



Adapting to Climate Change in the Lake District National Park:

Initial Assessment of Risks, Opportunities and Actions

January 2012



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Adapting to Climate Change in the Lake District National Park

1.0 Introduction

The Climate Change Act 2008¹ established that a UK-wide climate change risk assessment must take place every five years. To enable this assessment to take place the Government introduced a statutory power to require bodies of a public nature to report on how they assess the risks and opportunities relating to climate change and the measures that are either underway or planned to address them. English National Park Authorities, although not legally obliged to report, accepted an invitation from Defra and have each produced adaptation reports covering future impacts to the National Park (the area) and the National Park Authority (the organisation).

National research confirms that climate change is happening on a global scale and will continue to do so over the coming decades. We also recognise that there will be inevitable impacts from this change which are likely to include hotter drier summers, warmer wetter winters and unpredictable and potentially disruptive extreme weather events for the Lake District. The Vision for the Lake District National Park is that by 2030 it will be an inspirational example of sustainable development in action and in order to support this goal we must plan for and adapt to the impacts of climate change. We are already playing a leadership role in managing climate change regionally and the current context for this work is contained in a seminal report: 'Low-carbon Lake DistrictTM: Responding to Climate Change in the National Park'.² This report assessed the impact of climate change on the area, examining its physical effects and the likely impacts on the society and economy of the Lake District.

This is the first climate change adaptation risk assessment for the Lake District National Park and it examines the risks and opportunities of a changing climate and the adaptive actions that will enable the Lake District to better cope with these changes over the coming decades. Although a number of actions are already planned or underway, compiling this report has helped to prioritise existing adaptation work and understand future actions that need to take place.

2.0 Methodology

Following the invitation from Defra for all of the English National Park Authorities to submit adaptation reports, the English National Park Authorities Association Climate Change Working Group (ENPAA CCWG) developed a spread sheet template for each Authority to use to identify potential risks and opportunities relating to changing climate. The seven themes contained within this template are:

- landscape;
- biodiversity;
- historic environment;
- access, recreation and tourism;
- community culture and economy,
- farming and land management;
- the National Park Authority's own business continuity.

The resulting tables can be found in section 8.0 below.

¹ http://www.decc.gov.uk/en/content/cms/legislation/cc_act_08/cc_act_08.aspx

² <http://www.lakedistrict.gov.uk/index/caringfor/policies/climatechange/lowcarbonlakedistrict.htm>

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The specialist officers at the LDNPA involved in the assessment were:

- Head of Park Management Services
- Head of Environment and Heritage
- Head of Property Services
- Policy Planner
- Policy Advisor
- Carbon Reduction Adviser
- Ecologist
- Senior Archaeology and Heritage Adviser
- Conservation and Design Adviser
- Environmental Land Management Service Adviser
- Carbon Landscapes Co-ordinator
- Landscape Architect

A wider range of specialist officers including Rangers, the Tree and Woodlands Adviser and members of the Property, ICT and Learning Services were also consulted at the outset of the process during a half day adaptation workshop.

3.0. Lake District National Park – the area

The Lake District is one of the richest cultural landscapes in England. The landscape, handmade over centuries by hill farmers, inspired Romantic poets and artists such as Wordsworth, Coleridge and Turner. Battles over its protection led directly to the development of the modern conservation movement and the National Trust. This gives the Lake District an international significance which is being addressed through the current bid for World Heritage Site status.

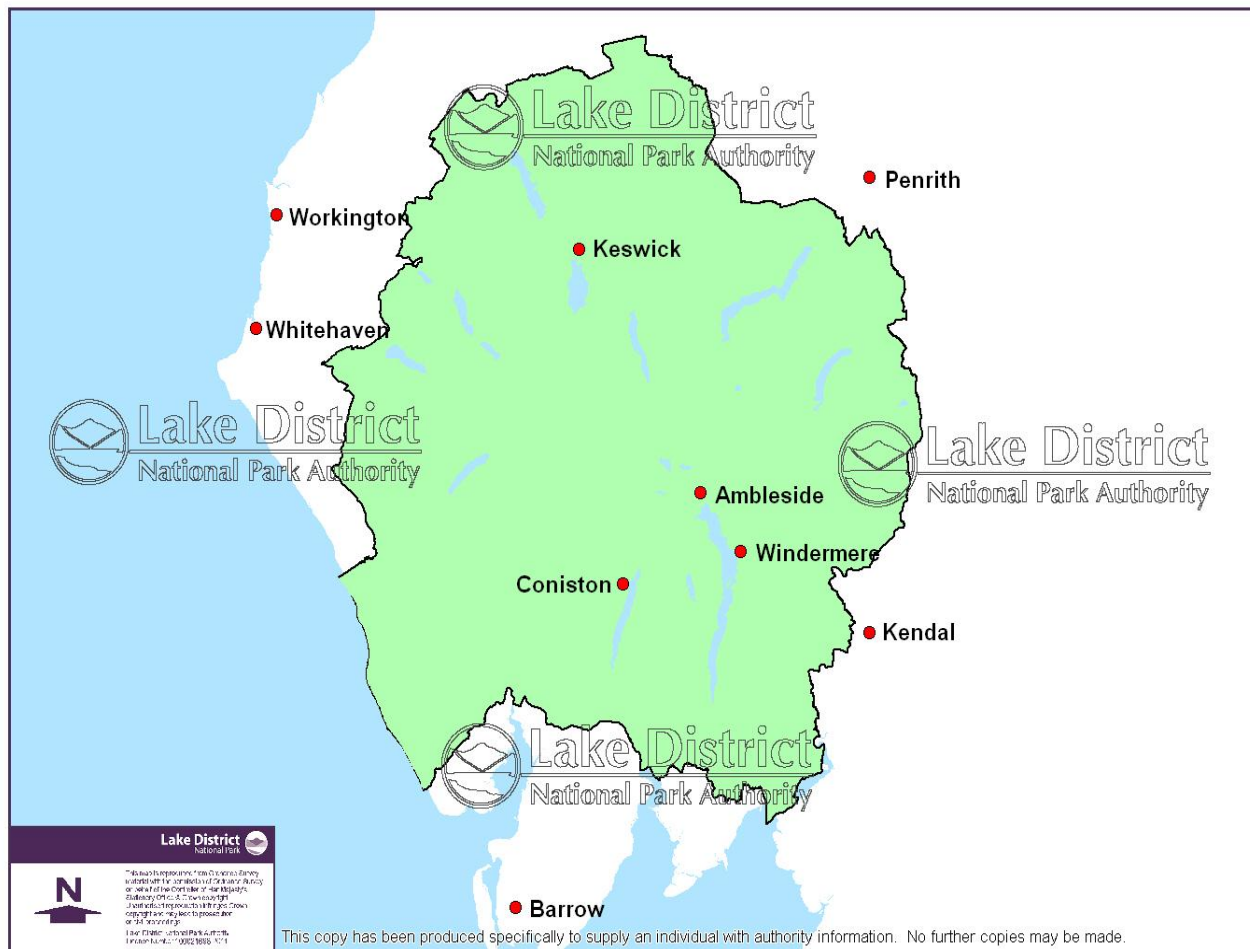
Habitats provide many of the products and services that are essential for well-being and economic prosperity such as clean water and air, high quality food, wood products, recreation and locking up carbon. When these they are in good condition they provide better quality and quantity of these products and services maintaining the character and quality of our countryside for future generations. Networks of healthy habitats, or green infrastructure, allow species to move more easily and make the landscape more adaptable to change. This will become increasingly important with climate change. Well managed peat bogs, for example, are valuable for biodiversity and absorbing and storing carbon.

Our high level paths are fragile with millions of visitors each year contributing to erosion of vegetation and soil compaction. We need to work hard to maintain them but this provides an opportunity to engage visitors in understanding the issues and contributing in some way.

Many businesses, especially the tourism industry, will rely even more on a high quality environment, and the richness of the natural resource attracts investment into the area. There is increasing pressure on land use and uncertainty as to public priorities for the uplands in the future which make it difficult to know future policy – for example, the potential tensions between ‘food security’ and other environmental services such as water and carbon.

The map below identifies the geographical extent of the National Park and a profile of the area is at Annex 1.

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3.1 Special qualities of the Lake District National Park

Special qualities distinguish National Parks from each other and from other parts of the country. We need to be clear about the Lake District's special qualities so we protect them and have a platform for effective management. Consultation on the Lake District National Park Management Plan in 2003 and World Heritage Site proposals in 2006 identified a number of characteristics that make the Lake District National Park unique. These have been carefully considered and reassessed. The special qualities of the Lake District are:

- Complex geology and geomorphology
- Diverse Landscape from mountain to coast
- Unique farmed landscape and concentration of common land
- Nationally important mosaic of lakes, tarns and rivers and coast
- Wealth of habitats and wildlife
- Extensive semi-natural woodlands
- History of tourism and outdoor activities
- Opportunities for quiet enjoyment
- Open nature of the fells
- Rich archaeology
- Distinctive areas and settlement character
- Celebrated social and cultural heritage

4.0 Lake District National Park Authority – the organisation

4.1 National Park Purposes

The Lake District National Park Authority is charged with supporting the delivery of the two national park statutory purposes as set out in Section 61 of the Environment Act 1995 (amending the 1949 Act) which are:

- To conserve and enhance the natural beauty, wildlife and cultural heritage of National Parks and
- To promote opportunities for the understanding and enjoyment of the special qualities of the National Parks by the public.

However, National Parks are cultural landscapes with a resident population, so National Park Authorities also have a duty in delivering the purposes to ‘foster the economic and social well-being of local communities within the National Park’.

During 2011 we thoroughly re-examined our priorities in relation to our Business Plan and the Vision for the Lake District National Park and agreed an Organisational Strategy with the following priorities for action:

- We will be experts in catalysing change
- We will deliver sustainable development in practical and visible ways
- We will engage with our communities
- We will demonstrate a high performance culture

4.2 Our organisation

We:

- are the planning authority, making decisions on planning applications, advising people how to comply and creating policies to guide development
- promote and fund sustainable development
- support and work with communities within and outside the National Park
- develop and maintain access to the countryside, encouraging responsible use
- run events and learning activities
- run the Lake District Visitor Centre at Brockhole, a boating centre at Coniston and information centres at Bowness, Keswick and Ullswater
- manage over 8,000 hectares of land including woodlands and lakes, and operate car parks and public toilets
- enrich wildlife, heritage and landscape
- manage the effects of climate change.

4.3 Lake District National Park Authority Members, Staff and Volunteers

The Authority is made up of 22 members. Six are appointed by Cumbria County Council, six are appointed by the District Councils covering areas within the National Park, six are appointed by the Secretary of State to represent the national interest and four are appointed to represent the National Park's Parish Councils.

We have 196 staff including park management and field rangers; information centres advisers, field workers, planners and specialists in ecology, archaeology, landscape and access. We also have a wealth of additional knowledge and experience to tap into in the form of our enthusiastic volunteer base.

5.0 Lake District National Park Partnership and Plan

5.1 The Lake District National Park Partnership Approach

Much of our work is with the other 23 organisations that form the Lake District National Park Partnership (Annex 2). The Partnership's Plan is the Management Plan for the National Park which tells everyone where we are heading, what the issues are and how we are going to tackle them with limited public funding.

The Partnership is also responsible for agreeing the Vision for the Lake District National Park.

Vision for the Lake District National Park in 2030

The Lake District National Park will be an inspirational example of sustainable development in action. It will be a place where a prosperous economy, world class visitor experiences and vibrant communities all come together to sustain the spectacular landscape, its wildlife and cultural heritage.

Local people, visitors, and the many organisations working in the Lake District or have a contribution to make to it, must be united in achieving this.

5.2 Delivering Adaptation through the Partnership's Plan

The partnership approach is an extremely positive method of working together to address issues of mutual interest and recognises that a key consideration is how the National Park needs to adapt to and mitigate climate change. Climate change mitigation, through carbon reduction, is a key part of the current Plan. The Lake District is one of the first areas to establish and manage a 'carbon budget' for the area, looking systematically at opportunities for reduction of carbon and other greenhouse gases. The key actions identified in this Adaptation Report will be incorporated into the next revision of the Partnership's Plan.

6.0 UKCP09 North West England Climate Projections

The UK Climate Projections (UKCP09) provides information on the projected changes in our climate over the coming decades. This report considers the mean summer and winter temperature and rainfall levels in the North West of England using the medium greenhouse gas emissions central estimate.

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Figure 1: **Hotter drier summers**

Period	Time slice	Increase in average summer temperature (compared to the 1961 – 1990 average) is			Change in average summer rainfall (compared to the 1961 – 1990 average) is		
		very unlikely to be less than:	as likely as not to be: (central estimate)	very unlikely to be more than:	very unlikely to be less than:	as likely as not to be: (central estimate)	very unlikely to be more than:
2020s	2010-39	+0.6 °C	+1.5°C	+2.5°C	- 23%	- 8%	+ 9%
2050s	2040-69	+1.2°C	+2.6°C	+4.1°C	- 36%	- 18%	+ 1%
2080s	2070-99	+2°C	+3.7°C	+5.9°C	- 43%	- 22%	+ 0%

Figure 2: **Warmer wetter winters**

Period	Time slice	Increase in average winter temperature (compared to the 1961 – 1990 average) is			Change in average winter rainfall (compared to the 1961 – 1990 average) is		
		very unlikely to be less than:	as likely as not to be: (central estimate)	very unlikely to be more than:	very unlikely to be less than:	as likely as not to be: (central estimate)	very unlikely to be more than:
2020s	2010-39	+ 0.5°C	+ 1.2°C	+ 2°C	-1 %	+ 6%	+ 14%
2050s	2040-69	+ 1°C	+ 1.9°C	+ 3°C	+3 %	+ 13%	+ 26%
2080s	2070-99	+ 1.4°C	+ 2.6°C	+4°C	+ 3%	+ 16%	+34 %

Figure 3: **Projected Sea Level Rises**

	Edinburgh - medium projection	Belfast- medium projection
2000	1.6cm	1.7cm
2010	3.5cm	3.8cm
2020	5.7cm	6.0cm
2030	8.2cm	8.6cm
2040	10.9cm	11.4cm
2050	13.9cm	14.5cm
2060	17.1cm	17.8cm
2070	20.6cm	21.4cm
2080	24.4cm	25.3cm
2090	28.4cm	29.4cm
2095	30.5cm	31.6cm

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Some of the likely impacts on the Park in the future that we have considered for the purposes of this assessment include:

- Extreme weather events, including more intense winter rainfall
- Migration of habitats to higher altitudes and resulting loss of reliant species
- Loss of indigenous species, and an increase in non-native species
- Changes to rivers and lakes (water levels, water quality and nutrient status)
- Increased water resource requirement
- Changes to woodlands (storm damage and drought)
- Drying out of peat and
- Accelerated erosion and landslips.

7.0 Adaptation in the Lake District – An Overview

Research suggests that sea level rises will be an inevitable product of climate change which, together with coastal erosion, could threaten communities in the Lake District. Managing water resources is also likely to be challenging. Our water tends to be associated with designated wildlife sites. More frequent or more severe droughts have potential to affect biodiversity, tourism and development. There will be social and economic implications: greater demand for water from other parts of the UK; and greater pressure on land for agriculture, energy crops and building. Some changes will immediately affect residents and visitors. Others will be more gradual or subtle, such as the loss of species and habitats. The cumulative effect could radically alter the look and feel of the Lake District.

The drought conditions of 2010 highlighted the impact of excessive drawdown of lakes used for water supply. There were profound effects on biodiversity, views and recreation. Water supply security can affect development and sustainable water use needs to be promoted. We will address concerns about naturalising rivers and future flood-proofing. The landscape will continue to change as we seek to protect the 'Lakes' brand.

Discussions between those who completed this assessment identified the predicted increase in frequency and severity of extreme weather events as the biggest risk to communities, business continuity and access and recreation in the Lake District, rather than the relatively small increases in temperature. The severe impacts of the 2009 floods were fresh in the mind as an example of the level of risk imposed.

However, for biodiversity a one degree shift in temperature could have a considerable impact on some species (e.g. Arctic Alpines), particularly when combined with competition for space from other species. Wetter winters, combined with greater extremes of wetting and drying through the year will likely accelerate soil erosion – which has impacts for water quality, landscape, archaeological features and farming. The combination of higher winter temperature and rainfall also poses a risk of increases in new and existing pests and diseases. While the severity of this could vary significantly, the impact could be wide – potentially affecting landscape, farming and land management, woodland and forestry, the historic environment and biodiversity.

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7.1 Case Study on Flooding – the November 2009 Floods

Many towns and villages in the Lake District are situated in close proximity to large rivers and watercourses. Increasingly frequent and damaging flooding in the Lake District hints at what we can expect if we don't adapt.



Figure 4. Windermere Lake Cruises Ticket Office and Rydal Beck (November 2011)

The floods of November 2009 were consistent with predictions for climate change. On 19 November 2009 314mm of rain fell on Seathwaite in Borrowdale in one 24 hour period. This was a new record for England. The River Derwent and the River Cocker which drain the Borrowdale and Buttermere valleys could not contain that amount of water. Tragically, a life was lost. The main street of Cockermouth was a raging torrent and people had to be rescued by boat from the upper floors or the roofs of their houses. The River Greta in Keswick also burst its banks.

Across Cumbria six bridges collapsed under the force of the water and all 1,800 bridges in the county needed checking. Around 1,300 homes and businesses were destroyed by the floods in Cockermouth, Keswick, Ulverston, Workington, Kendal and other smaller communities.

Lake Windermere rose an estimated 210 cm over five days, of which around 130 cm was on 19 and 20 November - around 36 hours³. From a business continuity point of view for the Lake District National Park Authority, our Tourist Information Centres at Bowness Bay and Ullswater were flooded, as was our Boating Centre at Coniston.

In September 2007 we commissioned a strategic flood risk assessment for the Lake District National Park to inform our Local Development Framework. The assessment identifies areas that have a low, medium and high probability of flooding, recommended appropriate land uses within flood affected areas together with possible flood mitigation solutions.

Following the November 2009 floods, working with Cumbria County Council, we secured £1.7 million from external sources for flood recovery work in the Lake District to:

- restore the network for the benefit of local people, businesses and visitors
- develop and implement practical works that help adapt to improve flood resilience
- replace or repair all of the 253 missing or damaged right of way bridges
- improve and repair 84 public paths which have suffered severe surface damage, undercutting or compromised drainage

³ Freshwater Biological Society
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- 61 paths with improved or replacement pieces of access furniture where they had destroyed gates, stiles and signage.



Figure 5 - Brockstones path: before and after flood recovery work

8.0 Lake District National Park Adaptation Risk Assessments

A simplified version of the completed ENPAA CCWG Climate Change Risk Assessment spreadsheets has been incorporated into this report. The scores were obtained by using this detailed matrix to assess the combination of likelihood and impact which was summarised to low medium or high impact as below.

Figure 6: Detailed Risk/Opportunity Matrix

Risk	-5	Catastrophic	-5	-10	-15	-20	-25
	-4	Major	-4	-8	-12	-16	-20
	-3	Moderate	-3	-6	-9	-12	-15
	-2	Minor	-2	-4	-6	-8	-10
	-1	Slight	-1	-2	-3	-4	-5
	0	No Change	0	0	0	0	0
Opportunity	1	Slight	1	2	3	4	5
	2	Minor	2	4	6	8	10
	3	Moderate	3	6	9	12	15
	4	Major	4	8	12	16	20
	5	Fantastic	5	10	15	20	25
			Rare	Unlikely	Possible	Likely	Almost certain
			1	2	3	4	5
			Likelihood				

Figure 7: Summary Risk/Opportunity Matrix

Risk/Opportunity Assessment Score (+/-)	Level of Impact	
1-6	Low	
7-15	Medium	
16-25	High	

8.1 Access, recreation and tourism

Potential Impact (risk/opportunity)	Risk/Opportunity rating			Current, planned or potential actions
	2020s	2050s	2080s	
Risk: Increased frequency of wild fires on fells leading to access restrictions				Current: Cumbria Wildfire Group assists others to create fire plans for certain vulnerable sites, procure fire fighting equipment and train partner staff. Planned: Further public awareness raising, training and fire plans for private landowners
Risk: Warmer, wetter winters leading to less accessible areas due to wetter ground, higher lake and river levels and greater vegetation growth				Current: 3-year 'Paths for the Public' programme increasing flood resilience of vulnerable paths and take opportunity for increasing user benefit. Planned: Investigate use of volunteers to conduct prioritised clearance following rights of way surveys.
Risk: Damage to public access and transport infrastructure by extreme weather events, particularly floods, damage to public perception of area, safety of staff and public				Current: Paths for the Public programme increasing flood resilience of paths and bridges. Lessons learned from November 2009 floods. Planned: Work with media to promote on going opportunities for visitors. Consideration of building in resilience capacity when undertaking maintenance works.
Risk: Loss of coastal rights of way and recreation infrastructure due to sea level rise				Planned: Identify vulnerable routes and negotiate with landowners. Develop protocol for erecting warning signs when routes are lost or damaged.
Opportunity: Increased opportunities for visitor businesses due to longer, warmer visitor season, especially water-based businesses.				Current: Implementing Access to lakes, rivers and coast strategy. Provision of countryside access improvements that meet wider social goals.
Risk: Loss of winter conditions for winter sports affecting winter visitor numbers and spend				Current: Provision of winter weather and climbing condition information – Weatherline and Fell Top assessors. Planned: None.
Risk: Increased low and high river and lake levels, poor water quality incidents damaging water recreation opportunities				Current: Catchment-scale projects led by partners and communities to improve water quality and moderate flows. Planned: Development of landscape-scale management framework and actions that consider – environmental, social and economic aspects and prioritises activities to provide multiple benefits.

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8.2 Biodiversity

Potential Impact (risk/opportunity)	Risk/Opportunity rating			Current, planned or potential actions
	2020s	2050s	2080s	
Risk: Changes in distribution and balance of species (flora and fauna), leading to change in habitat composition and condition due to higher year-round average temperatures and more extreme rainfall patterns. Risk of some species extinctions (e.g. montane heath and arctic alpiners) leading to conservation objectives for some SSSI designations unlikely to be achieved. Species immigration may bring opportunities or risks of invasion. Loss of synchronisation between interdependent species.				Current: Arctic Alpine conservation project started. Agri-environment schemes encouraging sustainable land management. Planned: Develop resilient habitat networks through Nature Improvement Areas, strategic projects and agri-environment schemes. Potential: Site, species and habitat research to understand tolerance levels, likely impacts and review and revise policies, strategies and management plans.
Risk: Loss of veteran trees to storm damage and pests and diseases				Potential: Manage good age structure of trees and maintain veteran trees in sheltered sites
Risk: Coastal squeeze on coastal habitats and species (e.g. Natterjack Toad sites)				Potential: Identify vulnerable sites and habitats and investigate options for compensatory habitat creation
Risk: Increase in pests and diseases affecting flora and fauna species and habitat condition				Current: Cumbria Freshwater Invasive Non-Native Species (FINNS) Strategy. Forestry Commission monitoring of phytophthora ramorum
Risk and opportunity: Increased peak flows and droughts in rivers damaging species (e.g. freshwater pearl mussel and habitats) and creating new habitats (e.g. through river naturalisation).				Current: Valley planning in Patterdale and Borrowdale is exploring future options for river management
Risk: Lower river flows and lake and tarn levels will result in concentration of pollutants and higher water temperatures in summer leading to impacts on species such as salmon, arctic charr and vendace. Indirect effect of requests to dredge to maintain boathouse and jetty access, impacting lake bed and marginal vegetation and fish spawning grounds.				Current: Catchment projects in Bassenthwaite and Windermere catchments to improve water quality and moderate flows. Species ark projects to protect populations of vulnerable species Potential: Consideration in boathouse/jetty design/planning to accommodate greater fluctuation of water levels. Riverside planting schemes to increase shade and lower water temperature.

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Risk: High rainfall leading to higher soil erosion and surface run-off as well as wash out from polluted mines; all leading to higher sedimentation and pollution inputs into rivers and lakes affecting species				Current: Catchment projects in Bassenthwaite and Windermere catchments to improve water quality and moderate flows. Planned: sustainable drainage systems
Opportunity: Limit of the tree-line will increase in altitude, providing opportunities for woodland creation schemes.				Potential: woodland creation schemes
Risk: Drying out of peat due to higher summer temperatures and less rainfall, leading to increased tree colonisation, exacerbating drying and trend toward unfavourable condition of peat habitat. Greater management resources required.				Current: Wetland restoration works to increase resilience to drying out Potential: Monitoring and removal of tree colonisation
Risk: Lowland bogs at risk of change from freshwater to saline system as a result of sea level rise				No defined actions at this stage

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8.3 Community, culture and economy

Potential Impact (risk/opportunity)	Risk/Opportunity rating			Current, planned or potential actions
	2020s	2050s	2080s	
Risk: Demand for retro-fitting of existing building stock with micro renewable infrastructure, air-conditioning, insulation, water storage and other building adaptations. Practical and design aesthetic challenges				Planned: Reviewing supplementary planning policy guidance / building design guide. Potential: Identify demonstrations of best practice with developers and communities.
Opportunity: new build with innovative design, including climate adaptations				Planned: Reviewing supplementary planning policy guidance / building design guide. Potential: Identify demonstrations of best practice with developers and communities.
Risk: Flooding and other storm damage to built environment causing disruption to businesses, increased insurance costs, disruption to community life				Potential: Work with business sector to raise awareness of risks and adaptive options
Risk: Long term sea level rise, coastal erosion and storm surges disrupting coastal communities				Current: The St Bees Head to Earnse Point Shoreline Management Plan includes the coastal area in the National Park. It sets out the management objectives and the strategic coastal defences for the coastal region.
Opportunity: Increased visitor numbers over warmer, dryer, longer summer season increasing visitor spend				Current: We are working closely with our partners in the tourism sector to maximise and manage this opportunity through our function as the planning and development management authority and in promoting sustainable tourism and the Low-carbon Lake District™.
Opportunity and risk: increase solar energy potential in summer, hydro in winter, but more extreme conditions limiting year round use of either				Current: Our adopted Local Development Framework Core Strategy includes CS16 which aims to increase the proportion of energy generated through renewable and low carbon sources. We are working partnership with the Energy Saving Trust to offer energy saving and renewables advice to planning applicants
Risk: Increased interruptions to grid power supplies due to storm events				No defined actions at this stage

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8.4 Historic environment

Potential Impact (risk/opportunity)	Risk/Opportunity rating			Current, planned or potential actions
	2020s	2050s	2080s	
Risk: Increased dampness and condensation in historic buildings resulting in increasing damage; costs of maintenance and repair; pressure for intrusive changes risking historic character and historic integrity and potential health risk for occupants.				Potential: make owners aware of best practice for maintaining buildings and identify opportunities for increasing available resources. Awareness campaign for high risk properties.
Opportunity: Reduced levels of freeze-thaw damage to historic buildings				No defined actions at this stage
Risk: Increased rainfall causing water damage to structural fabric of historic buildings (e.g. deterioration of traditional building mortars) and overwhelming rainwater goods. Risk of loss of historic character and integrity. Extreme events pose risk of severe damage to historic settlements and difficulty of insurance.				Current: Regular formal inspection and maintenance of listed features and National Park owned buildings (cost implications). Potential: make owners aware of best practice for maintaining buildings and identify opportunities for increasing available resources.
Risk: Increased UV-light on building materials increasing rate of deterioration and need for renovation work.				Potential: Provide guidance on best practice for treatment of UV sensitive materials, may require investigation.
Risk: Long term sea level rise and short term storm surges damaging historic buildings and archaeological features Opportunity: to increase archaeological knowledge through excavation as part of mitigation strategy (additional resources required to carry out).				Potential: identify vulnerable buildings and likely timescales and plan adaptation actions

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Risk: Greater drying and wetting of soil causing damage due to higher water table and erosion of features. Risk of subsidence in dry periods. Stonework decay accelerated.				Potential: Raising awareness with owners and contractors. Encouraging use of traditional materials and techniques for repair.
Risk: Increased growth rates of vegetation e.g. bracken damaging buried archaeology and visibility of sites				No defined actions at this stage
Risk: Flood damage to historic mines and increased water erosion of archaeological features. Risk of disruption to buried sediments and damage to earthworks.				No defined actions at this stage
Risk: Storm damage, drier summers and diseases and pests hindering the maintenance of historic parks and gardens				No defined actions at this stage
Risk: Increase in pests and diseases poses a greater risk to historic fabrics and collections.				No defined actions at this stage
Risk of drier summers resulting in peat shrinkage, damaging paleo-environmental and archaeological deposits. Potential loss of vegetation leading to erosion and damage to archaeological deposits. Increased risk of wildfires potentially affecting archaeological and listed features in susceptible areas.				Potential: Include information on archaeology and listed features in emergency planning.
Risk: Changes in land management patterns affecting buried archaeological sites, traditional farm buildings and historic landscape				No defined actions at this stage

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8.5 Farming and Land Management

Potential Impact (risk/opportunity)	Risk/Opportunity rating			Current, planned or potential actions
	2020s	2050s	2080s	
Risk: Increased frequency and severity of wildfires removing grazing value of fell and posing risk to livestock, impacting on farm businesses. Carbon storage also affected.				Current: Plans for closure of moorland areas due to fire risk. Potential: increase fire breaks, water storage near high risk sites and fire training for staff
Risk: Lower soil moisture and periods of drought can slow growth rates and lower crop yields/quality. This may affect timing of agricultural practices; increase the need to buy-in feed and impact market prices. Poorer quality diet affects productivity and increases enteric emissions (methane). Drier soils increase vulnerability to erosion potentially leading to water contamination and reduced reservoir storage (silting up). Peat soils risk loss of anaerobic conditions, degrading habitat and affecting carbon store.				Current: Regular ground-water testing. Potential: Upgrade water storage and distribution systems and reduce water loss from cracked pipes. Develop soil conservation training for land managers. Greater use of natural windbreaks where appropriate to reduce soil erosion.
Risk: Higher temperatures and periods of drought increase stress on livestock, particularly hill breeds. Supplementary water supply and creation of additional shade may be required. Heat/drought tolerances need to be introduced into breeding – opportunity to introduce new breeds. Area of viable grazing land could be reduced due to insufficient water supply, particularly areas already susceptible to drought e.g. limestone				Potential: Upgrade water storage and distribution systems.
Opportunity: Increased mean annual soil temperatures provide a longer growing season, and opportunities for new crops. A potentially longer grazing season reduces period of housing and associated feed/bedding costs and slurry storage.				No defined actions at this stage

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Risk: This could lead to inappropriate grazing and/or increased poaching of soils.				
Risk: More days of saturated soil and flooded land results in loss of grazing land and need for reduction in stocking rate or longer housing period; supplementary feeding and associated costs. It can also increase livestock health problems requiring greater levels of animal husbandry; increase poaching of soil and the anaerobic conditions and compaction may affect soil quality. Vehicular access to fields, remote farm buildings, crops and livestock may become more difficult, affecting ability to operate farm business effectively, or result in soil erosion and rutting.				Potential: Landowners to maintain drainage infrastructure and to continually move water/feeding areas within fields.
Risk: Recovery time needed after flooding events which can cause: accelerated soil erosion; deposition of silt/gravel; damage to tracks/boundaries; long-term reduced access as C-roads are lower priority for repair; and loss of yield/livestock.				Potential: Landowners to maintain drainage infrastructure
Risk: Adverse weather and increased rainfall may result in higher lamb mortality, associated costs of increasing provision of livestock shelter and poses a risk to existing farm buildings. More rainfall increases risk of effluent entering water course and removal of topsoil and nutrients.				No defined actions at this stage
Risk: Greater extremes of wetting and drying may affect wall foundations, with a risk of needing additional maintenance.				No defined actions at this stage
Risk: Increase in wet ground and lack of prolonged cold temperatures leading to increase in new and existing pests and diseases for plants, trees and livestock. Risk of enhanced transport by surface water flow. Risk to animal welfare; possible restrictions on livestock movement and time/cost				No defined actions at this stage

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of medication application. Implications on water pollution (e.g. potential increase in sheep dipping). Risk of tree loss, and change in structure/composition of woodlands.				
Risk of change in structure/species composition of woodlands. Water stress may result in tree loss/damage and affect establishment of new planting. Adverse weather increases likelihood of wind-blow and storm damage. Phenology changes expected (date of bud break etc). Extremes of wetting and drying may lead to greater uprooting of trees.				Potential: Greater consideration by woodland managers for wind-blow. Future planting needs to consider tolerant species.
Risk: Changes in agricultural practices may be required (e.g. timing of growth, cutting, grazing regime) which could impact specified dates in agri-environment agreements. Changes in weed management may be needed to deal with species competition.				No defined actions at this stage

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8.6 Landscape

Potential Impact (risk/opportunity)	Risk/Opportunity rating			Current, planned or potential actions
	2020s	2050s	2080s	
Risk and opportunity: extreme flood events leading to landslips, gully erosion and river re-naturalisation changing landscape				Planned: Identify vulnerable sites and agree mitigation or pre-emptive action to minimise disruption of process.
Risk: Sea level rise and storm surges changing coastal features and landscapes (e.g. dune systems and salt marshes) which may also be under stress due to changes in river flow from drier summers/wetter winters.				Current: Coastal management plans to agree aims and actions.
Risk: Increase in frequency and severity of wildfires damaging amenity value of fells and woodlands				Current: Plans for closure of moorland areas due to fire risk. Potential: increase fire breaks, water storage near high risk sites and fire training for staff
Risk: Drought, pests and diseases, storm events all changing woodland composition, structure and limiting new planting				Potential: Increase planting rates in advance of more difficult conditions.
Risk: Reduced rainfall causing potential stress to and loss of vegetation; soil loss through windblow and increase in sedimentation elsewhere. Changes to vegetation distribution and abundance (including risk of invasive species) as a result of changes in temperature and rainfall.				Current: Catchment-scale projects led by partners and communities to improve water quality and moderate flows. South Cumbria Rivers Trust non-native invasive species management. Planned: Development of landscape-scale management framework and actions that consider – environmental, social and economic aspects and prioritises activities to provide multiple benefits.
Risk: Increase in altitudinal limit of tree-line leading to potential loss of open fell and change of character.				No defined actions at this stage
Risk: Visual impact of lower summer water levels of lakes and tarns; reservoir drawdown and potential algal blooms				No defined actions at this stage
Risk: Landscape character areas which are dependant on peat are at risk where peat is likely to dry out. Similarly lowland bogs at risk from sea level rise.				No defined actions at this stage

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8.7 National Park Authority Business Continuity

Potential Impact (risk/opportunity)	Risk/Opportunity rating			Current, planned or potential actions
	2020s	2050s	2080s	
Risk: Wildfire damage to NPA properties, in particular woodlands and common land damaging environmental, access and economic value				Current: Plans for closure of moorland areas due to fire risk. Potential: increase fire breaks, water storage near high risk sites and fire training for staff. Review insurance.
Risk: Flood damage to NPA buildings and operational sites damaging assets, raising insurance costs and reducing commercial value and service to the public				Potential: refurbish properties adapted to flood risk, retrofit flood protection measures. Avoid building in high risk areas. Update procurement toolkit to ensure new build projects take flood risk into account
Risk: Disruption to travel to work due to flooding, storm damage increasing staff absenteeism from workplace, reducing services and delaying project delivery				Current: Infrastructure in place for staff to work from home. Potential: Expand potential for home working to all staff.
Opportunity: reduction in heating requirements for properties, reducing energy bills.				Current: Continue to monitor and review heat and power demands of workplaces and predict future changes Potential: Invest in renewable energy
Risk: Extreme weather events, potential damage to estate health and safety impacts on staff and public				Current: Site closure procedures in place for key sites. Potential: Consider extending and adding to existing health and safety audits

9.0 Interdependencies

There are a number of interdependencies to consider. Some examples include:

- Increase in new and existing pests and diseases – affecting biodiversity (possible impact on species); farming and land management (livestock, trees, crops, restrictions on movement/timber extraction) and landscape (e.g. impact of entire species of tree being affected or affecting widespread woodland composition).
- One example from flooding – access (lost bridges); biodiversity (many bridges support bat roosts). For an action to resolve this it needs an understanding of the interdependencies. Action: Climate proofing should include re-instating of bat roost potential.
- Increased rain leading to risk of wash out from and damage to mines (part of historic environment): polluted wash out affecting biodiversity; water quality; recreation and potentially livestock water source. Financial implications of mitigation or restoring polluted land/waterways.
- Change in species composition: biodiversity (some species out-competed; some new species gained; risk of new invasive species); archaeology (vegetation e.g. bracken can affect visibility and structure of archaeology); landscape.
- Wildfires – access and recreation (can cause and be impacted by); archaeology; biodiversity; landscape; farming (livestock at risk/recovery time for vegetation); land management (loss of carbon store; potential damage to seed bank limiting recovery; increased risk of erosion and water colour).
- Dry, hot weather causing peat shrinkage – land management (impact on carbon store and sequestration); biodiversity (degradation of important habitat); historic environment (risk to paleo-environmental and archaeological deposits preserved within).
- Changes to agricultural practices – affecting farming; historic environment and landscape.

10.0 Barriers and opportunities

The assessment has shown that whilst the projections for changes in climate within the Lake District bring both opportunities and risks, the risks are greater in number. Furthermore, the opportunities are perhaps more likely to be realised (trialled by entrepreneurs) than all of the risks addressed. However, early proactive adaptive action is likely to reduce the costs of reactive measures later on.

The key barriers to adaptation action will be associated with resource and behavioural issues:

- Getting people to accept the concept of climate change and the risks it imposes
- Dealing with change and doing things differently
- Making adaptations early enough for them to reduce the risk, which will be challenging where action incurs a cost.

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Resource issues present a barrier for the National Park Authority, as well as organisations, businesses and individuals within the area. Many of the risks can be reduced by undertaking adaptive measures, but without the resource to fund them they are unlikely to happen. The Authority's main source of income is its National Park grant which is set to reduce by 28% by 2014. Many of the National Park Partners are also facing reduced resources and associated reductions in available staff time. We are in a period of widespread financial pressure which extends to businesses and individuals: prioritising actions for adapting to climate change will therefore present a significant challenge.

There will also need to be acceptance that some things might be lost regardless of the action taken, applying particularly to certain species, use of specific sites and associated change to the landscape. However, the landscape continues to evolve with development, agriculture, forestry and other land management practices as well as climate change. One of the National Park Partnerships' main delivery aims is therefore to ensure change strengthens the character of the Lake District's landscapes, whilst sustaining cultural heritage and natural resources to deliver ecosystem services.

A strategy for planning adaptive action is to immediately start to undertake those actions which will not have an adverse effect in today's climate (termed 'no regret' options⁴). Some of these actions will also deliver opportunities: such as getting habitats into good condition to make them more resilient and establishing wildlife corridors.

Various other opportunities are expected to be exploited by businesses and individuals regardless of any additional governing advice, e.g. an increase in summer visitors and hence visitor spend in the area; opportunities to introduce new crops or livestock breeds at sites that were previously incompatible; increased seasonal outputs for solar and hydro-power and innovative building designs.

Despite this, risks remain that require direction, leadership and resources to reduce the threat to this protected landscape and those who reside within and visit it.

11.0 Going forward

The National Park Partnership is well-placed to apply a joined-up approach to tackling adaptation. It is also well-experienced at working at a landscape scale, which is highly applicable to adaptive actions.

There are three key opportunities which could be taken by the Partnership, and on an organisation/business/individual level within the National Park:

- Encourage the undertaking of early adaptive 'no regret' actions, several of which will deliver benefits beyond adaptation such as strengthening habitats.
- Assess where the biggest potential gains are and prioritise: identifying both the quick-wins and where the biggest successes in risk reduction are likely to be achieved.

⁴ 'Climate Adaptation: Risk, Uncertainty and Decision-making' UKCIP Technical Report (2003)

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- Ensure that adaptation is considered as we go forward. For example, following the floods of 2009, footpaths and bridges were repaired with the event of future floods in mind – with bridges raised and paths strengthened to resist greater flows. Another example following the flooding in 2009 is where electrics were damaged in businesses in close proximity to water, they were replaced at mid-wall height to reduce the risk of future damage.

Whilst these opportunities would help to place the Lake District in the best position with regards to climate change, they remain subject to the barriers of resource issues and changing behaviours, as discussed above. This initial risk assessment will help prioritise existing adaptation work and will aid understanding of the future actions that need to take place.

12.0 References

1. Responding to the impacts of climate change on the natural environment: The Cumbria High Fells (Natural England 2009)
2. An Assessment of the vulnerability of the Natural Environment to climate change in North West England using the National Character Areas (Natural England 2010)
3. Mapping values: the vital nature of our uplands (Natural England 2009)
4. Vital Uplands – a ‘2060 Vision for England’s Upland Environment’ – developed by Natural England with partners for England’s upland environment in a changing climate.
5. North West Climate Change Action Plan
6. Cumbria Strategic Partnership Climate Change Action Plan (2009-2014)
7. UK Climate Projections 2009 (UKCP09)
8. Cumbria Biodiversity Partnership and Cumbria Biodiversity Action Plan
9. Low Carbon Lake District TM report (Rebecca Willis 2009)
10. Farming Futures (www.farmingfutures.org.uk)
11. ‘Farming for a Better Climate’ Information (Scottish Agricultural College)
12. England Biodiversity Strategy: Climate Change Adaptation Principles (Defra, 2008)
13. ‘Climate Change: Impact on UK Forests’ Bulletin 125 (Forest Research, 2002)
14. ‘Climate Adaptation: Risk, Uncertainty and Decision-making’ UKCIP Technical Report (2003)
15. Climate Change and the Historic Environment (English Heritage, 2008)

Annex 1: Lake District National Park Profile (2009)

Area	
Total Park area	229,200 Ha
Parishes totally or partly in the Park	80
Population	
Resident population	41,831
School and pre-school age (0-15)	6,326 and 15%
Working age (16-64)	26,429 and 63%
Pensionable age (65+)	9,076 and 22%
Settlements with 3,000+ population	3
Housing	
Housing stock	23,664
Resident households	18,539
Owner occupied	12,775 and 69%
Private rented	2,236 and 12%
Social housing	3,528 and 19%
Nature Conservation	
Sites of Special Scientific Interest	41,947 Ha
Special Protection Areas	36,037 Ha
Special Areas of Conservation	36,404 Ha
RAMSAR Sites	757 Ha
National Nature Reserves	1,200 Ha
Land Use	
Moorland, heathland and unenclosed grassland	104,979 Ha and 45.8%
Farmland	76,815 Ha and 33.5%
Woodland	28,931 Ha and 12.6%
Heritage	
Scheduled Ancient Monuments	275
Conservation Areas	22
Listed buildings	1,756
Grade I	31
Grade II*	120
Grade II	1,605
Recreation	
Public footpaths	2,137 km
Public bridleways	875 km
Other public rights of way	33 km
Open access land	46 %

Annex 2: Membership of the Lake District National Park Partnership

The Lake District National Park Partnership currently consists of 24 members:

- Action with Communities in Cumbria
- Allerdale Borough Council
- Copeland Borough Council
- Country Land and Business Association
- Cumbria Association of Local Councils
- Cumbria County Council
- Cumbria Tourism
- Cumbria Wildlife Trust
- Eden District Council
- English Heritage
- Environment Agency
- Forestry Commission
- Friends of the Lake District
- Lake District Local Access Forum
- Lake District National Park Authority
- Lake District National Park Partnership's Business Task Force
- Local Enterprise Partnership, Cumbria
- National Farmers' Union
- National Trust
- Natural England
- Nurture Lakeland
- Royal Society for the Protection of Birds
- South Lakeland District Council
- United Utilities

Annex 3: Extreme Weather Events in the Lake District over the last 30 years

- June 2010: Drought year. Hosepipe ban imposed. On 4 July Thirlmere was only 37 per cent full.
- November 2009: Major flooding across areas of Cumbria. Rivers Derwent, Cocker and Greta broke their banks.
- January 2005: Storms batter Cumbria – a gust of 111 knots recorded on Great Dun Fell – many trees blown down.
- Summer 1995: Drought year. Haweswater reservoir 89 per cent empty and the drowned village of Mardale visible.
- 31 Jan 1995: 100mm of rain overnight cause floods that change the course of Raise Beck - Dunmail Raise - to flow to Grasmere instead of Thirlmere Reservoir.
- July 1988: Grasmere had its wettest month of the 20th century.
- Summer 1984: Drought year. Drowned village of Mardale visible in Haweswater reservoir.
- Feb 1984: Over 600 mm of snow fell in some areas of the District.
- July 1983: Temperature in Ambleside reached 31.7C.