policy impacts on Natural England

Sector	Mitigation policy	How it might affect Natural England objectives
Agriculture, horticulture and forestry	Increase in biofuel production Increase carbon store in soils and	Landscape change, increase in monoculture Habitat creation potential

Sector	Mitigation policy	How it might affect Natural England objectives
	biomass	
Flood management	Support use of non-carbon intensive forms of flood defence	Habitat creation potential
Water resources	Reduce energy demand of water treatment	Diffuse pollution
Energy	Shift to renewable energy or nuclear	Landscape impact of wind turbines / new power stations
Transport	Renewable transport fuel Increase in public transport	Landscape change, increase in monoculture Shift in how people access recreational facilities, new infrastructure required
Manufacturing and industry	Burning of biofuels and CHP	Landscape change, increase in monoculture. Opportunity to capitalise on demand for waste organic products (e.g. wood chippings generated through reserve management)

Appendix 3 Tables to accompany narrative

Table A3.1 Impacts on valued assets of the Dorset Downs and Cranborne Chase

Key
Indirect impacts are highlighted in italics
<u>Policy impacts are underlined</u>

Ref	Asset	Risk	Nature of risk effects	Extent of Effects	Projected Impacts	Key Assumptions
1	**Lowland calcareous grassland** Priority HAP[1] synonymous with NVC[2] types CG1 – CG10 inclusive. Designated SSSI features. Annex 1 type under Habitats Directive. **Dorset Downs CG2, CG3, CG4 (and CG5 and CG7)**	Drier, hotter summers Wetter, warmer winters	Drought Longer growing season Fire	Increased summer drought is likely to be a particular threat for those communities which already have a highly xeric character.	<u>1a. Loss of/declining condition in parts of the SSSI[3]/SAC[4] series.</u> <u>1b. Continuing unfavorable conservation status for Annex 1 habitat.</u> 1c. Results from Monarch indicate that certain species gain suitable climatic space in the North and West whilst losing it in the South (*Cirsium acaule, Blackstonia perfoliata, Helianthemum nummularia*). Loss of dominant species, including grasses, is predicted in certain climatic models. 1d. Increase in spring biomass and decline in summer biomass. 1e. Decline in abundance and diversity of associated fungi communities and specialist mosses.	'Typical' chalk grassland is a diverse and herb rich sward containing betony, *small scabious, devil's bit scabious* and *saw wort.* Neglected' chalk grassland quickly moves through scrub into secondary woodland, with *upright brome* in Wiltshire and *false oat-grass* in Dorset dominating. Species rich scrub, including the internationally important Juniper scrub, houses a diverse assemblage and has particular importance for invertebrates, birds and mammals.

[1] Habitat Action Plan
[2] National Vegetation Classification types
[3] Site of Special Scientific Interest
[4] Special Area of Conservation

Ref	Asset	Risk	Nature of risk effects	Extent of Effects	Projected Impacts	Key Assumptions
					1f. Increased risk of wildfires resulting in damage to lower plant assemblages. 1g. Possible losses/declines of perennials due to die back through drought– giving rise to increase and expansion of drought tolerant ephemerals and re-colonization by annuals with a persistent seed bank. 1h. Warmer winters may delay succession, as gap formation in the sward will provide sites for colonisation of annuals, thereby enabling their persistence in the sward at the expense of perennials. 1i. Perennial grasses at risk from drier summers. *1j. Bromopsis erecta* (a key grass of the chalk and limestone) whilst favoured by moist springs and mild winters, is retarded by a dry season, so may be at a competitive disadvantage under future climatic conditions. Evidence suggests that the rhizomatous perennial grass *Brachypodium pinnatum* can increase in dominance and may expand its range under increased summer drought conditions. 1k. Plants with underground storage organs, rhizomes, roots, tubers or bulbs may be expected to show greater ability to survive droughts. In contrast shallow rooted species will be disadvantaged.	Chalk heath comprises of an intimate mix of plants normally requiring chalky soils as well as species restricted to more acid conditions. Responses of chalk/limestone communities to climate change will be related to the life-history attributes of the dominant species. Sensitivity of the majority of perennial grasses to increasing incidence and intensity of summer drought resulting in possible substantial shift in community composition towards more annuality.
2	Invertebrate assemblages associated with chalk grassland	Summer drought Warmer winters	Food resources unavailable Dormancy failure Distribution changes		2a. Vegetation burn-off. 2b. Failure to complete life-cycle - population failure. 2c. Loss of regional differences and/or native distinctiveness.	Limited mobility
3	**Lowland hay meadows** NVC MG5 and MG8. Priority HAP type.	Wetter winters Drier summers Increased	Longer growing season Higher water tables Increased frequency and duration of	Across the range of the community but drought effects may be more pronounced in south east	3a. Wetter winters could threaten the integrity of alluvial flood meadows as the component plants of the community are more prone to increasing wetness than to summer drought. 3b. Temperature changes may cause certain species to flower/set seed earlier in season.	The component plant species of the various lowland meadow types mostly belong to the southern temperate, widespread temperate and temperate biogeographical elements. This suggests that the three lowland

Ref	Asset	Risk	Nature of risk effects	Extent of Effects	Projected Impacts	Key Assumptions
	Designated SSSI features.	temperatures	flooding Phenological changes	England	3c. Higher frequency/duration of high soil water tables/flooding events. 3d. Increased spring temperatures (and legacy of wetter winters) may boost total biomass and favour competitive species. 3e. Drier summers will favour stress tolerant (e.g. deep-rooted species) and ruderal species but retard competitors/stress-tolerant competitors. 3f. Phenology of characteristic lowland meadow plant species may change significantly. 3g. SSSI condition will become “unfavourable”. 3h. Difficulty in meeting lowland hay meadow HAP/BAP[5] targets.	meadow NVC types might be relatively resilient to climate change scenarios, especially those related to temperature.
4	**Chalk rivers and streams** Avon, Frome, Stour and Piddle provide key and distinctive river systems with base-rich spring water that is naturally clear and fast flowing. Floating water crowfoot beds. Bank and in-channel	More extreme rainfall conditions (more intense rainfall events and drought periods) Change in air temperatures	Increased wash-off of fine sediment and nutrients Flashier flow regimes Drier low flow periods Change in water temperature regime	Effects likely across the whole of England Low-flow effects of climate change perhaps likely to be most extreme in the south and east, where rainfall is already low and development	4a. Destabilization of existing riverine sediments and river banks. 4b. Downstream migration of perennial heads of streams and (where evident) winterbourne sections. 4c. Direct ecological consequences of changes in water temperature. Loss of riverine species from areas where water temperatures move outside the range required for the species to compete effectively. 4d. Enhanced nutrient and sediment delivery lead to	

[5] Biodiversity Action Plan

Ref	Asset	Risk	Nature of risk effects	Extent of Effects	Projected Impacts	Key Assumptions
	environment provide species variety, including *Otter, Water vole, Dipper, Cetti's warbler, Daubenton's bat* plus numerous fish and invertebrates.		Societal pressure to increase abstraction rates during low-rainfall periods, and enhance traditional fluvial flood defences	pressure is greatest, and in rivers with low natural catchment water retention (i.e. negligible groundwaters).	increased eutrophication and siltation effects, including increased algal growths and standing crop and consequent effects on the wider biological community, reduced spawning success of salmonid fish and other fish species using riverine gravels for spawning. 4e. More extreme periods of low river-flows create lower water levels, reduced dissolved oxygen levels and poorer flushing of contaminants - loss of species most adapted to flowing water conditions. Problems compounded by higher water temperatures and enhanced nutrient and fine sediment delivery. In headwater sections, ephemeral sections will become largely devoid of aquatic species, whilst perennial sections will become ephemeral – loss of riverine habitat. 4f. Loss of physical habitat complexity from any works to stabilize river channels and improve their flood banks.	
5	**Broadleaved and yew woodland** Lowland beech	Higher summer temperature Reduced summer rainfall Increase in storm frequency	Summer drought Increase in storm frequency – high winds	Primarily thought to be a problem for Kent, Sussex Surrey, but lesser effects possible elsewhere in the south-east Ancient semi-natural woodland is located mainly on steep scarps and derives from hunting forests with their species composition reflecting change over the centuries.	<u>5a. Loss of/declining condition in part of designated features in some SSSI/SAC in south-east England.</u> <u>5b. Difficulties in meeting beech woodland HAP targets in south-east.</u> <u>5c. Continuing unfavourable conservation status for Annex 1 habitat.</u> 5d. Reduced abundance of beech specialists (epiphytes, fungi, invertebrates). 5e. Increased die-back of canopy beech. Reduced abundance of beech as canopy tree from changing competition. 5f. Changed ground flora composition.	Beech sensitivity to increased temperatures/drought emerges in various modeling papers although the outputs are not always the same!

Ref	Asset	Risk	Nature of risk effects	Extent of Effects	Projected Impacts	Key Assumptions
					5g. Increased sun-scorch leading to bark-death of beech. 5h. Increased loss of mature trees to wind blow. 5i. Reduced winter cold leading to less bud initiation and eventually loss of beech completely from Britain.	
6	**Wood pasture**	Increased summer temperature Decrease summer rainfall Increase storm intensity	Increased summer drought Increased windiness or at least increased frequency of extreme storms	Whole country potentially affected	6a. Increased rates of loss of existing veteran trees. 6b. Loss of specialist associated species through loss of veteran tree habitat (primarily fungi, saproxylic invertebrates and lichens). 6c. Loss of landscape quality through loss of old trees. *6d. Agricultural intensification leading to improvement/ ploughing of pasture element, clearance of scrub etc.* 6e. Increased loss of mature trees to wind blow.	Main threat is assumed to be to the veteran tree population. However in addition changes in farming practice could affect both the sites and the landscapes in which they sit as an indirect consequence of climate change.
7	**Mixed deciduous woodland**	Higher summer temperature Changed rainfall patterns	Summer drought Change in relative competitiveness Change in suitable climate space	Widespread throughout the lowlands so even minor changes at individual sites will have significant cumulative impact. Effects likely to be most severe on dry south-facing slopes in south-east.	7a. Shifts in the regeneration patterns of trees (more regular masting)? 7b. Changes in the relative abundance of woodland species and communities, but probably no major changes in overall species pools. 7c. Changes in landscape context because of changes in lowland agriculture. 7d. Potential invasion/establishment of species from further south in Europe e.g. Holm oak. 7e. Decline in woodland cover/increased threat of fire on driest sites. *7f. Increased effects of agricultural practice on adjacent woodland.* 7g. Shifts in the composition of vegetations types or balance	Relatively little consideration has been given to this type of woodland to date, even though it is the largest single type.

Ref	Asset	Risk	Nature of risk effects	Extent of Effects	Projected Impacts	Key Assumptions
					of types has implications for reasons for site designation. 7h. Individual rare species may increase or decrease. 7i. Change in composition from invasive species.	
8	**Wet woodland**	Summer temperature Reduced rainfall in summer	Summer drought Lower water tables in sites affected by increased abstraction Higher intensity rainfall events Sea-level rise	Mainly a problem in the lowlands.	8a. Drying out of rainfall-dependent sites in summer. 8b. Changes in ground flora communities. 8c. Loss of condition of designated sites. 8d. Failure to achieve Favourable Conservation Status on Annex 1 habitats. 8e. Failure to meet HAP targets. 8f. Potential opportunities for habitat creation on flood storage land. 8g. Loss of coastal wetwoods through marine incursion.	Key factor is availability of water, primarily ground water for maintenance of this habitat.
9	**Arable Farmland**	Milder winters Increased spring temperatures	Longer growing season Phenological changes	Throughout	9a. Decline in productivity. 9b. Spring migrants arrive earlier, breed earlier.	Cultivated land is widespread and provides a significant resource for species such as farmland birds of open land such as Stone Curlew, arable ‘weeds’ and brown hare. Note most farmland birds and brown hare likely to be more affected by crop species and farmland management than by direct climate changes.

Ref	Asset	Risk	Nature of risk effects	Extent of Effects	Projected Impacts	Key Assumptions
10	**Public Rights of Way network**	Increase in temperature Dry spells Heavy rain	Increase in visitor numbers, increase population living near by Extreme weather conditions Flooding Fire	Particularly marked in fragile habitats but impact potential anywhere	*10a. Potential increase in opportunities for recreation – people more active, healthy and engaged. Greater opportunity for enjoyment of the outdoors.* *10b. More people using popular routes – congestion.* *10c. Increased erosion caused by recreation.* *10d. Loss of habitat through trampling.* 10e. Threat of flooding of recreation assets. 10f. Greater opportunity for accidents (fire etc) – summer becomes hazard season.	Review of the Relationship between Sport, Recreation and Nature Conservation (EN 2006 unpublished). England Leisure Visit Survey 2005. Assumes prevailing socio-economic scenario continues. Also assumes that an increase in temperature results in an increase in visitor numbers.
11	**Open access land (CROW)** Downland and grassland Woodland	Increase in temperature Dry spells Heavy rain	Increase in visitor numbers, increased population living near by Extreme weather conditions Flooding Fire	Particularly marked in fragile habitats but impact potential anywhere	*11a. Potential increase in opportunities for recreation – people more active, healthy and engaged. Greater opportunity for enjoyment of the outdoors.* *11b. More people using popular areas – loss of visitor experience, detrimental to landscape character.* *11c. Increased erosion caused by recreation.* *11d. Loss of habitat through trampling.* 11e. Threat of flooding. 11f. Greater opportunity for accidents (fire etc) – summer becomes hazard season.	Review of the Relationship between Sport, Recreation and Nature Conservation (EN 2006 unpublished). England Leisure Visit Survey 2005. Assumes prevailing socio-economic scenario continues. Also assumes that an increase in temperature results in an increase in visitor numbers.

Ref	Asset	Risk	Nature of risk effects	Extent of Effects	Projected Impacts	Key Assumptions
12	**Water**	Increased temperature Decreased rainfall	Drought	Chalk rivers and streams in Character Area	12a. Reduced water levels – impact on fishing. 12b. Less water available for water based activities.	Assumes prevailing socio-economic scenario continues. Also assumes that an increase in temperature results in an increase in visitor numbers.
13	**Market towns and urban areas**	Increased temperature Decreased rainfall in summer Increased rainfall in winter	Increase in visitor numbers, increased population living near by Drought Flooding	Market towns and gateways into the Character Area	*13a. Increased demand for visitor services – accommodation, car parking etc.* *13b. Increased pressure on resources e.g. water.* 13c. Flooding.	Assumes prevailing socio-economic scenario continues. Also assumes that an increase in temperature results in an increase in visitor numbers.
14	**Historic sites**	Increased temperature Decreased rainfall in summer Increased rainfall in winter	Increase in visitor numbers Drought Flooding	There are a number of National Trust sites in the Character Area	*14a. Increased visitor demand.* 14b. Flooding.	Assumes prevailing socio-economic scenario continues. Also assumes that an increase in temperature results in an increase in visitor numbers.

Table A3.2 Responses to climate change impacts in the Dorset Downs and Cranborne Chase Character Area

Key
<u>Policy responses are underlined</u>

Asset	Impact Ref	Response strategy	Priority	Timing	Cost	Extent to which impact dealt with by response	Responsibility	Barriers
Grassland		Ensuring best practice management of existing stands - current best practice may need to change	High	Immediate	Low	Very effective. Can be delivered through changes in agri-environment schemes	Natural England lead NGOs	CAP reforms Agricultural economics
	1c 1e 1g 1i 1j 3a 3d 3e	Increase area of existing habitat through targeted restoration and re-creation within England Habitat Network – particularly areas that are currently regarded as sub-optimal	High	Before 2020	Medium	Could be delivered through agri-environment scheme	Natural England lead NGO	CAP reforms Agricultural economics
	1a 1b 3g 3h	<u>Reflect potential for changes in species composition in conservation objectives and condition assessment.</u>	Medium	Before 2020	Low	Very effective but will require monitoring to ensure effectiveness persists	Natural England	EU – Habitat Regulations
	1d 3d	Promote adaptive grazing management of sites – sustain extensive grazing	High	Immediate	Medium (but high if necessary to re-establish livestock systems)	Very effective – essential to sustainable management	Natural England to lead with Defra	CAP reform Free markets – extensive livestocking becomes economically unsustainable
	1d 1h 3b	More flexible approach to site management e.g. varying the timing of the hay cut or the	High	Immediate	Low	Very effective. Can be delivered through changes in agri-environment schemes	Natural England lead NGOs	CAP reforms Agricultural

Asset	Impact Ref	Response strategy	Priority	Timing	Cost	Extent to which impact dealt with by response	Responsibility	Barriers
	3d 3f	timing/duration of aftermath grazing.						economics
Freshwater	4a 4d 4e	Increase ability of catchments to retain rainfall and reduce artificially enhanced surface run-off	High	Immediate	Medium	Very effective. Can be delivered through agri-environment scheme	Natural England Government (regulatory role) Forestry Commission Environment Agency Land use planners	Reliance on voluntary action – need regulation Character Area scale
	4e	Aquifer protection (reduce abstraction)	High	Before 2020	High (or very high)	Very effective	Environment Agency Water companies	Cost - compensation
	4a 4d 4e 4f	Targeted restoration of floodplain functionality	High	Immediate	Medium	Effective but requires more research and evidence base (particularly hydrology and geomorphology)	Environment Agency Land use planners Highways authorities	Public understanding Lack of advocacy Lack of evidence base
	4a 4b 4f	Restoration of natural physical form and function of river channels	High	Immediate	Medium	Effective but requires more research and evidence base (particularly hydrology and geomorphology)	Environment Agency Land use planners Highways authorities	Public understanding Lack of advocacy Lack of evidence base
	4a	Restoration of riparian	High	Immediate	Low	Effective	Natural England	

Asset	Impact Ref	Response strategy	Priority	Timing	Cost	Extent to which impact dealt with by response	Responsibility	Barriers
	4c	shading by trees					Environment Agency Land use planners	
	4d	Control of nutrient inputs to rivers	High	Immediate	High	Effective	Environment Agency Water companies	Cost
	4f	Removal of in-channel structures	High	Immediate	Medium	Effective but requires more research and evidence base (particularly hydrology and geomorphology)	Environment Agency Land use planners Highways authorities	Public understanding Lack of advocacy Lack of evidence base
	4c 4d 4e	<u>Reflect potential for changes in species composition, particularly with regards to invasives, in conservation objectives and condition assessment.</u>	High	Immediate	Low	Will need to be flexible and requires monitoring	Natural England	EU – Habitats Regulations
Woodland	5a 5d 5e 5g 6b 7b 7h 7i	Maintain existing habitat	High	Ongoing	Low	Will be partially effective but will need to be used in conjunction with other measures	Natural England	
	5d	Increase size of small	Medium	Before	Medium	Will be effective in the longer	Natural England	Lag time – not

Asset	Impact Ref	Response strategy	Priority	Timing	Cost	Extent to which impact dealt with by response	Responsibility	Barriers
	5e 6a 6c 6d 7c 7f	woods/buffer woods in intensive agricultural /urban areas		2020		term but will require monitoring of climate change impacts	Land use planners	visible Potential regrets Land use pressure Land owner attitudes
	5d 5e 5g 5i	Promote beech on north facing sites	High	Immediate	Low	Will be effective in the longer term but will require monitoring of climate change impacts	Natural England Land use planners	Land use pressure
	5d 5f	Address other threats e.g. lack of management (coppicing, pollarding etc)	Medium	Immediate	Low	Effective in conjunction with other measures	Natural England	Land owner attitudes
	5f 7d 7i	Monitor occurrence and abundance of new pests and diseases	Medium	Ongoing	Low	Only effective for easily identified species and if followed up by strategic approach to eradication	Natural England	Cost of invasive species control
	5e 5f 7b 7d 7h 7i 8b	Encourage/accept greater mix of trees in regeneration	Medium	Before 2020	Low	Will be effective in the longer term but will require monitoring of climate change impacts	Natural England NGOs	Land owner attitudes EU – Habitats Regulations
	5e 5f 7b 7d 7h 7i	<u>Reflect potential for changes in native tree composition in conservation objectives</u>	Medium	Before 2020	Low	Very effective but will require monitoring to ensure effectiveness persists	Natural England	EU – Habitat Regulations

Asset	Impact Ref	Response strategy	Priority	Timing	Cost	Extent to which impact dealt with by response	Responsibility	Barriers
	8b							
	5h 6a 6b 6c 6e	Improve management around existing veteran trees in site (less cultivation, reduced grazing & barking of trees, reduced fertilization/spraying)	High	Immediate	Low – potential cost saving	Effective but should be targeted to favourable soils and aspects. Asset may not be viable in the long term.	Natural England	Long term viability in drought vulnerable soils
	6a 6b 6c 6e	Move wood pasture	Medium	Before 2020	Medium	Effective if suitable climate space can be found. However, the value of wood pasture is place specific.	Natural England	Landscape Historic context
	5h 6e	Crown works on existing trees where this helps improved the root: crown ratio	Medium	Ongoing	Medium	Only effective on small scale – too many trees for it to be a widespread response	Natural England, land managers	
	8a 8b 8g	Promote wet woodland creation as part of larger wetland creation schemes	Medium	Before 2020	Medium	Will be effective in the longer term but will require monitoring of climate change impacts	Natural England Land use planners	Lag time – not visible Potential regrets Land use pressure Land owner attitudes
Access and recreation	10a 10b 10c 10d 11a 11b 11c 11d 13a 13b	Model increase in visitor numbers and identify areas most at risk of damage	High	Immediate	Low	Will make implementation of management more effective	Natural England Tourist Boards Local Authorities	

Asset	Impact Ref	Response strategy	Priority	Timing	Cost	Extent to which impact dealt with by response	Responsibility	Barriers
	14a							
	10a 10b 10c 106 11a 11b 11c 11d 13a 14a	Dispersal – promote other rights of way / attractions	High	Immediate	Low	Will require monitoring of visitor numbers and route usage. Effectiveness will depend on promotion and education.	Natural England National Trust Highways authorities	Public perception of honeypot sites
	10b 10c 10d 10e 11b 11c 11d	Potential temporary closure of footpaths	Medium	Ongoing	Low	Effectiveness will depend on promotion and education.	Natural England Highways authorities	
	10b 10c 10d 10f 11c 11d 11f 13b	Education of visitors through advertising and interpretive signing	High	Immediate	Medium	Will enhance effectiveness of other measures	Natural England Tourist Boards	
	10a 11a 13a	Link areas of open access land - form a recreation network	Medium	Before 2020	High	Effective response to climate change opportunity	Natural England Highways authorities	Land pressure

Asset	Impact Ref	Response strategy	Priority	Timing	Cost	Extent to which impact dealt with by response	Responsibility	Barriers
	10b 11b 13a	Increase public transport provision throughout JCA	Medium	Immediate	High	Uncertain – depends on condition of infrastructure. Will require monitoring of user numbers.	Natural England, public transport providers	High cost

Table A3.3 Assessment of responses against 'good adaptation principles'

Response	Work in partnership	Address climate and non-climate pressures	Adaptive management to deal with uncertainty	Low/no regrets and win-win options	Future adaptation	Conflict with mitigation	Robust to socio-economic scenarios
Maintain existing habitats	Landowners, farmers	Deals with habitat fragmentation, protects from agricultural and development pressures	Response can be delivered through adaptive management	No regrets	Improves scope for future adaptation	Potential synergy with mitigation – increase carbon storage capacity	Future biodiversity will depend on the diversity we conserve today even if it is different. Value of habitats may change under different scenarios.
Extend existing sites	Landowners, NGOs, Environment Agency (for flood plain habitats)	Deals with habitat fragmentation, protects from agricultural and development pressures	Swap certainty for uncertainty – don't know exactly what habitats will thrive. Limited value in recreating habitats which will not be sustainable under climate change	Low regret – although possible regret if based on existing composition	Can improve scope for future adaptation if flexible over what habitats are created	Potential synergy with mitigation – increase carbon storage capacity	Value of habitats may change under different scenarios. May have a different emphasis between conservation and recreation.

Response	**Work in partnership**	**Address climate and non-climate pressures**	**Adaptive management to deal with uncertainty**	**Low/no regrets and win-win options**	**Future adaptation**	**Conflict with mitigation**	**Robust to socio-economic scenarios**
Habitat re-creation or restoration	Landowners, NGOs, Environment Agency (for flood plain habitats)	Deals with habitat fragmentation, protects from agricultural and development pressures	Swap certainty for uncertainty – don't know exactly what habitats will thrive. Limited value in recreating habitats which will not be sustainable under climate change	Potential for regret if habitat is re-created based on current composition	Can improve scope for future adaptation if flexible over what habitats are created	Potential synergy with mitigation – increase carbon storage capacity	Value of habitats may change under different scenarios. May have a different emphasis between conservation and recreation.
Changing conservation objectives	No	Can be used to account for invasives and non-native species	Must be flexible in response to uncertainty	Low regret	Must remain flexible in order to have no impacts on future adaptation	No interaction with mitigation	Attitude to conservation may be different. Value placed on habitats and species may be different. May be greater or lesser emphasis on recreation over conservation.

Response	Work in partnership	Address climate and non-climate pressures	Adaptive management to deal with uncertainty	Low/no regrets and win-win options	Future adaptation	Conflict with mitigation	Robust to socio-economic scenarios
Manage grazing level – extensive grazing	Landowners, farmers, graziers	Can be used to deal with changes in agricultural economics – shift towards arable cultivation	Adaptive management therefore allows flexibility in the face of uncertainty	No regret	No impact on future adaptation – adaptive management therefore flexible / reversible	Increased stocking levels may increase methane emissions	Will be mediated by changes in agriculture sector
Flexible hay cutting date and timing/duration of aftermath grazing	Landowners, farmers		Adaptive management therefore allows flexibility in the face of uncertainty	No regret	No impact on future adaptation – adaptive management therefore flexible / reversible	No interaction with mitigation	Will be mediated by changes in agriculture sector
Monitor occurrence and abundance of new pests and diseases	Farmers, Forestry Commission, NGOs	Pests and diseases can arrive independently of climate change – e.g. through import of plants	Allows management actions to be adjusted as new data comes to light	No regret	Beneficial impact on future adaptation	No interaction with mitigation	Useful information regardless of socio-economic scenario
Crown works on existing trees where this helps improve the root:crown ratio	Reserve managers	Assists in control of succession and maintenance of biodiversity		Low regrets	No impact on future adaptation	Reduced biomass carbon store	Socio-economic scenarios unlikely to affect response

Response	Work in partnership	Address climate and non-climate pressures	Adaptive management to deal with uncertainty	Low/no regrets and win-win options	Future adaptation	Conflict with mitigation	Robust to socio-economic scenarios
Replacement of trees with a mix of species	Land managers, NGOs	More resilient to pests and diseases	May not be robust as uncertainty over which species will thrive	Potential regret if species chosen not sustainable – requires research	No impact on future adaptation if flexible	Potential synergy with mitigation – increase carbon storage capacity	Value of species may change under different scenarios. Attitudes towards non-natives and invasives may change.
Promote beech on north facing sites	Farmers, Forestry Commission, land use planners	Does not address non-climate pressures	Uncertainty over the ability of Beech to persist – response is not adaptable in the short term	Potential regret - Beech may die out regardless of efforts made now therefore would be a waste of resources	Long term land use change therefore may prevent other adaptive uses	Potential synergy with mitigation – increase carbon storage capacity	Value of species may change under different scenarios.
Move wood pasture	Farmers, Forestry Commission, landscape	Does not address non-climate pressures	Uncertainty over persistence of wood pasture	Potential regret – value of wood pasture in landscape is due to historical context. Would not be possible to recreate this.		No interaction with mitigation	Value of species may change under different scenarios.

Response	Work in partnership	Address climate and non-climate pressures	Adaptive management to deal with uncertainty	Low/no regrets and win-win options	Future adaptation	Conflict with mitigation	Robust to socio-economic scenarios
Increase ability of catchments to retain rainfall and reduce artificially enhanced surface run-off	Environment Agency Highways authorities Land use planners	Addresses run-off from development and agriculture		No regrets and win-win for many sectors. Reduces flood risk, increases soil moisture and water available for abstraction	No impact on future adaptation	Synergies with mitigation – collected water can be used for cooling buildings	
Aquifer protection (reduce abstraction)	Environment Agency Water companies	Addresses pressure from development and potable water demand	Level of abstraction can be varied to take account of uncertainty	No regrets and win-win. Improves water quality and biodiversity	No impact on future adaptation	Reduced emissions associated with pumping and transferring water	
Restoration of natural physical form and function of river channels and floodplains	Environment Agency Land owners Land use planners	Addresses pressure from development, reduces flood risk	By allowing systems to naturally respond to changes deals with uncertainty	Low regrets. Win-win – improvements in flood defence, water quality, landscape	Benefits future adaptation as flood risk is lower	No conflicts with mitigation	Whilst our perceptions of biodiversity and landscape may change, reduced flood risk will be seen as a benefit under all scenarios
Restoration of riparian shading by trees	Environment Agency Land use planners Forestry Commission	Improves landscape		Low regrets. Win-win – benefits for landscape	No impact on future adaptation	Potential synergy with mitigation – increase carbon storage capacity	Socio-economic scenarios unlikely to affect response

Response	Work in partnership	Address climate and non-climate pressures	Adaptive management to deal with uncertainty	Low/no regrets and win-win options	Future adaptation	Conflict with mitigation	Robust to socio-economic scenarios
Control of nutrient inputs to rivers	Environment Agency Water companies Farmers	Addresses existing pressure from agriculture and recreation		No regrets	No impact on future adaptation	Potential conflict if more energy required to treat water to a higher standard. Potential synergy with preference for organic farming	Will be mediated by changes in agriculture sector
Dispersal of visitors	Highways authorities, local authorities, tourist board	Alleviates existing pressure on honeypots which will be exacerbated by a population increase	Robust to uncertainty over visitor levels	No regrets. Benefits for biodiversity.	No impact on future adaptation	No conflict with mitigation	Sensible regardless of socio-economic scenario. May see a decrease in visitor numbers.
Sustainable public transport provision	Public transport providers, local authorities	Alleviates congestion due to population increase	May not be viable under scenarios of lower visitor numbers	No regrets	No impact on future adaptation	Benefits for mitigation	May not be viable under scenarios of lower visitor numbers
Model increase in visitor numbers and identify areas most at risk of damage	Tourist Board National Trust and other visitor attractions	Addresses damage done by increase in visitor numbers due to population increase	Use adaptive management once areas at risk identified	No regrets. Win-win – useful information for other bodies. Benefits for biodiversity.	Should benefit future adaptation – can tailor it to highest priority sites	No conflict with mitigation	Research should take differences into socio-economic scenarios into account

Response	Work in partnership	Address climate and non-climate pressures	Adaptive management to deal with uncertainty	Low/no regrets and win-win options	Future adaptation	Conflict with mitigation	Robust to socio-economic scenarios
Potential temporary closure of footpaths	Highways authority	Addresses damage done by increase in visitor numbers due to population increase	Closures would be temporary therefore could be classed as adaptive management	Some regrets – constraining recreation opportunity, will need to re-create lost paths elsewhere. Benefits for biodiversity.	No impact on future adaptation	No conflict with mitigation	Use of footpaths will depend on attitudes to the environment and outdoor recreation
Education of visitors through advertising and interpretive signing	Tourist Board, Local Authorities	Can improve visitors appreciation of the natural environment	Robust to uncertainty – material presented can be adapted	No regrets	Might be beneficial if people are aware of need for adaptation	No conflicts with mitigation	Material presented can be tailored to prevailing socio-economic scenario
Link areas of open access land - form a recreation network	Highway authorities Land owners Interest groups	Addresses congestion due to population increase		Potential regrets include increase in area of habitat disturbed.		May lead to increase in vehicle emissions if more people drawn to the area	Use will depend on attitudes to the environment and outdoor recreation

Table A3.4 Potential impact of climate change on ecosystem services and suggested responses
Indirect impacts are highlighted in italics

Category	Service	Impact of Climate Change	Response	Key assumptions
Provisioning services	Water resources	Lower summer flows - less water available for abstraction and recreation Increased erosion and siltation of water bodies Increased overland flow during high intensity events – less groundwater recharge	Catchment management – improving permeability of surfaces through planting, creation of wet woodland, SUDS etc Demand management Switch to more drought resistant plants On farm water storage	Increases in efficiency could limit problem of low water availability in summer
	Farming	Changes to livestock / crop viability New pests and diseases Summer drought – increase in irrigation demand	Crop / livestock switching Monitor occurrence and abundance of new pests and diseases Improvements in water management – on farm storage, reduced surface run-off, increase infiltration rates	
	Fishing	Lower summer flows – fish kills Change in species composition of water bodies	Limit fishing during low flow periods Disperse fishing away from most popular sites Set up artificially stocked lakes	
Cultural services	Recreation	More opportunities *Indirect impacts – congestion, footpath erosion, trampling* Decrease in fishing opportunities	Improve recreational infrastructure where appropriate Identify vulnerable areas Limit fishing during low flow periods	Assumes increase in visitor numbers with increase in temperature. Assumes conventional development prevails.

Category	Service	Impact of Climate Change	Response	Key assumptions
	Tourism	More visitors (especially in shoulder months) *Indirect impacts – congestion, footpath erosion, trampling* *Greater pressure on resources – accommodation, transport infrastructure, water etc*	Improve recreational infrastructure where appropriate Identify vulnerable areas Education Infrastructure vs. protection (debate needed)	Assumes increase in visitor numbers with increase in temperature. Assumes conventional development prevails.
	Education	*Increased demand for field studies*	Change in curriculum	Assumes increase in visitor numbers with increase in temperature.
Supporting services	Soils	Quaternary deposits could be lost through erosion – important as they record the impact of recent past climate change on the landscape. Valuable in understanding long term trends and how the landscape has responded to climate change in the past. Contain archaeological evidence of human activity in the landscape	Improvement in soil and vegetation management Changes in agricultural practice Limiting visitor numbers in sensitive areas	
	Geology	*Access issues if widespread habitat creation in response to climate change* Change in fluvial processes	Ensure access to geological features (may conflict with habitat extension and creation programmes)	

Category	**Service**	**Impact of Climate Change**	**Response**	**Key assumptions**
Regulating services	Flood protection	Increase in flood risk – greater winter rainfall, more overland flow, more storm events *Indirect impact on infrastructure – roads, rail, isolated communities etc*	Catchment management – improving permeability of surfaces through planting, creation of wet woodland, SUDS etc Habitat creation opportunity from flood defence works – flood storage areas, managed realignment Temporary closure / diversion of rights of way	
	Water quality	Diffuse pollution – less dilution due to lower flows Increase in nutrient loading due to increase in visitor numbers and potential agricultural re-intensification.	Vegetation and soil management to achieve potable water improvements Vegetation buffer strips around fields Reduce nutrient input to water bodies	

Table A3.5 Socio-economic impacts and responses in Dorset Downs and Cranborne Chase

Sector	Socio economic changes	Impact on Dorset Downs Character Area	Response	Key assumptions
Agriculture, horticulture and forestry	Increase in demand for organic produce Changes in payments and subsidies	Increase in invertebrate and bird species due to reduction in pesticides used Reduction in diffuse pollution Improved countryside stewardship Reduce monoculture	Extension of the habitat network through habitat creation on arable field margins	Assumes conventional development. Demand for organic and local produce would be highest under Local Markets
Water resources	Increase in water metering Introduction of variable tariffs Increased pressure on water resources due to population increase	Potential increase in water available for habitats as potable consumption reduces Potential decrease in water available for habitats	Wetland habitat creation and restoration Resist development in areas of water stress through the water resource and spatial planning system	Assumes water demand grows as population grows. Greater water efficiency may reduce per capita consumption.
Energy	Increase in oil price and concern over security of supply	Switch to renewable - negative landscape impact of wind turbines and biofuels	Resist inappropriate structures on the landscape through spatial planning system Strengthen landscape designations in Dorset Downs and Cranborne Chase Character Area	Increase in oil price and concern over security of supply could lead to increase in nuclear power rather than renewables

Sector	Socio economic changes	Impact on Dorset Downs Character Area	Response	Key assumptions
Buildings	Increase in new build rates to meet demand from population growth and urban expansion	Pressure on land	Resist development in sensitive areas through spatial planning system Strengthen landscape designations in Dorset Downs and Cranborne Chase Character Area	Assumes UK population will increase
Transport	Demand for new infrastructure – roads, railways, runways etc. to meet growing demand	Habitat fragmentation, landscape impact. Positive impact on access to countryside	Resist development in sensitive areas through spatial planning system Improve public transport access to Character Area – reduce demand for travel	Assumes conventional development and limited use of public transport.
Leisure and tourism	Increased demand for outdoor activities – walking, cycling, gliding Increased demand for eco-tourism	Increase in visitor numbers and demand for facilities and infrastructure Reverse some of the negative effects of previous tourism	Visitor dispersal Education	
Health	Increase in obesity	Increased potential to market the countryside as part of a healthy lifestyle – increase number of people enjoying the countryside	Market the countryside as part of a healthy lifestyle	Assumes conventional development – lifestyles may change to be less sedentary