Perceptions of climate change, adaptation and the policy process within the Forestry Commission of Great Britain - a comparative study of England, Scotland and Wales

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by

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Dedicated to my mother and to my late father, to whom I am forever grateful for bestowing upon me the most precious gift a parent could ever give a child; the gift of education

Abstract

Forests are an important part of the landscape and provide benefits to society. The vulnerability of forests to climatic changes is already becoming more evident. Forest management is thus a key factor in tackling adverse climatic impacts and studies have suggested changing management planning and practices to aid forests in adapting to climate change.

The aim of this study was to identify the perceptions of climate change, adaptation and the policy process among the staff of the Forestry Commission of England, Scotland and Wales. A documentary study was undertaken of key documents, and semi-structured interviews conducted through scheduled telephone interviews with key respondents. The data was transcribed in NVivo for analysis.

The results show that temperature in the UK is projected to become warmer by the 2080s and changes will be greatest for the High Emissions scenario. Similarly, precipitation will experience changes, with drier summers and wetter winters expected. Forests may experience increased productivity and longer growing seasons in some areas. A change in the ranges of species distributions and competition between species is also expected. Abiotic disturbances caused by fires, wind, flooding and drought are predicted to increase in frequency and severity.

From the results of the interviews, the respondents seem to have a clear understanding of climate change, with majority of them of the opinion that climate change is occurring. The main reason they give is that '*there is significant evidence of it*'. The respondents also believe that climate will change to a degree that will significantly impact on forests in GB. Also, the respondents have a knowledgeable understanding of what adaptation entails. With regards to AFM, majority of respondents are not aware of it, and tend to confuse it with general adaptation strategies. The opinion of the respondents on adaptation within the FC is varied and they mention the need for more research and greater evidence before they can adapt their practices fully. The main drivers of forest operations are the policy documents which provide clear guidance to achieve set goals and targets. The climate change agenda is adequately addressed across the three countries, although it is not the only factor influencing forest policies and operations. The descriptions of the policy process differed for the policy and implementation staff, although adequate channels for feedback and consultation were identified. Overall, it can be concluded that there is no major difference in perceptions between the three countries or the policy and implementation staff.

Keywords: adaptation; climate change; forestry; perceptions; policy process; Great Britain

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'You know that your students have learned when they can, in turn, explain.' My time at ITC has been a process of learning, all culminating in this thesis, my turn to explain.

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List of acronyms

AFM	Adaptive Forest Management
CCF	Continuous Cover Forestry
CO_2	Carbon dioxide
DECC	Department for Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
EBP	Evidence-based Policy
ESC	Ecological Site Classification
EU	European Union
FC	Forestry Commission Great Britain
FCE	Forestry Commission England
FCS	Forestry Commission Scotland
FCW	Forestry Commission Wales
FD	Forest District
FDM	Forest District Manager
FDP	Forest Design Plans
FEE	Forest Enterprise England
FM	Forest Management
FR	Forest Research
FSC	Forest Stewardship Council
GB	Great Britain
GHGs	Greenhouse Gases
GLA	Greater London Authority
IPCC	Intergovernmental Panel on Climate Change
LISS	Low Impact Silvicultural Systems
MCPFE	Ministerial Conference on the Protection of Forests in Europe
NAS	National Adaptation Strategies
NRS	Northern Research Station
OGB	Operational Guidance Booklet
PAG	Programme Advisory Group
PAWS	Plantations and Ancient Woodlands Sites
PBE	Policy-based Evidence
SFM	Sustainable Forest Management
SSSI	Site of Special Scientific Interest
UK	United Kingdom
UKCIP	United Kingdom Climate Impacts Program (02)
UKCP	United Kingdom Climate Projections (09)
UKFS	United Kingdom Forestry Standard
UKWAS	United Kingdom Woodland Assurance Scheme
UNFCCC	United Nations Framework Convention on Climate Change
WFD	Water Framework Directive

1. Introduction

1.1. Climate change and forestry in Great Britain

Forests are an important part of the landscape and provide benefits to society. They provide various vital ecosystem services such as maintaining ideal atmospheric gas concentrations, protecting water catchment areas, preserving habitats for biodiversity and ensuring soil stability (Bravo et al. 2008). In addition, forests are often managed to meet various objectives. In the UK, these include timber production, recreation and amenity use, restoration or conservation of semi-natural forests, and maintenance of native genetic resources (Forestry Commission 2004).

The Forestry Commission of Great Britain is the largest individual land manager in the country, with responsibility for approximately 753,000 hectares (as at 31st March, 2009) of sustainably managed woods and forests. In addition to commercial timber production, the Forestry Commission's responsibilities include research, sustainability programmes, policy and the provision of facilities for learning and recreation (Forestry Commission 2009a). Within its research activities, the Forestry Commission spends around a quarter of its research budget on climate change and related programmes, and an example of such a project is ForeStClim (Forestry Commission 2009c).

Climate change is defined as, 'the change in climate over time, as a result of human activity that alters the composition of the global atmosphere, and that is in addition to the natural climate variability observed over time' (IPCC, 2007). The magnitude and rate of predicted climate change indicates that at regional scales, forests will be significantly affected. The impacts include drought-induced dieback, wind throw due to strong winds, invasive species, fire risk, pests and diseases, and loss of genetic diversity (Roberts 2008; Allen 2009; Bernier et al. 2009; Nazimova et al. 2009).

The vulnerability of forests to climatic changes is already becoming more evident. According to the IPCC, vulnerability is 'a function of the character, magnitude and rate of climate change and variation to which a system is exposed, the sensitivity of a system to change, and its adaptive capacity or resilience' (IPCC, 2007). Studies show that factors such as tree growth and regeneration rates, tree structure and composition, susceptibility to pests, diseases and fire hazards, respiration rates and photosynthesis rates are all adversely affected by changes in climatic conditions (Bravo et al. 2008; Blate et al. 2009; Konkin et al. 2009; Maroschek et al. 2009).

1.2. Adaptation strategies for forest management

Practical responses to the threats posed by climate change involve adaptation and mitigation. The IPCC defines adaptation to climate change as 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities' (IPCC, 2007). Adaptation measures minimise the effects of climate change as it progresses, while mitigation is an attempt to limit its magnitude (Broadmeadow et al. 2005). Through adaptation strategies, the severity and extent of the adverse effects of climate change can be reduced, and the positive effects can be maximised (Mansourian et al. 2009).

One of these adaptation strategies is Adaptive Forest Management (AFM) which is defined as 'a dynamic approach to forest management in which the effects of treatments and decisions are continually monitored and used, along with research results, to modify management on a continuing basis to ensure that objectives are being met' (Helms 1998). Adaptive forest management strategies take into account the fact that forest management practices that have been successful in the past may not succeed in the future and will need to be re-evaluated regularly (Bravo et al. 2008).

Forest management is thus a key factor in tackling adverse climatic impacts. Within the EU, studies have suggested changing management planning and practices to aid forests in adapting to climate change (Mohren 2003; Bernier et al. 2009; Seppälä et al. 2009). These changes include gene management, forest protection, forest regeneration, silvicultural management, and forest operations (Lindner 1999; Spittlehouse et al. 2003). In GB, suggestions include the use of low-impact silvicultural systems and species mixtures to spread risk and provide a basis for adaptation strategies (Ray 2008a). It is important, however, to note that recommendations and decision-making aimed at integrating adaptation into national forest policies and practices should start with an analysis of the existing policies and practices. This ensures that the nature and extent of management intervention required to influence successfully the adaptation of forest ecosystems to climate change is well understood (Kalame et al. 2009).

1.3. Forest policy in Great Britain

Forest policy is defined by the Forestry Commission as 'a set of orientations and principles of actions adopted by public authorities in harmony with national socio-economic and environmental policies in order to guide future decisions in relation to the management, use and conservation of forest and tree resources for the benefit of society' (Forestry Commission 2004). Forestry in the UK was devolved in 1999. This resulted in transfers of responsibility at national level, including funding, from the Westminster Government (UK) to the Scottish Parliament for Scotland and the Welsh Assembly Government for Wales. However, international forestry policy development remained a central responsibility of the UK Westminster Government (FAO 2005).

The Scottish Forestry Strategy was reviewed and a new version launched in 2006. Similarly, England's Forestry Strategy was reviewed, and a new version titled a strategy for England's Trees Woods and Forests was launched in 2007 (Weldon 2004). More recently, the Welsh Forestry Strategy has been reviewed, and launched in 2009. Since devolution the challenge to the Government departments, the devolved administrations, private forestry organisations, NGOs and representative bodies has been to ensure effective communication and appropriate consultation with stakeholders in the development of forest policies (FAO 2005).

1.4. Research problem and justification

Climate change is anticipated to have significant impacts on forests worldwide. So far, the focus has been on mitigation of these impacts, but research now shows that adaptation is also necessary (IPCC 2001). However in the definition above, it is evident that the objectives of forest policy across the UK are encapsulated in the principle of Sustainable Forest Management (SFM) (Read et al. 2009).

Therefore, it is often the case that clear adaptation strategies are not distinguished from general SFM practices and hence it is difficult to define specific adaptation measures (Lindner et al. 2008).

Measures to adapt to climate change impacts also have their limits. A wide array of adaptation options is available, but more extensive adaptation than is currently occurring is required to reduce vulnerability to future climate change. There are formidable environmental, economic, informational, social, attitudinal and behavioural barriers to implementation of adaptation (IPCC 2007). Although the science to provide policymakers with information about climate change impacts and adaptation potential has improved since the IPCC Third Assessment, it still leaves a number of important questions unanswered (IPCC 2007).

Planning for adaptation occurs primarily through government policy making. Research asserts that the objectives of an organisation are set at the policy level and the strategies are defined at management level, whereas the actual outcomes are produced at the operation level (Steudler et al. 2004). This could serve as a basis for the promotion of regional collaboration at an agency level, which might help to spread successful practices that are adapted to local conditions and encourage managers to select the most suitable options (Eastaugh et al. 2009). However, with the devolution of forest management in the UK, challenges have arisen in regards to effective policy communication and consultation (FAO 2005). There is therefore a need to investigate the policy process.

Previous studies have been done before in Canada on forest policy actors and forest practitioners (Stedman 2004; Ogden et al. 2007) which state that a notable gap is research to document the perceptions of forest professionals and practitioners on priorities and mechanisms for adaptation. In Europe, research has also been done on public perceptions towards forest management (Wiersum 1998), but not on the perceptions of managers. It is on this basis that the research aims to identify the perceptions of staff in the Forestry Commission. One important objective of research based on environmental perception is to provide a systematic and scientific understanding of the view from the inside-out, in order to complement the more traditional and external scientific approach (Whyte 1977).

In order to implement proper and efficient adaptation strategies, suitable policy and management practices are needed (Weldon 2004). Thus it is important to focus attention on whether the current systems in place for forest management in GB prove adequate for the new policy and management challenges presented by climate change. This assessment of effective management requires knowledge on the attitudes and perceptions of the key personnel and managers, clarity on the policy process and an understanding of the guidelines and policies governing the organizations (Mickwitz et al. 2009).

This research hopes to investigate the differences, if any, in perceptions of climate change, adaptation and the policy process in post-devolution UK. The aim is to identify how the three devolved organisations of England, Scotland and Wales are adapting and how perceptions influence this adaptation to climate change. Comparisons are to be made between the three countries and between the policy and implementation staff. The research objectives and questions are outlined in the Section 1.4.1 below.

1.4.1. Research objectives

The main objective of this research is to identify how climate change, adaptation and the policy process are perceived within the Forestry Commissions of England, Scotland and Wales. The research objectives and specific research questions of this study are outlined in the table below (Table 1.1). The research is targeted at two groups of staff at the Forestry Commission, as elaborated in the conceptual framework in Section 1.5 below.

Table 1.1: Research Objectives and Questions

Research Objective	Specific Research Questions
1. To identify how anticipated climatic change and its likely impacts on forests is perceived in Great Britain's policy and legislation documents and the Forestry Commission's research documents (a factual understanding)	1. What are the projections of temperature and precipitation change in Great Britain? 2. To what extent will climatic change influence forest characteristics and development in Great Britain?
2. To investigate how anticipated climatic change and its likely impacts on forests is perceived by key individuals in the Forestry Commissions of England, Scotland and Wales (an understanding of perceptions and attitudes)	1. What is your definition of climate change? 2. Do you think climate change is occurring? 3. Do you think climate will change to a degree that will significantly impact on forests in Great Britain? 4. What sources of information are influencing your perceptions? 5. What strategies, plans and practices, if any, are you putting in place to manage the impacts that you mention or to respond effectively to the impacts?
3. To identify forest management adaptation strategies in response to climate change, as perceived by key individuals in the Forestry Commissions of England, Scotland and Wales	1. Could you tell me what your definition of adaptation is? 2. Are you practising adaptation to climate change? 3. Could you tell me what you understand by the term 'adaptive forest management'? 4. Do you apply this in your work? 5. In your opinion, is the Forestry Commission adapting to climate change?
4. To identify the policy process and the main drivers and influences of forest policies and forest operations, as perceived by key individuals in the Forestry Commissions of England, Scotland and Wales	1. What are the main drivers and influences of forest policies or forest operations at the moment? 2. How has the climate change agenda influenced forest policies and forest operations and what are the specific outcomes of this? 3. How would you describe the policy process within the Forestry Commission? 4. Are there opportunities for consultation and feedback in the policy process of the Forestry Commission?

1.5. Conceptual framework

The conceptual diagram of the research is shown in Figure 1.1 below, adapted from policy research (Engelen 2000). According to this concept, forest and climate change policies have an influence on forest management objectives and strategies, and on climate change scenarios and projections. These in turn impact on the current state of the forest system. If this current system state differs from the anticipated or expected state, then policy should be adapted accordingly. This research study will focus on the area bound by the red box.

The main actors in the conceptual framework are the forest policy makers and the forest managers. The forest policy makers are driven by climate change and other environmental and social factors. They, in turn, influence the objectives of the forest managers. The forest managers initiate strategies and practices in line with their objectives, which then influence the forest system. They play a critical role in forest planning and implementation of silvicultural strategies. Any difference in perception or behaviour of these two actors would subsequently result in a change in the forest system, either positive or negative.

The two actors in the context of the FC are the:

- Policy and planning staff as the policymakers
- Implementation and operations staff as the forest managers/practitioners

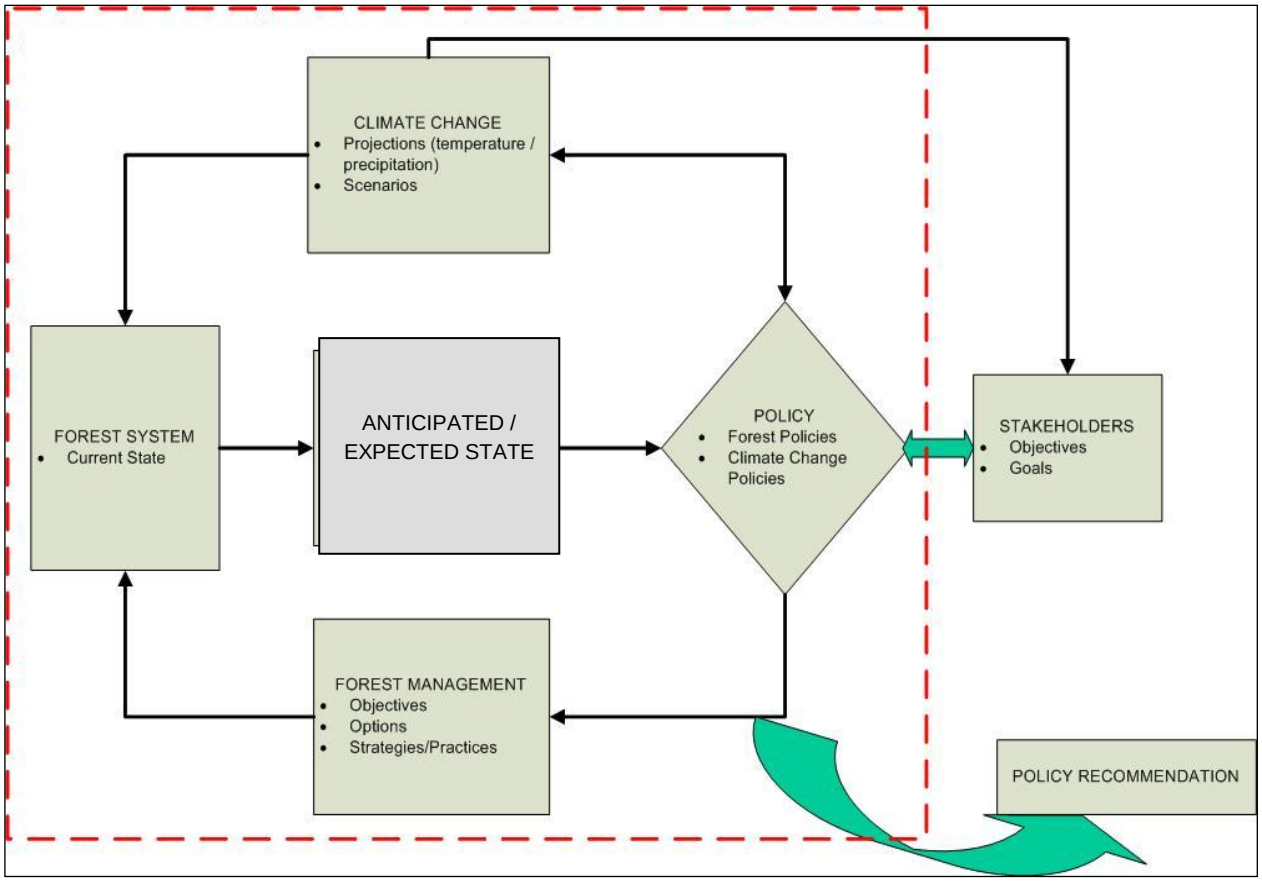

Figure 1.1: Conceptual diagram (adapted in part from Engelen, 2000)

1.6. Organisation of the thesis

Chapter 1
The general background of the research, the research problem, the research objectives and the conceptual framework are covered in this Chapter.

Chapter 2
A literature review on climate change, adaptation and policy in Great Britain is covered, in addition to a review of forest management and perception research.

Chapter 3
The description of the Forestry Commission organisation and the data collection and analysis method are given in this Chapter.

Chapter 4
The results and discussion of the perceptions of climate change, adaptation and the policy process are recorded in this Chapter, with each section covering one of the four research objectives as stated above. Each question is concluded with a summary and each objective is discussed in a sequential manner.

Chapter 5
This Chapter contains the conclusions and recommendations drawn from this research.

2. Climate change, adaptation and policy in Great Britain

"It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is most adaptable to change." Charles Darwin

This Chapter reviews existing literature relevant to this study in order to place it in context of scientific research. It explores the themes of climate change, adaptation, forest policy, forest management, climate change policy, and perception research.

2.1. Climate change and adaptation

Global warming occurs as a result of an increase in GHG concentrations. These gases form a layer in the atmosphere which traps a proportion of radiant energy from the sun. As a result, global surface temperatures gradually rise, thus resulting in a change in other climatic variables such as precipitation, humidity and wind speed (Broadmeadow 2000). Weather patterns and the seasonality of weather may also be affected. Predictions of climate change at a global scale are for a warming of some 3–5ºC over the coming century. This magnitude and rate of change is predicted to have significant implications globally (Broadmeadow et al. 2005).

Mitigation and adaptation are the two best approaches for minimising the adverse effects of climate change but their interplay and their impacts need to be better understood and assessed. Adaptation is defined as "the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC 2007). Adaptive capacity, in relation to climate change impacts, is "the ability of a system to adjust to or cope with climate change, including climate variability and extremes, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences" (IPCC 2007). In the social sciences, "adaptive capacity is the ability of a social system to change or cope with stress or anticipated stress" (Straussfogel 2006). The inclusion of 'anticipated stress' is mirrored in the IPCC (2007) definition of adaptation. An adaptation in a social science sense then is an activity that raises adaptive capacity and reduces social vulnerability, which reduces the sensitivity of the system and hence reduces the biophysical vulnerability, or overall outcome risk (Eastaugh 2008).

Adaptation options exist for the major forest regions of the world but the scientific basis for these adaptation options and their potential effectiveness varies across regions. Because of the great variation in local conditions, no recommendations can be made that are applicable to an entire domain (Seppälä et al. 2009). The choice of management option will depend on the likely changes occurring in the forest, the management objectives of that forest, its past management history and a range of other factors. Thus, local managers must have sufficient flexibility to choose the most appropriate suite of management options for their conditions. Failure to implement fully the multi-faceted components of sustainable forest management is likely to limit the ability of forest management to

adapt to climate change. Careful monitoring and evaluation will be required, with a change in focus from outputs to outcomes (Seppälä et al. 2009).

While much research has been undertaken, there are still large gaps in the knowledge of the most appropriate adaptation strategies to climate change. Majority of adaptation strategies to climate change that have taken place are planned, while others have been reactive and spontaneous to perceived and actual risks in the environment or related to changing economic constraints or opportunities (Adger 2001). A key adaptation strategy that is applicable to forests is adaptive forest management. This is defined as 'a dynamic approach to forest management in which the effects of treatments and decisions are continually monitored and used, along with research results, to modify management on a continuing basis to ensure that objectives are being met' (Helms 1998). Adaptive forest management incorporates the integration of design, management, and monitoring to test systematically assumptions in order to adapt and learn (Salafsky et al. 2008). The scale and complexity of the interactions between society, ecosystems, and global climate change present an unprecedented scientific challenge and call for new types of innovative solutions, especially on regional and local scales (Swart et al. 2009). Effective mechanisms are required to ensure that existing and novel adaptation approaches can be readily translated into policy and practice (Swart et al. 2009).

2.2. Forest policy in Great Britain

Sustainable forest management (SFM) is the basis of forestry policy in Great Britain, as demonstrated in the forestry strategies for England, Scotland and Wales. The Second Ministerial Conference on the Protection of Forests in Europe (MCPFE) in Helsinki, defined SFM as 'the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems' (MCPFE 1993).

Forest policy objectives in GB are founded on the principles of SFM. However, with an increase in adaptation strategies, there is often confusion between these and normal SFM practices. In an IUFRO report that sought to determine to what extent forest agencies are changing their policies and management operations in response to current and anticipated future climate change, Eastaugh (2009) summarised the state of the art of forest policy responses regarding adaptation to climate change in 14 countries. The main findings were that most countries are in the early stages of adaptation, mainly developing enabling programs and stimulating research. Furthermore, the prevailing functions of forests and the expected impacts shape the strategy chosen by forest agencies. In these countries, anticipatory measures are more frequently adopted than reactive ones, probably due to the expected long term effect of climate change on forests and the difficulty of finding evidence of actual impacts. In addition, in contrast with mitigation mechanisms, economic instruments are rarely developed for adaptation. Thus, it is difficult to disentangle adaptation to climate change from general SFM practices. Similar conclusions were drawn from a recent survey in Europe (Lindner et al. 2008). Undoubtedly, successful adaptation depends on SFM, and SFM equally depends on successful adaptation (Eastaugh et al. 2009).

An important challenge for research on climate change impacts and adaptation is to disentangle climate change-driven changes from management-driven changes at the stand level, although certainly the two are closely linked (Eastaugh et al. 2009). Logical management responses to climate change, such as reducing stand densities, treating landscapes, and shifting to more drought-tolerant species are consistent with management responses to other important issues, including forest health, wildfire control, older forest attributes, and protection of habitats (Gregory et al. 2006; Fürstenau et al. 2007; Bernier et al. 2009).

Climate policy integration has taken place within all types of policy instruments such as regulations, economic instruments and information. Consequently, policies aimed at climate change adaptation often interact with forest policies. This is demonstrated internationally in the Stern Review (Stern 2006) and the IPCC report (2007), and in the UK, by the Climate Change Act of 2008 (UK Government 2008) and the Climate Change (Scotland) Act of 2009 (Scottish Government 2009). The increased emphasis on climate change adaptation is also reflected in new policy instruments or changes of existing policy instruments. One such instrument is policy frameworks which have a long-term impact on the development of the forest sector and especially on forestry (Mickwitz et al. 2009) such as the FCS climate change action plan of 2009-2011 (Forestry Commission Scotland 2009). Recently, national adaptation plans and strategies have either been created or are under preparation in most EU countries between 2005–2008 (Swart et al. 2009). Scotland has followed this trend by creating a National Adaptation Framework, released in December 2009 (Scottish Government 2009).

2.3. Forest management in Great Britain

Forests are vulnerable to both climate change and a number of mitigation strategies. As a result, forest agencies are expected to deal with these uncertainties through the development of a wide range of adaptation strategies. Similarly, forests in GB have, in recent years, started to be viewed as a tool to deliver wide-ranging government objectives, for example carbon sequestration and wood fuel policies. Thus, climate change has added another layer to forest policy and poses significant challenges to achieving an appropriate balance of the demands placed on Britain's forests and woodlands (Read et al. 2009).

Consequently, forest agencies are expected to manage their forests not only under today's climatic conditions, but also tomorrow's. However, the anticipated impacts of climate change on particular forests are often highly uncertain, which hampers effective planning. Nevertheless, forest management agencies are introducing new policies and management measures to respond to the effects or the threats of climate change (Eastaugh et al. 2009). The structure of forest management in GB is elaborated on further in Section 3.1.

2.4. Climate change policy integration, coherence and governance

Adapting to the impacts of climate change is a significant challenge to structures of governance at all temporal and spatial scales. Adaptation can be based on uncoordinated choices and actions of individuals and stakeholders or on collective actions and choices at multiple levels, for example, local, regional, national, supranational (EU) and international (Mickwitz et al. 2009; Read et al. 2009).

Consequently, authority may be shifted upwards (top down approach) or downwards (bottom up approach), but it can also be dispersed across multiple territorial levels and among a variety of private and public actors (Swart et al. 2009). In seeking the appropriate scale of governance for adaptation, the projected impacts and the nature of adaptation have to be accounted for in order to alleviate vulnerability and reduce the threats.

Adaptation to climate change in different European countries is taking place through the involvement of multiples scales of governance (Swart et al. 2009). Decisions as to whether or not to adapt are taken at different levels, ranging from individual citizens to the international level (Klein et al. 2005). Climate change adaptation has become one of the major concerns at the International and European level, and for national, regional, and local governments (Read et al. 2009). There is a growing recognition that successful implementation requires the integration of adaptation policies across sectors and within the different institutional scales in a coordinated manner (Klein et al. 2005).

There is a widespread recognition in the national adaptation strategies (NAS) that adapting to climate change requires efforts of the whole society and is a concern for the multiple levels of governance. Moreover, this challenge has also called for the involvement of individuals and different stakeholders (Swart et al. 2009).

2.5. Perception research

Perception research is the study of how individuals or groups perceive their environment. Perceptions attempt to understand the complex interrelationships between man and the biosphere. Man's decisions and actions concerning his environment are based not only on objective factors, but also on subjective ones. This is the underlying principle of environmental perception research (Whyte 1977).

Environmental perception research shares a paradigm of human-environment relations in which the individual and collective understanding is seen as a major force in shaping that environment through their choices and behaviour A perception approach to human-environment relations recognises that for each objective element and relationship in the biosphere, there are many perceived elements and relationships as seen and understood by different people and at different times and places (Slimak et al. 2006).

For the purposes of analysis and decision-making, the present state of scientific knowledge of the environment is usually taken to be 'objective reality'. In this sense, the environmental perception of an individual or group may be brought more closely into line with scientific, 'objective' understanding by education and information (Perri 2005)).

Environmental perception provides a systematic and scientific understanding of the view from the inside-out, in order to complement the more traditional and external scientific approach. In this case, the inside view is characterised by familiarity and long experience often coupled with inability to effect rapid changes. It is seen as personalised and subjective. In comparison, the outside view becomes associated with development, action and objectivity against internal tradition and resistance to rapid change. It is where these two ends of the spectrum come up against one another in a conflict

of interest that the differences in perceptions between the two groups, and the need to understand both within the same analytical framework, becomes highlighted and of urgent, practical importance (Whyte 1977).

In conclusion, in order to increase management efficiency of natural resources, the perceptions of the people directly involved need to be taken along with those of experts or officials. This therefore forms the basis of the method used in this research of investigating the perceptions of FC staff in the three devolved countries. It involves interviewing the people directly involved, i.e. the implementation staff and the experts or officials, i.e. the policy staff.

3. Methods

"We know what we want -- we are sampling with a purpose." W.M.K. Trochim, Research Methods.

This Chapter outlines the study area and the methods applied in this study. The study was carried out in Great Britain, which comprises England, Scotland and Wales (Figure 3.1 below). Section 3.1 gives an overview of the Forestry Commission and its organisation structure. Section 3.2 describes the forest statistics for Great Britain. Section 3.3 explains the data collection method used while Section 3.4 elaborates on the data processing and analysis.

3.1. The Forestry Commission organisation

The Forestry Commission (FC) operates as a cross-border public body within Great Britain. It works to promote the benefits of forests and forestry while improving the lives of people in Britain's cities, towns and countryside through the provision and sustainable management of woods and forests (Weldon 2004). The FC manages the national forests of England, Scotland and Wales. This constitutes 753,000 hectares (as at 31st March, 2009) of public forest land owned or leased by Ministers to provide a wide range of public benefits, including sustainable timber production, public recreation, nature conservation, and rural and community development (Forestry Commission 2009b). It also supports woodland managers with grants, felling licenses, regulation and advice for the stewardship of existing woodlands and woodland expansion in the private sector (Forestry Commission 2004).

The FC serves as the forestry department of the UK administration, advising Ministers in the UK Government, the Scottish Executive and the Welsh Assembly Government on forestry policies. It also works with partners in putting the policies into practice. The devolved structure of Forestry Commission England (FCE), Forestry Commission Scotland (FCS) and Forestry Commission Wales (FCW) allows the organisation to focus more clearly on delivering the policies of the individual Governments while still having the ability to take a GB-wide approach to cross-border issues (Weldon 2004; FAO 2005). The organisation structure of the FC is summarised in the diagram below (Figure 3.2).

The FC in each country is led by a Director who is also a member of the GB Board of Commissioners. Delivery of policy, as well as progress against strategy objectives, is overseen in each country by the Commission's National Committee for England, National Committee for Scotland and National Committee for Wales. The Committee has the responsibility of giving strategic direction to the Commission's activities. The Forestry Ministers' Group discusses matters of common interest, such as the UK Forestry Standard, which sets out the criteria and standards for the management of all UK forests and woodland (Forestry Commission 2004).

Figure 3.1: Study Area, United Kingdom. Source: Google Maps, 2009

The public forests, woodlands and other lands in England and Scotland are managed by Forest Enterprise agencies on behalf of the Forestry Commission in that country. These two executive agencies work to targets set by Commissioners and Ministers (Forestry Commission 2009a). Forest Enterprise England (FEE), an executive agency of Forestry Commission England, is responsible for managing the public forest estate, which amounts to 201,000 hectares of England's woodlands. Forest Enterprise Scotland (FES) manages the national forest estate which totals 447,000 hectares. Forestry Commission Wales has the responsibility of managing of the Welsh public forest estate, and delivery of forest operations on FC managed land. It manages the 105,000 hectares of woodland owned by the Assembly (Table 3.1 below) (Forestry Commission 2009b).

The agencies in England and Scotland take their direction from their respective country governments but their basic remit is to provide environmental, social and economic benefits from the forests they manage. Each of the agencies has a Chief Executive who reports to the Forestry Commission Country Director and who is responsible for the management of that country's forests and woodlands (Forestry Commission 2004; Weldon 2004).

Figure 3.2:The Forestry Commission organisation structure

Table 3.1: Area of woodland (thousand hectares) by ownership and forest type as at 31/03/2009

FOREST TYPE AND OWNERSHIP	ENGLAND	WALES	SCOTLAND
CONIFERS			
FC woodland	146	91	418
Non-FC woodland	219	65	624
Total	*365*	*156*	*1042*
BROADLEAVES			
FC woodland	55	14	29
Non-FC woodland	709	114	271
Total	*764*	*128*	*300*
TOTAL			
FC woodland	201	105	447
Non-FC woodland	928	179	894
Total	*1128*	*284*	*1341*

Source: Forestry Commission, 1995-1999 National Inventory of Woodland and Trees

In leading the implementation of their respective Government's policies, the FCE, FCS and FCW are guided by the Forestry Strategy document for each country (Weldon 2004). These set out the key targets for the Commission such as planting of new woodland, promoting the sustainable use of the woodland resource, and encouraging access for local communities. Grant aid for woodland expansion and stewardship in the private sector is carried out through the Grants Scheme in each of the three countries. The priorities of each administration are all underpinned by the UK Forestry Standard (Figure 3.3 below) (Forestry Commission 2004).

Level	Governing framework	Supporting standards	Monitoring
International	▸ United Nations Forum on Forests (UNFF) ▸ Convention in Biological Diversity (CBD) ▸ Ministerial Conference for Protection of Forests in Europe (MCPFE) and its Pan-European Criteria (PEC) ▸ EU Regulations	▸ Helsinki and Lisbon MCPFE Guidelines for the Management of Forests in Europe	▸ Monitoring of UK implementation and trends
UK and Country	▸ UK and country regulations ▸ Country forestry strategies ▸ Country forestry grants and development, including research	▸ The UK Forestry Standard	▸ Monitoring by UK and country administrations ▸ UK Criteria and Indicators
Forest	▸ Forest Management Plans ▸ Forest operations management ▸ Forest certification	▸ The UK Forestry Standard and supporting Guidelines ▸ UK Woodland Assurance Standard	▸ Monitoring by UK and country administrations and monitoring by certification bodies

Figure 3.3: The UK Forestry Standard Conceptual Framework

Forest Research (FR) is a GB-wide agency which aims to deliver high-quality scientific research and surveys, to inform the development of forestry policies and practices, and promote high standards of sustainable forest management (Forestry Commission 2009a).

3.2. Forest statistics for Great Britain

Great Britain has no natural forest, but has about 650,000 hectares of semi-natural woodland of which 288,000 hectares are classed as ancient and semi natural (1.2% of land area). Semi-natural woodlands are important for wildlife conservation, landscape and cultural heritage. Timber production and recreation are also important uses of semi-natural woodland, but careful management is required to avoid conflict with special wildlife interests. The common species of trees are broadleaved species and conifers such as the native Scots pine and the exotic Sitka spruce (UK Forestry Standard 2004). The main tree species are summarised in the Figure 3.4 below.

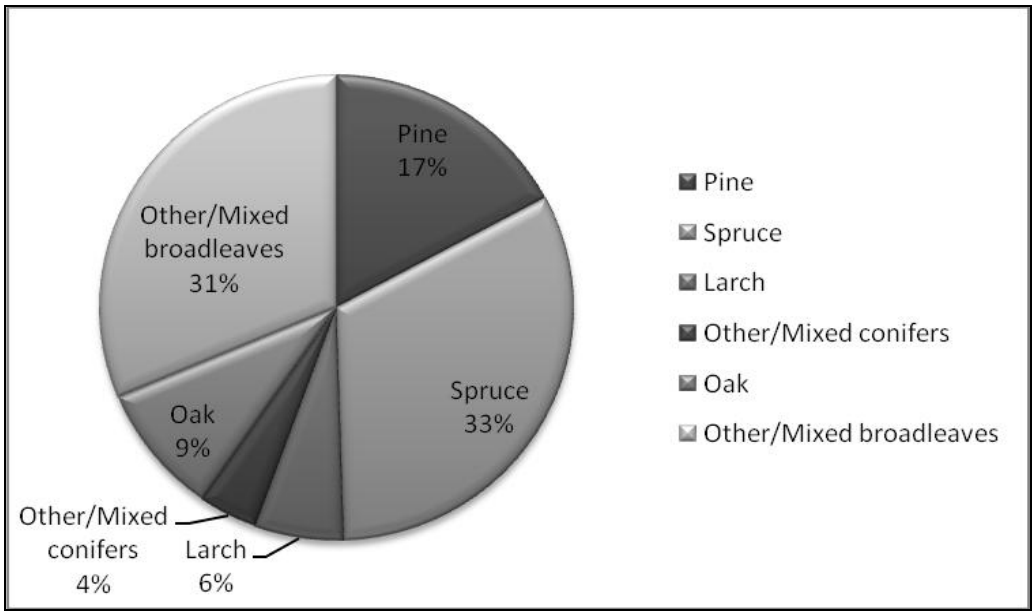

Figure 3.4: Main tree species in Great Britain (%) Source: Forestry Statistics 2009

3.3. Data collection

The aim of this study was to identify the perceptions of climate change, adaptation and the policy process among the staff of the Forestry Commission. The qualitative research methodology as described by Richards (2005) was chosen to investigate and collect the necessary data. Qualitative research involves exploring the range and nature of views, experiences and behaviours, while adhering to scientific research principles (Martin et al. 2005). In this research, two methods were selected for the data collection process, a review of key organisation documents and conducting key informant interviews using semi-structured interviews.

Prior to the fieldwork period, research was undertaken on the organisation and structure of the FC, in order to gain a greater understanding of how to conduct the surveys. Also, to better understand the field of qualitative research, literature was reviewed and previous case studies assessed. This helped in attaining a focal point on which to centre the research. NVivo 8 was identified as suitable software for the analysis of the qualitative data to be collected and a preliminary investigation was done to grasp how it works.

3.3.1. Documentary study

In order to effectively answer research question one, a substantive literature review was carried out. This was of secondary data sources such as reports, books and papers published by the Forestry Commission, Forest Research, the UK Government and the respective Governments of each of the devolved countries. Relevant policy and forest management documents were also assessed.

The process started off with selecting the relevant sources and material. This was followed by an initial screening and incremental selection. Finally, analysis was carried out and the results were integrated with other methods.

3.3.2. Interviews

3.3.2.1. Sampling strategy

In an ideal world, qualitative investigation would involve a continuous process of data collection and conceptualisation until new data does not add to the developing theory. However, because of resource constraints, it is usually more practical to sample respondents for qualitative data capture purposively (ONS 2005). The sampling method chosen for this research was purposive sampling. In this method, the respondents were chosen because they have particular positions and roles in the organisation which enable detailed exploration of the research objectives. It is not possible to draw statistical inferences from this kind of sampling method since, with a purposive non-random sample, the number of people interviewed is less important than the criteria used to select them (Trochim 2006).

Purposive sampling is usually used in qualitative studies, where the focus is on gaining an in-depth and context rich understanding of issues. A smaller number of participants are worked with in more depth than would be the case for an equivalent study using a quantitative approach. The aim of sampling is therefore to select participants who are not necessarily representative of a particular population but who give a particular opportunity to study a topic of interest (ONS 2005). A purposive sample is one which is selected by the researcher subjectively. The researcher tries to ensure that a range from one extreme to the other is included. Purposive sampling can be very useful for situations where one needs to reach a targeted sample quickly and where sampling for proportionality is not the primary concern (Trochim 2006). With a purposive sample, one is more likely to get the opinions of the target population, but also likely to overweight subgroups in the population that are more readily accessible, which may be a potential source of error.

This research utilized two sub-categories of purposive sampling. The first process was expert sampling which involved the assembling of a sample of persons with acknowledged experience and insight into the field or topic (Trochim 2006). During the first week of fieldwork at the NRS, an introduction to the FC was given by Mr. Duncan Ray. A field tour of a managed forest, Craik Forest was undertaken, which gave insight into the management strategies that are undertaken and the challenges that are encountered. Meetings with various implementation and policy staff were held whereby professionals in the field of forest research provided expert advice on the key informants who would be relevant to the research. The experts were also able to examine the research objectives and comment on the appropriateness and validity of the study. As a result of this, the study was able to elicit the views of persons who have specific professional expertise in forest management. Expert sampling is also useful in providing evidence for the validity of another sampling approach chosen (Martin et al. 2005).

Snowball sampling was the second process of purposive sampling used in the research methodology. Snowball sampling involves first identifying someone who meets the criteria for inclusion in the study (Martin et al. 2005). Thereafter, they recommend others who they may know who also meet the

criteria. Although this method does not lead to representative samples, it may be the best method available in certain situations, for example, when trying to reach populations that are inaccessible or hard to find, or in this case, when researching within an organisation. The researcher selects the sample based on who they think would be appropriate for the study. This is used primarily when there is a limited number of people that have expertise in the area being researched (Trochim 2006).

Snowball sampling can introduce an important type of error known as self-selection error, whereby the respondents themselves decide that they would like to take part in the survey. This error often makes it unlikely that the sample will accurately represent the broader population (Trochim 2006). In this research, self-selection error was eliminated by conducting the sampling through the two-step process of expert sampling followed by snowball sampling.

3.3.2.2. Sample population

A careful review of the organisational structure and hierarchy of the FCE, FCS and FCW yielded a substantial number of potential respondents for this research. In line with the organisational structure, this research opted to subdivide the sample population into two distinct groups:

- Policy and Planning staff – with policy or planning roles
  - *Directors, Heads of Policy, Strategic Policy advisers, Policy and Programmes managers, Project officers, Planning managers.*

- Implementation and Operations staff – with implementation and delivery roles
  - *Heads of Regions, Heads of Grants and Regulations, Heads of Estate Management, Forest District Managers, Conservators (Scotland), Regional Directors (England), District Forest Planners.*

A total of 54 staff members were contacted via email and out of this number, only 31 responded and were interviewed. The table below (Table 3.2) outlines the number of staff interviewed per country.

Table 3.2: Number of implementation and policy staff interviewed per country.

	ENGLAND	SCOTLAND	WALES	TOTAL
IMPLEMENTATION	7	5	4	16
POLICY	7	4	4	15
TOTAL	14	9	8	31

3.3.2.3. Questionnaire

A questionnaire is an instrument or form used to collect answers to questions, collect factual data, and gather information or measures. It is a series of written questions in a fixed, rational order (ONS 2005). A semi-structured questionnaire was designed to tackle the research objectives. The formulated questions ranged from Informative or Objective questions about facts, Knowledge questions to establish what the respondents know about the subject on which their opinion is sought, and Opinion or Subjective questions which were related to the research objective (Zee 1999).

The questionnaires are in appendix 1 and 2. The questionnaire was compiled in five thematic sections:

- General information
- Drivers and influences
- Climate change
- Adaptation
- Policy process

The questionnaires were standardised for both the implementation staff and the policy staff, with the exception of the wording of some questions. For example, implementation staff were asked: *"how has the climate change agenda influenced forest activities/forest operations?"* A similar question for the policy staff was: *"how has the climate change agenda influenced forest policy/forest plans?"* This differentiation was done in recognition of the different roles the respondents have in the organisations. Research has shown that standardising questions is one strategy to minimise interview biases (Whyte 1977).

Prior to the survey, pretesting was carried out by asking the questions to three staff members of FR. This was done in order to identify any ambiguous or conflicting questions and difficulties in wording which may affect the reliability, logic and consistency of the questionnaire. Furthermore, the pretesting gave an idea of some of the responses that could be expected from the respondents. This was an indication of the internal validity of the questionnaire (Whyte 1977; Yin 2009).

The survey was conducted in October and November 2009, through scheduled telephone interviews with the key respondents. Each interview was recorded, with the permission of the interviewee. The questions were asked in a semi-structured manner, allowing the key individuals to elaborate and give as much in-depth information as they thought was necessary. This method also enabled both the respondent and the interviewer to clarify any question or answer, respectively, which was unclear.

Using a semi-structured interview for perception research is advantageous in that it encourages the respondent to present not only their perceptions of a situation but also to let them define the situation in their own terms, to include, what they regard as relevant (Whyte 1977). Statements that may be considered as inconsequential remarks can often reveal important information.

3.4. Data Processing and Analysis

A project was created in NVivo which contained the primary and secondary material collected in the study. In NVivo, the project is arranged into different folders which include:

- The Internal source materials consisting of primary data such as the field notes, the audio interviews and the transcriptions.
- The External source materials representing the books, publications and articles collected as secondary data.
- The Memos folder which stored observations and ideas as the research progressed.

- Nodes which are a collection of references about a specific theme, place or person. In this research, the nodes represented the five themes as outlined in the questionnaire: General information, Drivers and influences, Climate change, Adaptation, and the Policy process.
- Queries for finding patterns or relationships and pursuing ideas

The audio files from the interviews were stored in the Internals folder and subsequently transcribed to allow for qualitative analysis and interpretation. The interview transcriptions were then coded using the five thematic nodes. Coding is selecting source content and defining it as belonging to a particular topic or theme to catalogue ideas and gather material by topic (Richards 2005). The codes are given labels, adjusted, and clustered in a process of sense-making. Coding of literature was also done to extract the thematic information from the key publications and documents. Screen shots of the software interface are attached in appendix 3.

4. Perceptions of climate change, adaptation and the policy process

"If people define situations as real, they are real in their consequences" W.I. Thomas, sociologist

This Chapter presents the findings of each of the four research objectives based on the methods applied. The first research objective (Section 4.1) identifies anticipated climatic change and its likely impacts on forests as perceived in Great Britain's policies and FC's research documents. The second research objective (Section 4.2) investigates how anticipated climatic change and its likely impacts on forests is perceived by key individuals. The third research objective (Section 4.3) identifies forest management adaptation strategies in response to climate change as perceived by key individuals. The fourth research objective (Section 4.4) identifies the policy process and the main drivers and influences of forest policies and operations as perceived by key individuals. The specific research questions are presented for each research objective and the summary is given at the end of each Section. The first research objective is answered through a documentary study. The second, third and fourth research objectives are answered through the semi-structured interview conducted among the key individuals in the Forestry Commissions of England, Scotland and Wales. The answers presented are differentiated for implementation staff and policy staff to allow for comparison both between and within the three countries. The discussion section at the end of each objective discusses the findings of the research objectives and questions, and relates the answers given with relevant literature.

4.1. A factual understanding of anticipated climatic change and its likely impacts on forests

The first research objective sought to identify how anticipated climatic change and its likely impacts on forests is perceived in Great Britain's policy and legislation documents and the Forestry Commission's research documents. A thorough analysis of GB policies and key FC documents was done in order to gain a factual understanding of the anticipated impacts of climate change on British forests. The aim was to establish the projections of climate change as accepted by the FC, and the impacts the FC anticipates on the forests that they manage.

4.1.1. Projections of temperature and precipitation change in Great Britain

The first research question was '***What are the projections of temperature and precipitation change in Great Britain?***' Various models predicting future global climatic conditions have been developed and projections of changes to temperature and precipitation are now available. The UKCIP02 and the UKCP09 are examples of such models that have been developed for the UK. These models are based on IPCC research (Intergovernmental Panel on Climate Change 2001; Intergovernmental Panel on Climate Change 2007) and Met Office Hadley Centre data.

The UK climate projections (UKCP) have been developed to help understand possible future climate in the UK. The prediction of climate change is subject to uncertainty and these projections take this uncertainty into account by considering a number of feasible socioeconomic scenarios of the future, each with an associated profile of GHG emissions (Broadmeadow et al. 2005). The UKCP provide information on how the UK's climate is likely to change in the 21st Century, as it responds to rising levels of GHGs in the atmosphere. The results are in a form which can be used by a wide range of organisations that need to assess the level of risk they face (DEFRA 2009). The information also serves those who need to plan on how they will adapt in order to help society and the natural environment cope with a changing climate (Murphy et al. 2009). The FC is one such example of an organisation requiring this information.

The UKCIP02 is a single deterministic projection published in 2002. It provides a snapshot of future climate for three 30-year periods, the 2020s, the 2050s and the 2080s. It is based on new global emissions scenarios published in 2000 by the IPCC. The scenarios describe four alternative future climates for the UK which are Low Emissions, Medium-Low Emissions, Medium-High Emissions and High Emissions. The standard dataset for the UKCIP02 is a 5 km observed monthly climate data set from 1961 to 2000 (Hulme et al. 2002).

UKCP09 is the fifth generation of climate information for the UK. Unlike UKCIP02 and previous generations of climate information, it provides probabilistic projections of climate change based on simulations from climate models and on quantification of the known sources of uncertainty. There is also an increased focus on the UK past and current climate, including trends that establish climate variability (Jenkins et al. 2009). UKCP09 projections are appropriate for decisions on adapting to long-term climate change which need to be taken on the basis of current knowledge (Murphy et al. 2009).

The UKCP09 are based on a methodology designed by the Met Office, which allows a measure of the uncertainty in future climate projections to be included in the information. Therefore, rather than presenting a single best estimate for each emission scenario, UKCP09 provides probabilistic projections under three different emission scenarios, and the probabilities represent the strength of evidence that supports a projected climate outcome. The three scenarios are High, Medium and Low, based on the IPCC's Special Report on Emissions Scenarios (SRES) (Intergovernmental Panel on Climate Change 2000). The projections are averaged for seven 30-year time periods covering the period from 2010 to the end of this century and at a 25km spatial resolution. The three different scenarios represent High, Medium and Low greenhouse gas scenarios. This can help to demonstrate the importance of reducing greenhouse gas emissions and also assist in establishing appropriate adaptation measures (Murphy et al. 2009).

4.1.1.1. Temperature

Overall, UK climate is projected to become warmer. By the 2080s, annual temperature averaged across the UK may rise by between 2ºC for the Low Emissions scenario and by 3.5ºC for the High Emissions scenario. There is anticipated to be greater warming in the south east than in the northwest, and there may be greater warming in summer and autumn periods than in winter and spring. By the 2080s for the High Emissions scenario, parts of the southeast may be up to 5ºC warmer in summer.

High summer temperatures are expected to become more frequent and very cold winters will become increasingly rare (Jenkins et al. 2009).

Figure 4.1 and Figure 4.2 below show the baseline long-term averages for temperature for Great Britain from 1961 to 1990 based on UKCP09. Figure 4.3 shows the same baseline period in the top left diagram, while the right part of the image shows the temperature change for the 2080s Low and High emissions scenarios for UKCIP02.

Scotland is likely to experience an increase in annual average temperature in all seasons, which will be greater in the south part than in the north part. This increase will occur regardless of the future emissions scenario used, with increases being greatest during summer and autumn months. The highest possible increase is up to 4ºC for the UKCIP02 medium-high emissions scenario by the 2080s (Barnett et al. 2006b).

4.1.1.2. Precipitation

Generally, the UK should expect drier summers and wetter winters all over the country. The relative changes will be greatest for the High Emissions scenario and in the south east of the UK, where summer precipitation may decrease by 50% or more by the 2080s and winter precipitation may increase by up to 30% (Hulme et al. 2002). By the 2080s, parts of England may experience reduced summer soil moisture for the High Emissions scenario. Furthermore, snowfall amounts will decrease throughout the UK, especially in Scotland by between 60 and 90% for the High Emissions scenario of the 2080s. However, heavy winter precipitation of rain and snow is anticipated to become more frequent with winter daily precipitation intensities of around 20% heavier for the High Emissions scenario of the 2080s (Jenkins et al. 2009).

Figure 4.4 and Figure 4.5 below show the baseline long-term averages for precipitation for Great Britain from 1961 to 1990 based on UKCP09. Figure 4.3 shows the same baseline period in the bottom left diagram, while the right part of the image shows the precipitation change for the 2080s Low and High emissions scenarios for UKCIP02.

Overall, in Scotland, the winter months may become wetter while the summer months may become drier than at present. This implies that there will be relatively little change to average precipitation amounts each year. The pattern of change may differ across Scotland, with eastern parts experiencing the most extreme percentage changes in precipitation (Barnett et al. 2006a).

The maps showing differences between the two long-term averages give some indication of the variability over the same time-averaging periods typically used as baselines for climate change scenarios, although the full measure of this variability is not reflected (Jenkins et al. 2009).

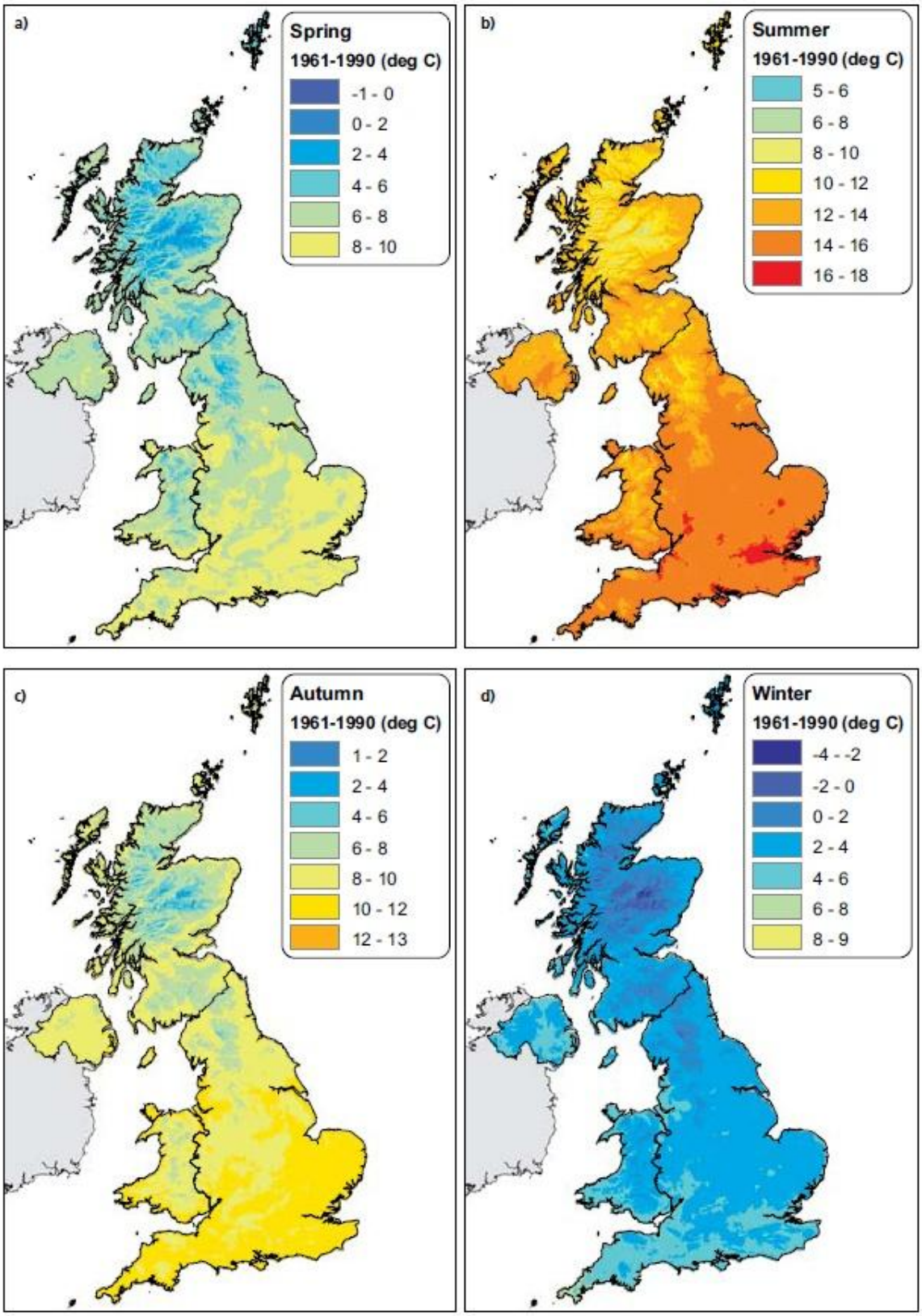

Figure 4.1: 1961-1990 average daily mean temperature (ºC) for a) spring, b) summer, c) autumn and d) winter (Jenkins et al. 2009).

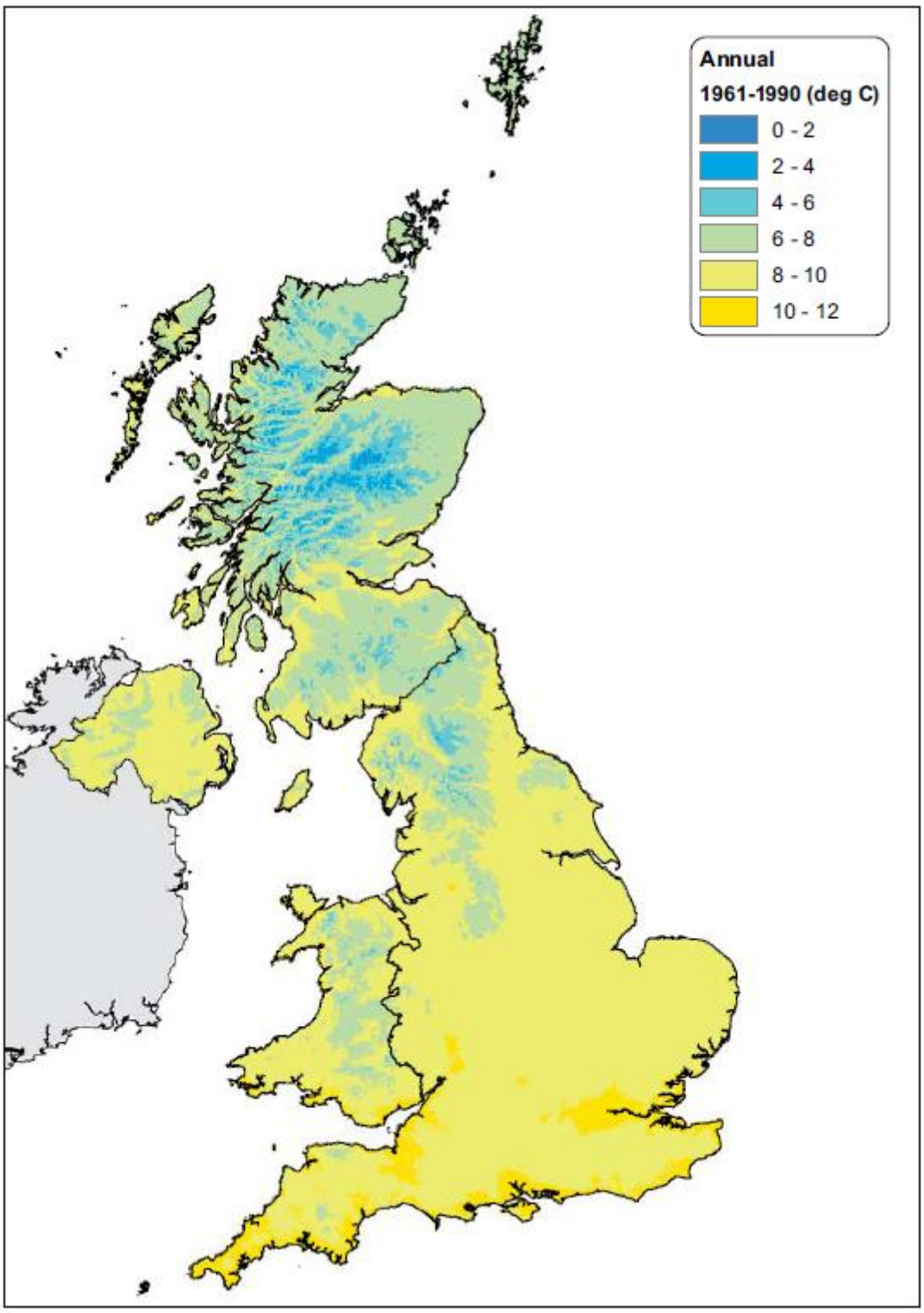

Figure 4.2: Annual average daily mean temperature (ºC) for 1961-1990 (Jenkins et al. 2009).

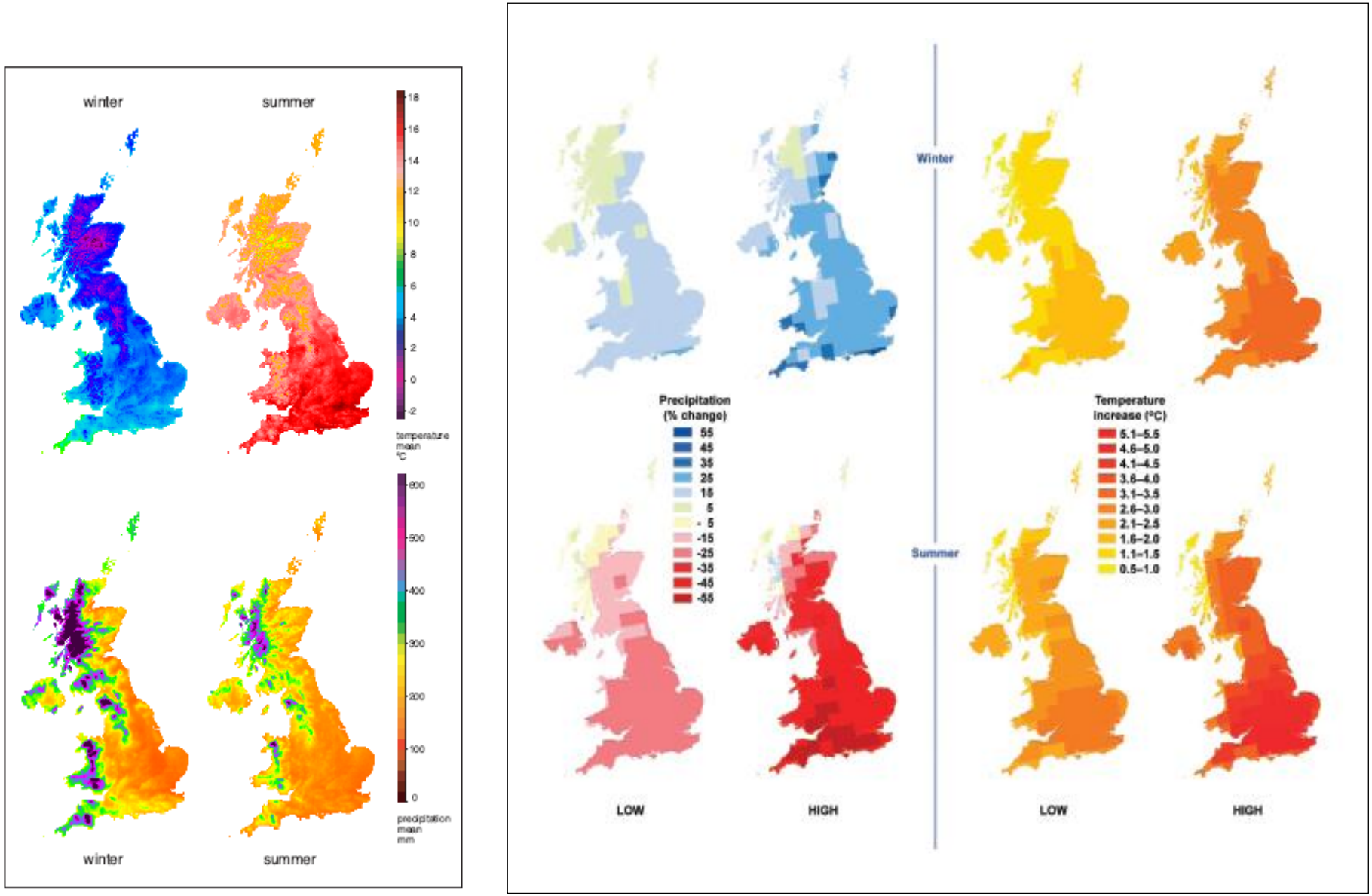

Figure 4.3: Left - Average observed 1961-1990 winter and summer temperature (ºC top) and precipitation (mm, bottom). Right - Rainfall and temperature predictions for the 2080s Low and High emission scenarios relative to 1961-1990 baseline. Source: Hulme et al. 2002

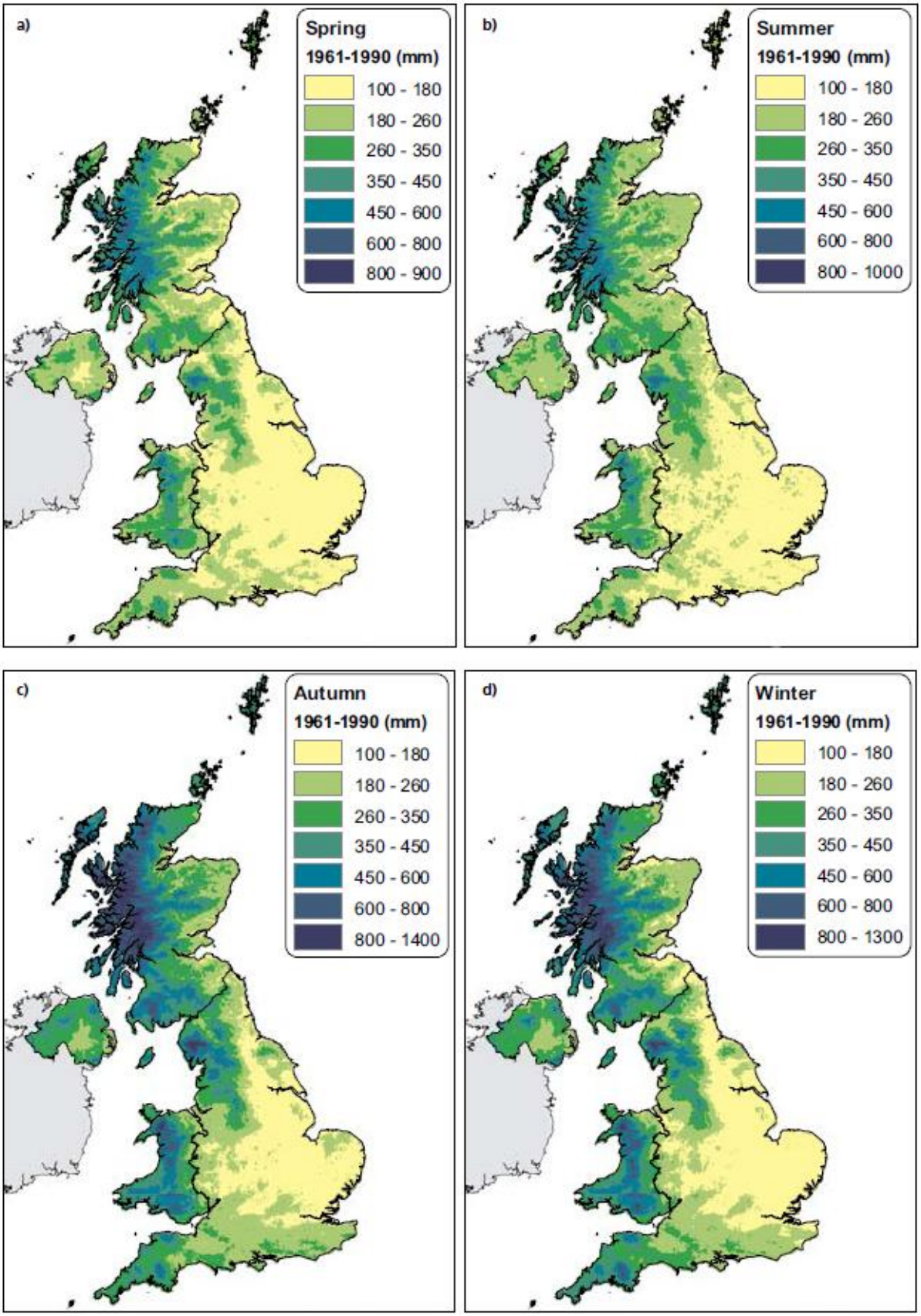

Figure 4.4: 1961-1990 average total precipitation amount (mm) for a) spring, b) summer, c) autumn and d) winter (Jenkins et al. 2009)

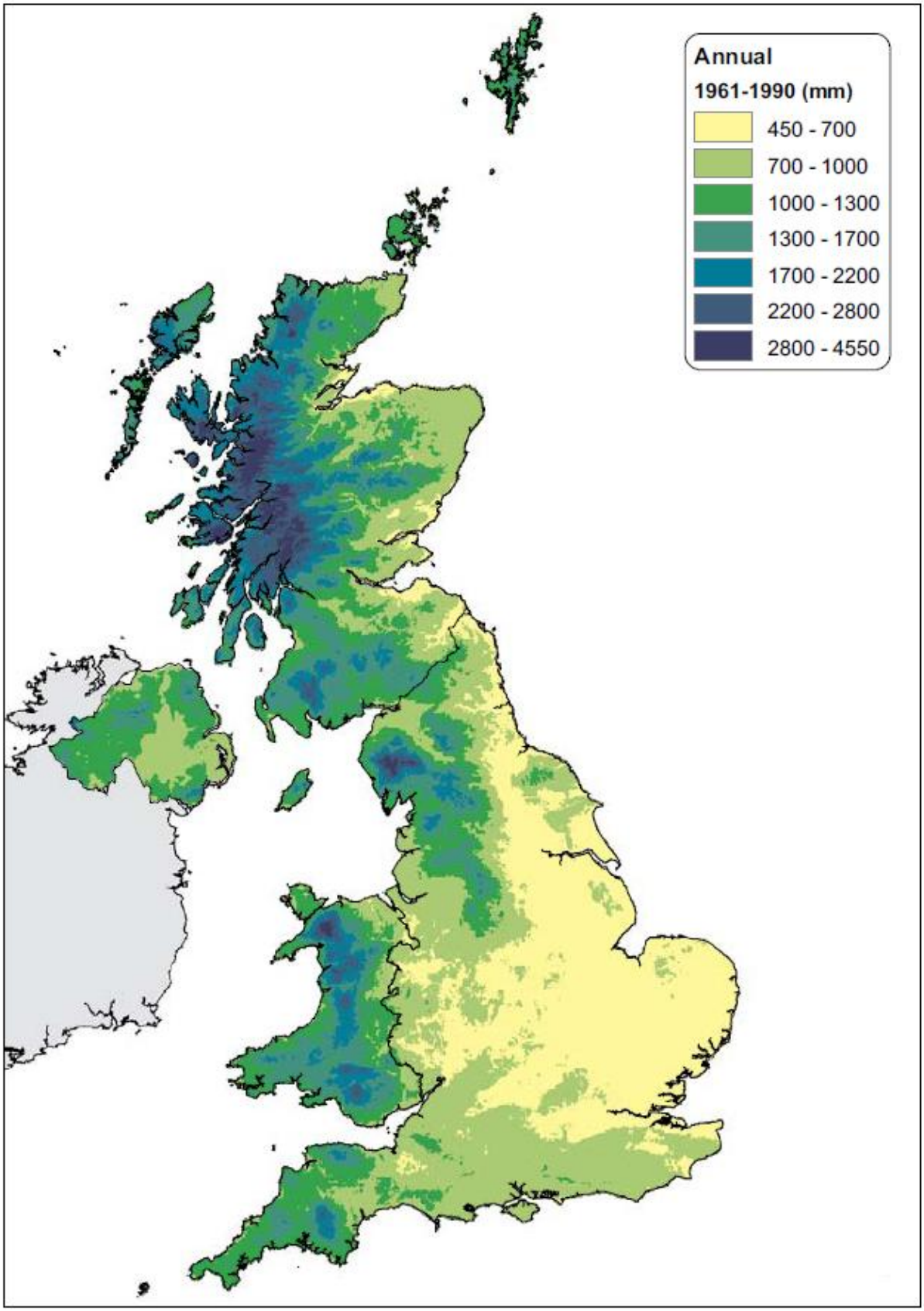

Figure 4.5: Annual average total precipitation amount (mm) for 1961-1990 (Jenkins et al. 2009).

4.1.2. The influence of climate change on forest characteristics and development

Based on a literature survey of scientific FC and FR publications, and project reports from relevant national and EU funded research projects, the major direct and indirect impacts of observed and projected climate change on GB forest were analysed. The research question was, '***To what extent will climatic change influence forest characteristics and development?'*** From the literature, it is established that climate change has an effect on atmospheric CO_2, temperature and precipitation, and this can significantly influence forest characteristics and development. This is elaborated further in the sections below.

4.1.2.1. Atmospheric CO_2 increase

Atmospheric CO_2 is necessary for plant photosynthesis. The UKCIP02 projections indicate that atmospheric CO_2 may rise to approximately 810 parts per million in the High Emission scenario by 2080 (Hulme et al. 2002). Therefore, these rising concentrations of CO_2 in the atmosphere will increase the rate of photosynthesis. However, tree growth rate might not increase proportionally with increase in photosynthesis because other factors, such as nutrient availability, may become more important, thus limiting the ability of trees to increase their growth rates, particularly in natural ecosystems (Broadmeadow et al. 2005; Ray 2008a).

4.1.2.2. Changes in temperature

The UKCIP02 projections predict a rise of between 2ºC and 3.5ºC by the 2080s, depending on the scenario (Hulme et al. 2002). These higher temperatures may extend the growing season in the northern latitudes of GB. However, in other regions, they may have a detrimental effect, especially if the precipitation does not increase as in the case of southern England. In the southern areas, production is more limited by water, and less by temperature and nutrients. Thus, higher temperatures will increase the length of the growing season but the increase in production could be restricted by water availability. For example, competitiveness between species can change due to alterations in temperature, CO_2 and radiation as has been found for European Beech (*Fagus sylvatica)* and Ash (*Fraxinus excelsior)* seedlings (Broadmeadow et al. 2005; Ray 2008a; Ray 2008b).

4.1.2.3. Changes in precipitation

Water is a principal requirement for photosynthesis and plant growth. In the UK, average annual precipitation is anticipated to decrease slightly by between 0-15% by the 2080s, depending on the scenario. The different climate projection simulations show a general increase in winter precipitation in northern and central Scotland, and substantial decreases in summer precipitation in parts of central and southern England (Ray 2008a; Ray 2008b). These changes in the rainfall patterns are likely to have large corresponding effects on forest productivity in regions where productivity is water limited, particularly in the south east of England. Site water balance is decisive for future forest growth, and as a result, any rise in temperatures without an increase in precipitation or with decreasing rainfall can lead to drought (Broadmeadow et al. 2005).

Climate variability is particularly important in connection with the changes in precipitation, because extreme events such as extended droughts and hot spells have much more drastic consequences on tree growth and survival than gradual changes in average climate conditions. The dry and hot year of 2003 caused strongly reduced primary productivity across large areas of GB and resulted in increased tree mortality in the following two years (Ray 2008a; Ray 2008b).

The effect of climate change on precipitation will also influence species composition of GB forests. For example, Oaks (*Querscus spp)* are found to be less sensitive to water stress than European Beech (*Fagus sylvatica*) and stand composition is likely to change if the number of years with water stress increases. Beech dominates natural forests in moderate dry to moist conditions but it is replaced by other species, such as Oaks in dry environments. Furthermore, the natural area of distribution of Beech to the south of England is mainly limited by water availability and therefore, Beech might face severe problems under drought conditions (Broadmeadow et al. 2005; Ray 2008a; Ray 2008b).

In addition to the effects of CO_2, temperature and precipitation changes on forests, other effects due to climate change have been observed. These are outlined in the sections below.

4.1.2.4. Resulting changes in tree species composition

Climate change will not only impact on tree growth and productivity, but changes in species distributions and competition between species is expected (Ray 2008a). The current distribution of tree species has been modelled under climate change using bioclimatic envelops which describe the potential long-term changes in distribution ranges. The model results show anticipated loss of species richness and functional diversity due to the loss of broadleaved deciduous trees. The range of *Picea abies* and *Pinus* sylvestris may retreat from the south and west of GB, while *Fagus sylvatica* and other temperate hardwoods spread to the north. When subject to continuing disturbance, coniferous forests show a more rapid shift to dominance by *Fagus sylvatica* and other temperate hardwoods. Delayed immigration of new species, including *Fagus sylvatica*, would favour early-succession species such as *Betula pendula* and *Quercus spp*. in a forest with reduced biomass and diversity (Broadmeadow et al. 2005; Ray 2008a; Ray 2008b).

4.1.2.5. Abiotic disturbances

The main abiotic disturbances that occur in GB forests are caused by fires, wind storms, flooding and drought. Under climate change, extreme weather patterns of wind, floods and drought are projected to intensify. These extreme conditions have several direct and indirect impacts on the forests. For example, the years 2003 and 2007 demonstrated that forest fires may be substantially more devastating when large scale droughts prevail. As a result, these events may frequently cause an imbalance in the long-term planning of timber production (Broadmeadow et al. 2005; Ray 2008a; Ray 2008b).

According to the UKCIP02, increased wind speed and frequency is expected to occur in winter by 2080 (Hulme et al. 2002). Strong winds will cause blow down of trees leading to damage. The economic impact of wind damage is particularly severe in managed forests because of the reduction in yield of recoverable timber, the increased costs of unscheduled thinning and clear-cutting, and

resulting problems in forestry planning. Furthermore, broken and uprooted trees left in the forest can lead to detrimental insect attacks on the remaining trees because of an increase in the amount of available breeding material (Ray 2008a; Ray 2008b).

Extreme flooding events are expected to occur more frequently as a consequence of climate change (Hulme et al. 2002). Global circulation models predict that it is very likely that higher amounts of precipitation will occur, especially during winter and spring, considerably increasing the risk of flooding. Furthermore, the number of rain days is projected to decrease, but the number of days with heavy rain events is projected to increase. This means that there will be more periods of drought over summer but when it rains, there will be extreme flooding. Flooding is more harmful if it occurs during the growing season than if it occurs during the dormant season of plants. Plant responses to flooding during the growing season include injury, inhibition of seed germination, changes in plant anatomy and promotion of early senescence and mortality. Trees are most vulnerable to the effects of flooding in late spring, just after the first flush of growth (Broadmeadow et al. 2005; Ray 2008a; Ray 2008b).

4.1.3. Summary

Research Question 1: Various models predicting future global climatic conditions have been developed and projections of changes to temperature and precipitation are now available:

- The UKCIP02 and the UKCP09 are the projections of climate change that have been developed for the UK
- Temperature in the UK is projected to become warmer by the 2080s, with annual temperature expected to rise by between 2ºC for the Low Emissions scenario and by 3.5ºC for the High Emissions scenario.
- Precipitation changes will be greatest for the High Emissions scenario and in the south east of the UK, where summer precipitation may decrease by 50% or more by the 2080s and winter precipitation may increase by up to 30%. Overall, the UK should expect drier summers and wetter winters all over the country.

Research Question 2: Despite the considerable uncertainty over climate change progression in the 21st Century, it is evident that there will be significant forest responses:

- Forests may experience increased productivity as a result of rising CO_2 levels.
- The rise in temperature will result in longer growing seasons in some areas, and species competition in others.
- Precipitation will influence forest productivity in areas where productivity is water-limited, and also influence species composition.
- A change in the ranges of species distributions and competition between species is expected due to climate change.
- Abiotic disturbances caused by fires, wind, flooding and drought are predicted to increase in frequency and severity due to climate change, thus influencing the character and composition of GB forests.

4.1.4. Discussion

The first research question identifies the climate change projections that the FC has adopted in its activities. The FC uses the UKCIP02 projections in its reports. The UKCP09 projections are still relatively recent and have yet to be incorporated into forest research. Projections are instrumental in understanding the dynamic nature of climate change and its influence on the world. The fact that the UK has its own climate change projections is testament to their acceptance of the phenomenon and their willingness to prepare for the uncertainty. The projections provide a benchmark against which to measure future climate change and help with the development of strategies to adapt to the likely impacts (Barnett et al. 2006b). These projections are accepted in the devolved countries of England, Scotland and Wales, and the incorporation of the projections into their planning and policy making is part of the preparation process for coping with climate change.

Based on the UKCIP02 projections, temperatures are projected to become warmer, and in terms of precipitation, the UK is bound to expect drier summers and wetter winters. From such projections, it is likely that forest managers will be faced with greater challenges in the future. The results from the second research question identify the effects of climate change on forests, and these include changes in forest productivity, changes in growing seasons, species competition, shifts in species suitability, and an increase in extreme weather patterns of wind, floods and drought (Broadmeadow et al. 2005; Ray 2008a; Ray 2008b). These impacts have already been observed in some areas of GB, where forest managers are having to deal with the challenges. From this, it is therefore possible to conclude that the projections are reliable and offer a reasonable account of what is likely to occur in the future. However, it should be noted that the projections are subject to uncertainty and the scenarios developed to address this, may not occur as anticipated.

4.2. Perceptions of anticipated climatic change and its likely impacts on forests

The second research objective sought to investigate how anticipated climatic change and its likely impacts on forests is perceived by key individuals within the Forestry Commissions of England, Scotland and Wales. The questions were directed at both the implementation staff and the policy staff in each of the three devolved countries. This Section presents the responses to five questions posed in the interviews under the theme of climate change. The quotes by respondents are presented in verbatim in the text boxes to highlight and place emphasis on specific attitudes of interest.

4.2.1. Definitions of climate change

The first question posed to respondents was ***'What is your definition of climate change?'*** Overall, this question elicited varied reactions from the respondents, most of whom were surprised and humoured. It proved to be an interesting question to gain some understanding on what climate change means within the organisations.

4.2.1.1. England

Implementation staff

A range of answers were given, with all seven respondents mentioning keywords of the scientific definition of climate change such as *'man's influence', 'global scale'* and *'over a period of time'*. One respondent elaborated on the definition to mention the general impacts that are anticipated with climate change occurrence, and one respondent showed some uncertainty in giving an answer.

> *"Climate change is global warming, a result of cause and effect whereby man has intervened within the natural processes of the earth, creating an imbalance in the trend and trajectory of climate, rainfall, weather, temperature, thus bringing about changes through the human races own doing. There are negative impacts like increased rainfall and precipitation density, soil erosion, and higher temps in cities, with some positive aspects like drier and warmer climate in some areas therefore tourism might increase, but largely the impacts are negative."(03)*

> *"What is my definition of climate change? Well, am not quite sure. Is it the global alterations, either positive or negative, in temperature over a number of years? It is global variations in climate temperature."(01)*

Policy staff

All seven policy staff interviewed gave answers that are scientific and structured, which corresponds with the work they do of formulating and disseminating the relevant policies and plans.

> *"It is the anthropogenic emission of GHGs leading to the rise in global temperatures and associated climatic impacts." (11)*

> *"Our climate should still be in a period of cooling, but as a result of the industrial revolution and man's activities, we reversed that pattern. (12)*

4.2.1.2. Scotland

Implementation staff

Four of the five implementation staff interviewed were well versed on the definition of climate change, with the exception of one respondent who gave a broad, generalised answer.

> *"It is a change in the prevailing conditions within the climate, for example, temperature, rainfall, and seasonality, driven by actions of man, and which we can influence and change through our action by minimising GHG generations and modifying management practices."(15)*

> *"I don't know, it's not something I have ever really considered. From my point of view, climate change is something that is happening all around us, and happening as a result of man, industrialisation, etc."(18)*

Policy staff

Similarly, of the four policy staff interviewed, two of them had a clear understanding of climate change. The other two respondents included the principles of sustainability in their answer.

> *"Climate change is a natural process; we have had a number of phases of climate change, but this one is distinguished by the direct human induced element of it, no longer due to purely natural causes. The pace of change is defining the seriousness of it as it is taking place in a very short space of time."(21)*

> *"Trends of climatic change that impact upon our society, economy and ecology."(20)*

4.2.1.3. Wales

Implementation staff

All the four respondents gave well-defined answers to the question, demonstrating thus their knowledge on the subject.

> *"A significant irreversible change in the climate patterns of the world due to the influence of man. It has always happened to some extent, due to natural events, catastrophes, major solar events; but now it is under the influence of man."(27)*

Policy staff

Of the four respondents, one of them elaborated on the impacts that are expected to occur as a result of climate change, rather than giving a clear definition. The other three respondents gave accurate responses.

> *"A combination of generally higher temperatures globally, and more extreme weather events; leading to severe environmental degradation and habitat loss, and economic crises, resulting from droughts and floods."(28)*

> *"The anthropogenic impact on the world's climate; it has always varied, but now the variation is due to man's impacts. The facts are clear on variation linked to CO_2 increase in last 250 years."(29)*

4.2.1.4. Summary

Overall, all the thirty-one respondents in the three organisations, with the exception of five, gave a definition of climate change that is similar to the scientific definition of the IPCC (Intergovernmental

Panel on Climate Change 2001; Intergovernmental Panel on Climate Change 2007). This illustrates the high level of understanding and awareness of climate change within the organisations. There is no difference between the understanding in England, Scotland and Wales.

There is however a noticeable difference between the policy and implementation staff. The policy staff tended to give structured and scientific responses, which correspond with their work of creating and disseminating the relevant climate change policy documents. The implementation staff tended to answer the question using examples of impacts that they are aware of in the forests they manage.

4.2.2. The occurrence of climate change

The second question posed to respondents was ***'Do you think climate change is occurring?'*** This question sought to find out whether the respondents believe that the climate change phenomenon is currently taking place.

4.2.2.1. England

Implementation staff

Out of the seven implementation staff interviewed, two respondents expressed their scepticism and uncertainty on the occurrence of climate change. However, the other five respondents were certain that climate change is occurring.

> *"I think the climate is always changing; I am a little bit of a sceptic. I do believe this is climate change, but I don't think perhaps it's as extreme in some places or as different as what has always happened, but I accept there is a change."(02)*

> *"It (climate change) could be part of a natural cycle or man has had a huge influence, but I am not sure as it is still a contentious issue."(04)*

> *"Yes indeed, there is no doubt that climate change is happening, no question about it, and no cynicism. And we recognise the need to do our best under the circumstances."(03)*

Policy staff

All the seven policy staff were of the opinion that climate change is occurring, with some stating the broad scientific evidence and the impacts that support their belief.

> *"Yes, there is a broad range of evidence, for example, the change in length of growing seasons. And there are both beneficial effects and adverse impacts. The wealth and extent of information which is coming out from recognised scientists now is hard to ignore."(11)*

4.2.2.2. Scotland

Implementation staff

Out of the five respondents interviewed, four believe that climate change is taking place. However, one respondent was uncertain about the occurrence of climate change.

> *"I am recognising that change is taking place before my eyes and hearing things, reading things, watching things on TV."(18)*

> *"It is hard to say. People recognise that things are happening. Currently, operational decisions are based on uninformed judgement rather than hard and fast evidence. We do not know exactly what will happen with climate change, and we have to strike a balance between waiting for more evidence and working with the current knowledge."(15)*

Policy staff

All four policy staff interviewed believe in the occurrence of climate change and that it is backed by a strong body of research evidence.

> *"As an evidence-based policy maker, the facts suggest that climate change is occurring."(20)*

> *"The evidence is absolutely overwhelming that it is man-induced and rapid and extremely serious. There is man-made and rapid instability in our climate."(21)*

4.2.2.3. Wales

Implementation staff

All four respondents agree that climate change is taking place, with some mentioning the scientific evidence and the impacts already experienced.

> *"Yes, climate change is taking place. There is scientific evidence of it."(27)*

Policy staff

Similarly, all four policy respondents believe in the occurrence of climate change, and one respondent expressed concern about the uncertainty that surrounds the phenomenon.

> *"Yes, it is taking place. There is evidence all around, for example, from changing weather patterns and from research."(30)*

> *"Yes, it is but because of the state of uncertainty, no one can particularly predict exactly what is going to happen where, there are probably no winners to this. Everyone is going to lose out. No one has a vested interest in climate change."(28)*

4.2.2.4. Summary

With the exception of three respondents, the respondents believe that climate change is happening. The three who expressed doubt are among implementation staff of England and Scotland. The reason they give is the uncertainty and lack of sufficient evidence to support the claim.

In contrast, all policy staff in the three organisations agree that climate change is taking place. This could be because they are exposed to the research and sources of evidence of climate change, and are therefore more likely to believe in it taking place. All respondents in Wales believe that climate change is occurring. This could be an indicator of the level of awareness on climate change within FCW.

4.2.3. The impact of climate change on forests in Great Britain

The third question posed to respondents was ***'Do you think climate will change to a degree that will significantly impact on forests in Great Britain?'*** This question sought to find out from the respondents if they believed that climate change would have a significant impact on GB forests. It also aimed at establishing the impacts, if any, that they anticipate to occur.

4.2.3.1. England

All the implementation and policy staff agreed that the change in climate would significantly impact on the forests in England. The responses to this question were varied and wide-ranging in their scope. The most common answers focused on general climate change impacts such as *hotter drier summers, wetter windier winters, violent or severe fluctuations of weather, shifts in seasons or weather patterns, summer droughts, storms, heat waves,* and *higher frequencies of extreme events.*

Other responses were specific with reference to the impacts of climate change on forests. These included beneficial impacts such as *net biomass gain due to increased length of growing seasons due to warmer weather, refuge for other native tree species,* and *suitable growing conditions for more species.*

Some of the adverse impacts mentioned include *changes in species suitability with a potential species shift northwards (migration), greater unpredictability of tree growth, susceptibility to increased flooding due to waterlogged soils, damage by gale winds, and pests and diseases outbreaks (red band needle blight and fungal infections)*. Based on the impacts mentioned, some of the expectations among staff are the need 'to *adapt the species that are grown', 'to respond to more queries about trees'* and *'to receive more information from FR'.*

4.2.3.2. Scotland

Similarly, all the implementation and policy staff are of the opinion that climate change will impact on the forests in Scotland. The changes they anticipate include *changes in weather patterns, fewer snow days, increased flooding especially in riparian or watercourse woodland, shifts in site suitability, certain tree species struggling to survive in the future, drought or less rain in some areas affecting Sitka spruce and Scots pine, decline in wildlife numbers due to loss of biodiversity and*

habitat connectivity (species such as deer and capercaillie or grouse), pests and pathogens, more fires, loss of soil moisture, increased wind frequency, and *landslides or instability in vulnerable areas.*

One respondent mentioned two broad social impacts of climate change, *the destabilisation of politics* and *climate change migration.*

4.2.3.3. Wales

The answers given by the implementation and policy staff in Wales were similar as those mentioned by Scotland and England. The impacts given included *milder winters which will result in the survival of pests and pathogens (aphids) and tree species not hardening up fast enough, warmer and wetter summers leading to prolific weed growth, storm events resulting in wind blow down, increased threats to monocultures from incidences of pests, pathogens and diseases, different species growing in different ways,* and *more extreme events of rainfall, flooding, droughts, fires and gales.*

However, of the eight staff interviewed, one was of the opinion that Wales would not be significantly affected, while another was uncertain about the likely impacts.

> *"Yes, but not as significantly in Wales as in other parts of the UK or the world."(27)*

> *"Yes I think it will, but we don't know how or how it's going to change exactly. We have some ideas but we don't know exactly. We need to be quite flexible in how we can respond to it."(30)*

4.2.3.4. Summary

Overall, all thirty-one respondents agreed that the impacts of climate change are likely to be significant on forests in GB. This included the respondents who were sceptical and doubtful (in Section 4.2.2) of the occurrence of climate change. The staff mentioned not only likely impacts, but also impacts that they are already witnessing on the ground.

These impacts as mentioned in the interviews are consistent with the impacts identified in research literature in objective 1 (Section 4.1). This could imply that the policy and implementation staff of FCE, FCS and FCW are well aware of the anticipated climate change impacts as identified from research and also from their own observations. This is investigated further in the next Section 4.2.4.

4.2.4. Sources of information

The fourth question posed to respondents was ***'What sources of information are influencing your perceptions?'*** This question sought to find out the sources that the respondents use to base their knowledge and understanding of the meaning and occurrence of climate change, and to justify its likely impacts. In the tables below, the letter 'I' stands for 'Implementation staff' and 'P' stands for 'Policy staff' (Tables 4.1, 4.2 and 4.3).

4.2.4.1. England

The sources of information that influence the perceptions of the staff in England are summarised in the Table 4.1 below.

Table 4.1: Sources of information mentioned by FCE respondents

Sources mentioned	I	P
FC documents	7	7
FR research papers/publications	2	3
Expert opinion/judgement or other scientists	4	3
Own intuition/analysis or personal experience	3	2
Books/Newspapers/Magazines/Media/Internet/TV/Video	4	1
External research/University work	2	2
Met office historic data	2	0
Seminars and presentations	2	0
UKCIP	1	1
The Stern report	0	1

"For example, the FC climate change officers, I have close contact with them and they give advice which they get from recognised sources."(01)

4.2.4.2. Scotland

The sources of information that influence the perceptions of the staff in Scotland are summarised in the Table 4.2 below.

Table 4.2: Sources of information mentioned by FCS respondents

Sources mentioned	I	P
FC documents	5	4
FR research papers/publications	4	2
Expert opinion of other scientists	2	1
Newspapers/Media/Internet/TV	2	1
UKCIP	1	2
Politicians	1	0
FC Intranet	1	0
Seminars and conferences	0	2
External research - the Scottish Climate Impacts Partnership reports	0	1
IPCC reports	0	1

4.2.4.3. Wales

The sources of information that influence the perceptions of the staff in Wales are summarised in the Table 4.3 below.

Table 4.3: Sources of information mentioned by FCW respondents

Sources mentioned	I	P
FC documents	4	4
FR research papers/publications	4	4
Media/Internet	1	1
UKCIP/ Hadley Centre projections and graphs	1	1
Conferences	1	0
External research – EFI, Future Forests	0	2

4.2.4.4. Summary

The FC documents and FR publications are the main sources relied upon by the respondents in England, Scotland and Wales. Examples given include the strategy documents, the UK Forestry Standard and the FC's interpretation of the UKCIP.

In England, expert opinion, for example of the climate change officers, is an important information source. Implementation staff in England also use their own personal experience and various media as a reference for their perceptions.

Expert opinion also plays a role in Scotland but is not mentioned in Wales. The sources that are common between the three countries include the UKCIP data, seminars and conferences, media and external research. Overall, the staff in the three countries are exposed to a considerable amount of information, on which they base their perception of climate change and its impacts.

4.2.5. Strategies in response to climate change

The fifth question posed to respondents was ***'What strategies, plans and practices, if any, are you putting in place to manage the impacts that you mention or to respond effectively to the impacts?'*** This question sought to find out how the respondents are preparing or have already prepared for climate change.

4.2.5.1. England

Implementation staff

The strategies mentioned as responses to climate change impacts by the implementation staff ranged hierarchically from regional strategies to county strategies to local strategies. National strategies are influenced nationally by the policy and programmes staff. Local strategies are embedded in town and city plans, and some examples of the local interventions include planting mixed species for greater diversity, protection of valuable ancient and semi-natural woodlands to give them a degree of resilience, and planting more trees in exposed areas, open grounds or large areas of concrete (for

example in school playgrounds, hospital grounds and car parks) to ensure shade in the future to cope with the dramatic changes expected. There was also mention of business partnerships with the commercial sector, for example, promoting use of wood fuel.

> *"We have developed a climate change database on the web which gives an indicative range of species suitable to a particular location, using climate change scenarios on http://www.right-trees.org.uk/"(01)*

However, the answers given by two respondents expressed elements of uncertainty and the inability to influence decisions, particularly among private woodland owners.

> *"There are no strategies or plans in place, because there is too much opinion and not enough science. In practice, we would advice owners to plant more mixed species and diversify rather than plant single species. But we cannot force owners to plant certain species, we can only advice against it and promote mixed species. Grants are there to help people do things and not to force people to do things that we need to do. They are there to help owners do what they want to do. For example, some owners are planting Eucalyptus and the FCE has no clear view on Eucalyptus at the moment."(04)*

> *"The FR staff often talks to woodland owners about new insect pests as they become prominent. We are trying to educate and raise awareness (on climate change) but we are not in a position to say we will do this or we will not do that. We are in a sort of learning phase. There is no FCE guideline for dealing with or combating or reacting to climate change, we just have lots of words."(02)*

One respondent was of the opinion that the trees would be capable of coping on their own despite the changes in climate.

> *"We are aware of it, and very conscious of some of the implications, but trees have such a long lifespan, for example, Windsor Oak trees have lived to 1300 years old and have survived climatic changes, thus many of the UK species may have genetic resilience. So we will not stop planting oak just yet."(05)*

One practical suggestion offered for adequate preparation is to promote sharing of expertise or collaboration of practitioners across Europe, in a manner similar to the way scientists interact.

> *"We must speak with other nations and benefit from their evidence, for example France, Portugal, and Spain."(07)*

Policy staff

The seven policy staff interviewed mentioned the creation and dissemination of policies as their key strategy in managing the impacts of climate change. Two respondents mentioned that this process is a 'work in progress' and required more understanding and discussions.

"Our strategies include producing basic guidance bulletins for practitioners in the field, preparation of a climate change action plan for FEE, and involving and encouraging diverse members of staff, for example, the engineering teams."(12)

"We are creating a climate change action plan, promoting wind energy on the public forest estate, promoting the use of wood fuel energy as an alternative source of energy, and looking in the long-term to ensure productive capacity (of forests) is maintained."(11)

4.2.5.2. Scotland

Implementation staff

Four of the respondents mentioned taking a balanced approach with regards to planting certain tree species in order to reduce vulnerability. This is incorporated in the forest design plan and strategic plans.

"We are considering a species diversity plan but waiting for scientific research. We will address it (the species diversity plan) over the next 10-15 years. We want to plant species with a specific genetic base with a better chance of survival."(17)

One respondent mentioned the need for better modelling for greater understanding of the impacts. Furthermore, policies were identified as a determining factor for the strategies undertaken.

"FR research, the Woodland Assurance Scheme and the UK Forestry Standard all play a role in planning and management of forests for climate change, by continually trying to improve delivery. We must readdress our systems and policies to ensure that we meet the guidelines."(18)

Policy staff

The four respondents interviewed identified the Climate Change Act, the Climate Change Action plan and associated delivery plans as their main strategy in tackling climate change impacts. Two of them also stated the need for more evidence in order to influence change management.

"The development of the Scottish Government Climate Change Act and associated Delivery Plan which gives enabling powers for renewable energy production on the national forest estate and lays out where forestry fits with the overall CO_2 reduction target. It also sets out agreed interim forestry expansion targets for 2020 and a 42% CO_2 reduction."(20)

"Forestry is part of the solution to mitigate impacts and also has to adapt through silvicultural systems, species choice and creation of habitat networks. Strategies like the Climate Change Action Plan and other policies aim to change and influence practice and provide guidance through policy measures, grant schemes and state forest service. Policy runs ahead of practice."(22)

"There is huge uncertainty and a massive need to undertake serious change management, in order to carry people with you, so that they understand why changes are going to take place, if there are major changes. We must find a practical way through it."(21)

"For some of the changes that need to take place, we are still developing the evidence base for that as we want forest managers to understand the reason for doing thing or reasons behind the advice. We need to give sound advice using research knowledge transfer."(23)

4.2.5.3. Wales

Implementation staff

Among the four respondents, the strategy document and its corresponding implementation plan largely influence the activities that they undertake to manage climate change impacts. Some of the strategies in place include ensuring habitat diversity, water catchment management, thinning, and chemical applications for weeds.

"The Woodlands for Wales Strategy document puts greater emphasis on a mixture of species in forests, to make them more robust to weather events, or pests and diseases. There is also greater use of continuous cover forestry for a more robust forest ecosystem. The grants scheme supports this but is not fully aligned to the strategies, to ensure the incentives are fully in line with the revised Strategy document."(27)

Policy staff

According to the policy staff, the recent review of the Woodlands' Strategy has ensured that climate change is taken into account in all the policies and plans. It has promoted flexibility in terms of species diversity and forest management.

"We are making forests more diverse, with more species and range of differences in age structure, thus ensuring viable woodlands."(30)

"The Woodlands Strategy Advisory Panel is a stakeholder panel that advises the Minister periodically on reviews of strategy and its implementation or action plan. It considers policy proposals and offers advice."(29)

4.2.5.4. Summary

Overall, the thirty-one staff interviewed have put in place a strategy or plan for climate change impacts. For policy staff, this involves the creation and dissemination of relevant policies. The implementation staff are applying practical responses to the impacts experienced or expected.

In England, implementation staff mentioned the difficulties in influencing private woodland owners to put into practice suitable strategies. With privately owned woodlands taking up the largest percentage of woodland area in GB, this is a significant amount of forest. Therefore, the grants scheme in England, as well as Scotland and Wales should integrate climate change to promote the uptake of suitable strategies among private woodland owners.

A lack of sufficient evidence and research was also mentioned by both implementation and policy staff as a hindrance to the application of strategies to tackle climate change impacts. This indicates the need for greater awareness of the research and evidence that is available in the scientific world.

4.2.6. Discussion

The respondents seem to have a clear understanding of climate change because the definition of climate change they give is consistent with the scientific definition given by the IPCC. Furthermore, majority of the respondents are of the opinion that climate change is occurring, and the main reason they give is that 'there is significant evidence of it.' This consensus of perceptions may be a reflection of the level of awareness and understanding of climate change and its impacts among the respondents (Ogden et al. 2007).

The respondents believe that climate will change to a degree that will significantly impact on forests in GB. The impacts that they are experiencing correspond with the impacts mentioned in literature in Section 4.1.2. The main sources of information that they use to base their perceptions on is key FC documents and FR publications, particularly the strategy documents, the UK Forestry Standard and the FC's interpretation of the UKCIP02. These sources are considered clear and valid, and are the basis upon which suitable strategies and plans are formed. Consequently, the perceptions of the respondents are indicative of the state of knowledge among them and a high level of success of knowledge transfer from knowledge holders to knowledge users (Ogden et al. 2007). These responses show that people's perception of a phenomenon is often guided by how they experience it. Overall, there is a convergence of facts and perceptions.

4.3. Perceptions of adaptation strategies in response to climate change

The third research objective sought to identify forest management adaptation strategies in response to climate change, as perceived by key individuals within the Forestry Commissions of England, Scotland and Wales. The questions were directed at both the implementation staff and the policy staff in each of the three devolved countries. This Section presents the responses to five questions posed in the interviews under the theme of adaptation. The quotes by respondents are presented in verbatim in the text boxes to highlight and place emphasis on specific attitudes of interest.

4.3.1 Definitions of adaptation

The first question posed to respondents was ***'What is your definition of adaptation?'*** As in the case of the question on climate change definitions, this question also elicited a range of reactions from the respondents, such as laughter, surprise and confusion. It proved to be an interesting question to gain some understanding on what adaptation means within the organisations.

4.3.1.1. England

Implementation staff

The responses among the implementation staff ranged from a focus on the species choice to a focus on the silvicultural techniques used. Two respondents found it difficult to give a clear definition, finding the question confusing or challenging.

> *"Adaptation means ensuring that the trees we plant in the forestry context have the genetic ability to cope with a wide variety of climate change impacts."(02)*

> *"I find it difficult to separate adaptation from mitigation. Mitigation means finding ways of changing your environment to improve the effects of climate change, for example, planting trees; whereas adaptation means changing the way that you live, I don't know, I am not sure."(01)*

> *"Adaptation assumes that elements of climate change are a reality and therefore we have to do something to help the environment, economies or people adapt to those changes."(05)*

> *"Things that mitigate against changes that are or will happen (as a result of climate change), as opposed to mitigation which is how do we slow or stop the changes?" (06)*

One respondent also took the rural agenda and urban agenda into consideration in the definition.

> *"How do we help the countryside adapt by making it more resilient to drier or wetter or windier dynamics of the environment anticipated with climate change? How do we respond to the urban heat island effect in cities?"(07)*

Policy staff

The definition of adaptation among the policy staff in FCE tended to incorporate all aspects of forestry - the social, economic and environmental aspects, in the context of climate change. Two respondents answered the question by giving examples of the types of adaptation practised.

> *"There are two definitions of adaptation; anticipatory which is putting in place measures based on the best evidence at present of the future climate. It should make woodlands, the landscape and society more resilient to the impacts of climate change. The other is autonomous which in the case of woodlands, means they are dependent on their own adaptive capacity." (11)*

> *"We can react to things that are going wrong, like strong gales or diseases, or we can be more forward thinking by using the evidence base to take advantage of what is coming in front of us." (12)*

4.3.1.2. Scotland

Implementation staff

The definitions of adaptation among the implementation staff in Scotland placed emphasis on the forest management techniques and the specific impacts of climate change that are anticipated in the region.

> *"Adaptation means changing the methods that we are using to manage the forests such as cutting the forests by clear cutting or alternatives to clear fell, changing the timings of operations due to seasonal patterns of weather (summer or winter), and change in choice of species."(17)*

> *"Adaptation can be defined as a biological process that takes place over a period of time where species evolve to survive a changed environment from the one they are in or used to. It is a long-term progression of evolution over time to reflect changing environmental conditions."*
>
> *"However, in the short-term, adaptation can be defined as the change in man's practices or different ways of doing things to reflect the environment we are working in. A change in the way we are doing things to reflect the conditions we are operating in."(15)*

> *"With adaptation, we recognise, we are given information and we are aware of change taking place, and we have to adapt our policy and delivery to ensure that it meets those changes and looks to the future to see how those should continue to evolve."(18)*

Policy staff

All four of the policy staff interviewed defined adaptation as a wide-ranging, all-encompassing activity. Two of the respondents also provided scientific and detailed definitions that took into account the aspect of timescales which is very important in the forestry context.

> *"Adaptation means ensuring that the functions of forestry can be perpetuated into the future, in ways that make sense now and in the future. It means keeping our resilience for future climate change and managing that resilience; it is a form of risk management." (21)*

> *"There are different types of adaptation, one is maintaining the resilience of woodlands so that they can continue to fulfil their social, environmental and economic functions and link with sustainability; two is leaving flexibility for future generations to manage functional, healthy, surviving, vibrant and dynamic woodlands."(21)*

4.3.1.3. Wales

Implementation staff

The four implementation staff defined adaptation with a focus on the activities they undertake as forest managers.

> *"Adaptation includes measures that can be introduced into forest management that will enable the forests to cope with different climatic conditions, that is by creating greater resilience to change."(24)*

> *"It means adapting what we do in terms of woodlands, land use or woodland use to provide some mitigation against the impacts of climate change."(27)*

Policy staff

In their responses, the four policy staff interviewed incorporated the aspects of environment, society and economy in their definitions. One respondent gave an example of adaptation that recognised the role that trees and woods can play in helping society to adapt to climate change by managing woods in a certain way or creating new woods in new places to reduce impacts of climate change on people, for example in urban environments to minimise microclimate effects, or in upstream water catchments to reduce downstream flood risk.

> *"Adaptation is the need to adapt forest resource to make it more resilient and to spread risk from impacts of climate change."(29)*

> *"Adaptation means making changes to be able to cope with some new external factors. Climate change adaptation means making changes so that you can survive in a different climate."(30)*

4.3.1.4. Summary

All thirty-one respondents have a good grasp of what adaptation entails, although none gave a definition that incorporated '*the moderation of harm and the exploitation of beneficial opportunities*' as stated by the IPCC (2007). Implementation staff defined adaptation using examples of silvicultural and management techniques, species choice and practical measures targeting the impacts they anticipate or have already observed. Policy staff incorporated the aspects of sustainable forestry - environment, society and economy - in their definitions of adaptation. In conclusion, the respondents' definitions relate with their work and what they do within the organisations. Implementation staff linked adaptation with the forests, and policy staff connected it with the policies.

4.3.2 Adaptation in practice

The second question posed to respondents was ***'Are you practicing adaptation to climate change?'*** This question sought to find out if the respondents carry out any adaptation strategies, plans or practices in their work in implementation or in policy.

4.3.2.1. England

Implementation staff

Four of the seven respondents stated that they are practicing adaptation to climate change. This was found to be true particularly for the public forest estate managers.

> *"Yes, we are practising adaptation by planting woodlands in areas that expect stresses. This was determined by mapping the least resilient areas with high soil erosion rates, high likelihood of flooding, large areas of fertile agricultural land, more water pollution and areas of deprivation."(06)*

The three implementation staff who deal with the private land owners said that they are talking to owners about adaptation but cannot force them to carry out certain practices. This is because grants are there to assist not to control.

> *"I can give advice on ranges of suitable species and management methods, but I cannot specify seed sources or provenances. Thus the focus is still on planting native seed."(04)*

> *"Owners are given advice but do not have to follow it. The grants scheme enables owners to do things on their land, for which we give them advice and money. Grants are only for public access, benefit and biodiversity, not for timber."(02)*

Policy staff

All seven policy staff believe that they are practising adaptation to climate change in their work, particularly through the policies they create.

> *"Yes, mostly anticipatory adaptation by looking at changing provenances, or expanding floodplain woodland, or increasing canopy cover in urban areas. Also autonomous adaptation by ensuring that good forest management is implemented, allowing woodlands to demonstrate their adaptive capacity, and implementing management to encourage regeneration." (11)*

> *"Yes, we are practising adaptation to climate change, but by default rather than planned, although now we are trying to put plans in place. We are moving towards continuous cover forestry and low-impact silvicultural systems and closer-to-nature systems." (10)*

4.3.2.2. Scotland

Implementation staff

Among the five implementation staff interviewed, all agreed that they are practising adaptation to climate change.

> *"Yes, we practise adaptation, though on a fairly trial basis. It is not adopted as standard practice yet. We are trying things out to see how they work for example, planting eucalyptus species in suitable areas or trying different ground preparation techniques."(15)*

> *"Yes, I like to think that that is the case. We are aware of the potential change and we are trying to be forward thinking in how we go about our business. As an organisation, we pick up on things that we have done incorrectly in the past and we look at it and we develop a policy, which we put in place, not just to address the problem, but because we recognise that there is something to improve. We are not an organisation that does something then leaves it and ignores it." (18)*

Policy staff

All of the policy staff said that they are practising adaptation in their work, particularly through their policies. However, one respondent said that it is still early in the process and there is some uncertainty in the practice.

> *"If we know what the climate will be with certainty, then we can do a lot more precise measures, but climate change is still characterised by a high level of probability and risks attached to it."(23)*

4.3.2.3. Wales

Implementation staff

The four implementation staff interviewed mentioned some difficulties in trying to achieve adaptation policy. They admit that they are at the very early stages of setting out what strategies they wish to undertake, and have only begun to carry it out in very modest ways. They feel they can make subtle changes in terms of species distribution, but not a significant shift to different species, due to the constraint of lead-in time.

> *"For example, we recognise the need for more thinning to enable Corsican Pine stands to survive endemic Red-band needle blight infestations. Also changes in species choice are necessary to improve species diversity, resilience and robustness of forest ecosystems but we have not started to plant mixtures of different species yet. There is a need to think carefully of what species or combination of species when planted will perform and will create more adaptable forests."(25)*

> *"One of the constraints we face is our commitment in terms of plant supply with the nurseries. Even if we had a clear understanding today of what species we wanted to change or replant, we cannot make dramatic changes to our plant requirements until the winter of 2013 or 2014, which is the first year when different species would come through the nursery system."(24)*

Policy staff
Adaptation in Wales is clearly set out by the policy staff, all four of whom agreed that they are undertaking it, guided by social, environmental and economic principles.

> *"Once you have assumed that climate change is going to happen, then how do you prepare for it? So, in a woodland context that might mean introducing varieties of species of different provenances (from warmer places), or moving away from monocultures and clear felling and more mixed species and age classes." (28)*

> *"There is a strong policy drive to meet wider environmental and social requirements by delivering more attractive forests that are managed in a more acceptable way to more people, with more environmental benefits. Therefore, strategies such as continuous cover forestry can improve species diversity, and the resilience and robustness of forest ecosystems."(29)*

4.3.2.4. Summary

Adaptation is practised within the three organisations in different ways. In England, implementation staff practise it through silvicultural and management techniques. However, unlike public forest estate managers, the staff representing private woodlands experience difficulties in practising adaptation as they cannot influence private owners' activities. Similarly, Wales implementation staff experience difficulties in putting adaptation policy into practise, due to the level of uncertainty. Implementation staff of Scotland are also practising adaptation in their work, although they feel it is '*on a trial basis*' with them still '*trying things out*'.

The policy staff in the three countries apply adaptation, while taking sustainability into consideration, through the policies and plans that they create and disseminate. In Scotland, the policy staff expressed their concern about their activities still being in the '*early days*' and that '*uncertainty is high*'. Overall, the practise of adaptation is marked by high levels of uncertainty in the three countries and for both implementation and policy staff.

4.3.3 Understanding of adaptive forest management

The third question posed to respondents was ***'Could you tell me what you understand by the term "adaptive forest management"?'*** This question sought to find out if the respondents are aware of or have heard about adaptive forest management and what it means to them in their work.

4.3.3.1. England, Scotland and Wales

Generally, majority of implementation and policy staff interviewed in England, Scotland and Wales, do not know of 'adaptive forest management' and have not heard of it specifically. Ten of the respondents have heard of the term but do not know what it means. One respondent was able to give a proper definition (12).

> *"It is looking forward and trying to work out what you want for the future. At the FC, it involves planning using systems such as the Ecological Site Classification, changing provenances over time in a planned structure or changing ground preparation types." (12)*

Other examples of definitions are given below.

> *"Does it mean changing forestry practices to ensure that it increases the amount of carbon uptake by forests? I don't know, not sure."(01)*

> *"Adaptive forest management is managing forests to become more adaptive, for example, by planting Eucalyptus instead of other species, or by not planting Beech in some areas and planting other provenances, or by seeking out the original provenance of the non-native species in the country to see if they come from warmer climates and can stand the change in climate."(03)*

> *"Adaptive forest management means implementing approaches to forest management that maximise the ability of woodlands to adapt to the changing climate, whatever direction it may go in, thus increasing the resilience of the woodland. It has not been practiced in the past, but increasingly it will be. There is over-reliance on too few species which need to be broadened." (11)*

> *"Does it mean to manage forests to reflect changes to the environment in terms of species or crop management?"(15)*

> *"To adapt forest management techniques to fulfil requirements of the here and now with a thought to the future." (18)*

> *"Adaptive forest management means changing our management techniques, which may take 30-40 years from start to finish."(21)*

> *"Adaptive forest management is about making sure that you manage forests in a way that they are able to adapt to climate change in the future. It is about taking precautions, I guess, so that you will have a forest left to manage."(30)*

4.3.3.2. Summary

Only one of the respondents provided an answer similar to the scientific meaning or definition of AFM, which is '*a dynamic approach to forest management in which the effects of treatments and decisions are continually monitored and used, along with research results, to modify management on a continuing basis to ensure that objectives are being met*' (Helms 1998). The majority of answers given focused on the term 'adaptive' and 'adaptation'. The staff gave what they thought to be definitions of AFM but on comparison with the answers given in Section 4.3.1 on the definition of

adaptation, there are similarities. Therefore, this shows that the staff are not able to differentiate between AFM and adaptation.

4.3.4 Adaptive forest management in practice

The fourth question posed to respondents was ***'Do you apply AFM in your work?'*** This question sought to find out if the respondents apply adaptive forest management in their work. This question was asked despite the wrong definitions that had been given of AFM in the previous question, because it would give an idea into what practices the respondents term as AFM.

4.3.4.1. England

Implementation staff
The seven respondents all agreed that they are applying AFM in their work, as a way of coping with the challenges of climate change.

> *"Yes, it is practised, at national and regional level. For example, we are looking at whether the grants scheme is targeting the creation and management of adaptive forestry, and whether woodland owners are practising it in their own way by adapting to different environments such as insect pests, diseases and drought" (02)*

> *"We are aware of techniques such as continuous cover forestry, natural regeneration and later selection, which are good for tackling climate change as younger trees may have a strong genetic ability to cope with the impacts. Evolutionary processes would take place with natural selection rather than replanting."(06)*

Policy staff
Four of the seven policy staff agreed that this applies in their work, mainly by enabling facilitation of it, but not through direct involvement. Three of the respondents said that it does not apply in their work as yet, but gradually, they expect that it will.

> *"We create climate change information packs but we have no strategy, course or pattern of new thinking as it is still relatively new science."(13)*

> *"Not at the moment, but the Climate Change Action Plan aims to achieve this. There are design plans for the forest process, which get reviewed every 5-10years and we must build climate change into these plans and how to react to it." (12)*

4.3.4.2. Scotland

Implementation staff
The five respondents all agreed that they apply AFM through carrying out best management practices, but they do not use the specific term 'AFM'.

"Yes, it is applied but not in those words. Foresters are dealing with crops that were planted under different understanding or expectations or assumptions than we currently have and now have to deal with that through different management."(15)

Policy staff
All four respondents said that they are not practising AFM yet, but that they hope to integrate it in their policies once there is greater research and understanding.

"No, but we are hoping to start practising it when able to give good advice on choice of species and changing management from clear felling to continuous cover forestry, or shortened rotations."(21)

4.3.4.3. Wales

Implementation staff
The four implementation staff all said that they do not apply AFM in their work.

"From a policy perspective, yes, adaptive forest management is in practice in Wales, but we practitioners just need to put all the necessary instruments in place behind it."(27)

Policy staff
The four policy respondents all agreed that they are formulating policy to promote this, although it is a fairly new initiative.

"Forest policy in Wales is trying to promote adaptive forest management." (30)

4.3.4.4. Summary

Approximately half (16) of the respondents are of the opinion that they are practising AFM in their work. However, their understanding of AFM is incorrect as it is similar to the adaptation strategies that have been outlined for forests. Some interesting reasons were given for the lack of application of 'adaptive forest management', but the quote below could summarise the general opinion within the Forestry Commission.

"Adaptive forest management requires a very good level of silvicultural understanding, and the reality is that a lot of forest managers are not silviculturalists. They are involved in a variety of activities such as logistics of forest operations, community interests, managing the land in terms of how it impacts on other people, dealing with stakeholders -legal and commercial rights, and conservation and recreation programs. We do not have an organisation that is full of silviculturalists who have got a very clear understanding of how to create more adaptive forests, therefore we need to build that capacity because we cannot just continue practising what we have done in the past."

"The forestry that we have practised in the 20th Century is not going to be right for the 21st Century. And if we are going to create genuinely adaptable forests, then we need to develop some silvicultural solutions to an uncertain future and that requires a high degree of insight into how different species might perform under different conditions in the future."(24)

4.3.5 Adapting to climate change within the Forestry Commission

The fifth question posed to respondents was ***'In your opinion, is the Forestry Commission adapting to climate change?'*** This question sought to investigate if the policy and implementation staff interviewed thought that the FCE, FCS and FCW are adapting to climate change in their work and activities

4.3.5.1. England

Implementation staff

Within the FCE, the general attitude is that the organisation is beginning to consider climate change and adaptation as important. One staff member stated that the organisation is putting new policies into action which will support the requirements for climatic change. Another respondent is of the opinion that there is a need for working groups and thought patterns to review the concept. Three of the respondents believe that new science and greater evidence is required before they stop doing some things and start doing other things.

"We are beginning to think about it very seriously which is right for long term issues like forestry." (05)

"We are asking ourselves questions like, should ancient and native woodlands remain the same or should we introduce new species? Should we leave clear felling and new planting to support continuous cover forestry and natural regeneration systems?" (07)

"Compared to Europe and the world, the Forestry Commission is ahead in thinking on global climate change although there are no firm conclusions yet, but nobody has firm conclusions yet (on climate change)."(02)

"Overall, the FCE is doing its best within its capacity to prepare for or implement adaptive policies, but there is always a limit with regards to what can be done in terms of resources, changing other agendas, and funding change. There should be integrity in recognising changes in forestry have a long time scale, though we have to act now to get it right." (03)

"Although this is process of climate change adaptation is not going to happen overnight, there has to be a process of change. The Forestry Commission is handling the change quite well. We are making ourselves ready."(01)

Policy staff

All seven policy staff stated that they are gradually putting new policies and plans into action which will support the requirements for climate change adaptation. Overall, they are of the opinion that the FCE is doing the preparatory work but that there is still a long way to go.

"Yes, it is now, but it hasn't been in the past. Our processes are increasingly taking on climate change adaptation as well. It is definitely a period of quite rapid development, which has occurred over the last year, with the main driver being the Climate Change Act and the establishment of the Committee on Climate Change and the Adaptation Sub-Committee." (11)

"There is preparatory work underway, but there is still a lot to be done. In order to understand why it is not implemented in the field, we must speak the same language as the practitioners in the field and show examples of how things work."(12)

4.3.5.2. Scotland

Implementation staff

In FCS, the overall opinion among the five respondents is that the organisation is adapting to climate change. There is an awareness of it, testing of various approaches and scenarios, they are seeing some changes but they realise that they do not have all the tools and answers to questions to be able to close the gaps.

"I anticipate a gradual shift in mainstream practices in some areas in 5-10 years in terms of different operational approaches and large scale changes of species, based on the knowledge base been built up now; though we are not significantly changing at this point in time."(15)

In time, once a clearer understanding of the likely impacts and expectations of climate change are known, the implementation staff are of the opinion that they will know what options are available to them and what works best.

"We are not ready yet, still more research work is required. New information is always available with each new climate change article. We must ensure that we are aware of all information which we will use to make best decisions based on the maximum amount of data interpreted correctly." (18)

Policy staff
The four policy staff are of the opinion that the organisation is adapting to climate change in their activities, and not just in policies and management plans.

> *"Yes, it has embraced the profound implications of climate change; it has understood what climate change means for forests and what forests could mean to Scotland in terms of adaptation. It is aware of these measures and is actively putting in place delivery mechanisms to see it happen. It has a lot to learn to tap potential and do more for Scotland."(21)*

4.3.5.3. Wales

Implementation staff
Overall, out of the four implementation staff interviewed, three are slightly critical with regards to their level of readiness in adapting to climate change. They are of the opinion that they are yet to define the solutions and build the capacity to make forests adaptable, but realise the need to make them more adaptable. However, one respondent believes that they are on the right track and making significant progress.

> *"It would be too much to claim that we are adapting the forests today. We recognise the need, we are not in denial about climate change, and we recognise that it is going to be a major driver for forestry in terms of what benefits forests can provide. Also in terms of not taking the survival of forests for granted and that we need to actually adapt our forests to enable them to thrive in the future."*
>
> *"So we are not in denial, we realise that it is a big task, and we are approaching it with some humility but also focusing some effort and directing some silvicultural expertise to address issues and identify solutions."(26)*

> *"We are thinking in the right way but not yet practising different types of forestry. We are on the way to making that step, but have not made it yet. We are on the case."(24)*

> *"Yes, completely; we are supporting the development of both new and existing woodlands, and also in urban tree environments' perspective."(27)*

Policy staff
Similarly, the four policy staff interviewed believe that although they recognise the need to adapt, they feel there is no program of change fully identified that they are delivering. One respondent is of the opinion that policy is progressing well but the lag is in implementation.

> *"The FC has an influencing role to help other woodland owners and the woodlands it manages itself to adapt. But forestry is a long-term process, and it will not happen overnight. (30)*

"The fundamental building blocks in place recognise the need to adapt, for example the organisational capacity in place and the strategy document. But there's a long way to go especially in changing forest management practice. We are on the way to making that step, but have not made it yet." (29)

"The FC is in a good place to offer society help in adapting to climate change. We are doing lots of things to adapt to climate change, but I think there are still a lot of people who don't quite get it, who don't really get it yet. It is doing quite well, but it could do better. It is doing well at a policy level, but implementing it is another matter. Implementation takes quite a long time to catch up with the policy." (28)

4.3.5.4. Summary

Overall, the respondents in England and Scotland are of the opinion that the FC is adapting to climate change, although there is still a long way to go. They state that despite it being relatively recent, they are taking the necessary approaches. The staff in Wales are however more critical of their pace of adaptation to climate change, although they also recognise that they are taking action.

Some staff also mentioned the general adaptation practices that were taking place in the FC office environment and in the UK government such as promoting the use of wood fuel as an alternative energy source, recycling, and reduced travel by private means and more by public transport.

4.3.6. Discussion

The respondents have a knowledgeable understanding of what adaptation entails, although none gave a definition that incorporated '*the moderation of harm and the exploitation of beneficial opportunities*' as stated by the IPCC (Intergovernmental Panel on Climate Change 2001; Intergovernmental Panel on Climate Change 2007). However, the practise of adaptation is marked by high levels of uncertainty and challenges in carrying it out in the three countries, for both implementation and policy staff. Therefore, due to this uncertainty, the practise is not fully implemented. Hence, it can be argued that the respondents' opinions are a reflection of the level of awareness and understanding of adaptation within the FC. A similar observation is made in the discussion in Section 4.2.6 on climate change.

With regards to AFM, the respondents are not aware of it, and tend to confuse it with general adaptation strategies. Furthermore, they do not apply it in their work; what they practise is actually adaptation strategies and not AFM in its true sense. The reason for this could be explained in the quote below as stated by one respondent.

"Adaptive forest management requires a very good level of silvicultural understanding, and the reality is that a lot of forest managers are not silviculturalists. They are involved in a variety of activities such as logistics of forest operations, community interests, managing the land in terms of how it impacts on other people, dealing with stakeholders -legal and commercial rights, and conservation and recreation programs. We do not have an organisation that is full of silviculturalists who have got a very clear understanding of how to create more adaptive forests, therefore we need to build that capacity because we cannot just continue practising what we have done in the past."

"The forestry that we have practised in the 20th Century is not going to be right for the 21st Century. And if we are going to create genuinely adaptable forests, then we need to develop some silvicultural solutions to an uncertain future and that requires a high degree of insight into how different species might perform under different conditions in the future."(24)

Adaptive Management (AM) has been in practice in different fields over time, although it is relatively new thinking in forestry as AFM. Due to the long timescale of forest management and climate change, AFM would require many years to be conducted and its effects observed (Lindner 1998). Despite this, it is noted to be beneficial in adapting forests and it should be promoted. It can therefore be concluded that there is need for more awareness on the benefits of AFM within the FC. More research would also be required to find out its applicability on the national or public forest estate.

The opinion of the respondents on adaptation within the FC is varied. Overall, the respondents in England and Wales believe that they '*are on the right track*' and are '*making progress'* with regards to their policies and practices on adaptation. However, they state that '*there is still a long way to go'* and mention the need for more research and greater evidence before they can adapt their practices fully. On the other hand, FC Scotland has made substantial progress because it has created a 'Climate Change Action Plan', and this reflects in the responses given by policy respondents from Scotland that they have '*fully embraced adaptation'*. In contrast, the implementation staff of Scotland hold a different view to this, which is similar to the opinions of respondents in England and Wales. This, therefore, could serve as evidence of the perception that policy progresses faster than implementation, a notion which mentioned and discussed in Section 4.4.3 below on the policy process within the FC.

4.4. The policy process within the Forestry Commission

The fourth research objective sought to identify the policy process within the Forestry Commission and the main drivers and influences of forest policies and forest operations, as perceived by key individuals in the Forestry Commissions of England, Scotland and Wales. This Section presents the responses to four questions posed in the interviews under the theme of policy process. The questions were directed at both the implementation staff and the policy staff in each of the three devolved countries. The quotes by respondents are presented in verbatim in the text boxes to highlight and place emphasis on specific attitudes of interest.

4.4.1. Drivers and influences on forest policies and operations

The first question posed to respondents was ***'What are the main drivers and influences on forest policies or forest operations at the moment?'*** This question aimed at identifying the motivating factors that determine their actions, whether in policy making or in implementation of operations.

4.4.1.1. England

Implementation staff

The main influences mentioned by the seven implementation respondents are national policies and FC documents such as:

- the ETWF strategy document and delivery plan,
- the Corporate plan,
- the England Woodlands Grant Scheme,
- the Woodfuel strategy for England,
- Keepers of time: the Ancient woodlands policy,
- Fiscal policy,
- Health and Safety policy,
- FC Best Practice Guides, e.g. Forests and Water, Forests and Landscape,
- Operational Guidance Booklets,
- UK Forestry Standard,
- Local authority documentation such as the GLA policies,
- National/EU policies such as the Restoration of SSSIs and the Water Framework Directive.

> *"There is a Regional forestry framework for every region which creates the agenda of what to do and how to do it. The privately owned woodlands managed by the regional directors are guided by a framework, the England Woodlands' Grant Scheme which has different facets such as the Woodland Improvement Grant, which influence activity."(03)*

The staff state that there is a balance between rigidity and flexibility in implementation of activities.

> *"There is also some flexibility in targets despite external EU funding. There are however, restrictions on paying grants to landowners, undertaking formal contracts, and time frames. Overall, there are more rules than flexibility."(02)*

> *"Delivering government policy through the ETWF is a national bottom up process. Often, implementation teams work with partners to deliver against their agendas."(06)*

Policy staff

Among the seven policy staff interviewed, the main drivers are:

- the Climate Change Act,
- the Low Carbon Transition Plan,
- DEFRA's adaptation programme,
- the ETWF strategy document and delivery plan,
- Renewable energy plans such as wind energy on the public forest estate and wood fuel energy,

- Plantations and Ancient Woodlands Sites (PAWS) plans.

> *"The DEFRA agenda drives policy, which in turn initiates actions in the form of projects and programs."(13)*

4.4.1.2. Scotland

Implementation staff

The five implementation staff interviewed mentioned the following as the main influences and drivers of their activities:

- Habitat management for conservation of wildlife and species diversity,
- Delivery of programs such as creating new woodlands and managing existing woodlands,
- Landscape and the biological and social environment,
- Economic issues,
- the Strategy document,
- the UK Forestry Standard,
- National/EU policies such as the Water Framework Directive,
- Operational Guidance Booklets,
- FC Best Practice Guides,
- Providing ecosystem services such as water quality and sustainable flood management,
- Integrating landscape visual impacts, open associated habitats, riparian zones and archaeology guidelines in the Forest Design Plans.

> *"Production was the most significant driver in the past, the rate of return in terms of volume of timber per hectare was an important aspect. When carrying out new planting, it was important to maximise the delivery of conifers (Spruce) across the whole site. We did not take other issues such as watercourse management into consideration as carefully as now."(19)*

> *"When managing and planning the work in the district, I take a balanced approach but some issues take more preference than others depending on the part of the forest or district. Now, I am far more aware of the impact of forest management on associated habitats such as bogs, marshes, and riparian zones."(17)*

Policy staff

The four policy staff interviewed cited the following main drivers:

- Sustainable forest management and the non-market benefits of economic, environmental and social outcomes,
- Climate change mitigation and adaptation,
- Formalising devolution and developing policy capability,
- Integrated land use and policy development with partners,
- Delivery of public benefits,
- the Scottish Government Climate Change Act and associated Delivery plan,
- the Climate Change Action Plan.

"We provide policy direction for FCS to meet ministers' priorities and connect with other parts of Scottish Government policy portfolio and translate this into programmes to be implemented through key delivery mechanisms, through grants and regulations, through the public and state forest service, and by developing projects and partnerships."(20)

4.4.1.3. Wales

Implementation staff

Among the four implementation staff interviewed, the main drivers are:

- the Strategy document and other Welsh Assembly Government strategies and policies,
- the Corporate plan,
- Operational Guidance Booklets,
- Plantations and Ancient Woodland Sites (PAWS),
- National/EU policies such as the Water Framework Directive,
- Land use,
- Climate change mitigation and adaptation.

"Pre-devolution, we were more Forestry Commission GB-centric, with less sophisticated corporate outcomes, less emphasis on the social outcomes of forestry, and a focus on growing and harvesting trees; this has changed."(26)

"Forest Design Plans must encompass the wider landscape to ensure that they are fit for purpose; as well as maximise continuous cover forestry and species diversity to ensure they are fit for the future." (25)

Policy staff

The main influences among the four policy staff include:

- the Corporate plan,
- Devolution,
- Legislation,
- Woodlands resource: currently existing and yet to be established woods,
- Promoting social and economic benefits,
- Integration and competitiveness with the wider forestry sector,
- Environmental quality and contribution to wider environment,
- Climate change,
- Better Woodlands for Wales grants scheme,
- Programme development - FCW taking forward policies to corporate activities.

"The Corporate plan captures and sets out the work programs for the next 1 or 2 years, and beyond that into the imminent future. It is a series of levels of policy development and policy positions which outline clearly the FCW position, through to a set of programs to be followed to achieve these."(29)

4.4.1.4. Summary

Overall, all the staff interviewed are influenced and driven by the objectives of the Strategy documents, the Corporate and Delivery plans, and the UK Forestry Standard. In addition, the implementation staff rely mainly on the Operational Guidance Booklets, the Best Practice Guides and the Grants Scheme regulations.

On the other hand, the policy staff tend to be influenced in a thematic manner, listing their drivers as issues such as climate change, adaptation, biodiversity, sustainable forest management, renewable energy, and meeting social and economic benefits.

4.4.2. The influence of the climate change agenda on forest policies and forest operations

The second question posed to respondents was ***'How has the climate change agenda influenced forest policies and forest operations and what are the specific outcomes of this?'*** This question aimed at determining when the climate change agenda gained prominence in their work and how it has influenced the activities of the policy and implementation staff in the three devolved countries.

4.4.2.1. England

Implementation staff

According to the seven implementation staff, the climate change agenda has gained prominence in the last 3-5 years. The Regional forestry frameworks incorporated climate change 5 years ago, while the revised ETWF integrated aspects of climate change in 2007.

> *"It is now fixed, well understood, and well received, with a general understanding of climate change terms such as mitigation and adaptation, the role of woodlands, the broader international agenda, adaptation in cities and rural resilience, among others."(01)*

> *"Climate change has been well received within the Commission with initiatives such as the Business Sustainability Programme (Greenerways) trying to minimise carbon footprints, waste and miles, in all areas in addition to forestry activities."(07)*

Policy staff

The seven policy respondents in England stated that the climate change agenda began to play a role in policy and decision making during the last 4-5 years.

> *"Sustainable development was the focus for 15 years, but it is now enshrined within climate change and living within sustainable limits."(14)*

> *"At the policy and strategic levels, the senior managers are on board. Climate change is accepted, leading to multiple outputs and targeted interventions from silviculture and tree harvesting, to broader multi-purpose delivery."(08)*

4.4.2.2. Scotland

Implementation staff

According to the five implementation staff interviewed in Scotland, the climate change agenda was embedded in forest policy in 2006. However, they noted that there has been a general awareness of it over a long period of time.

> *"The climate change agenda is an important aspect. We have been aware of it over the last 10 years, and recognised it as something we could play a part in. 15-20 years ago, the Rio Convention of 1992 was a key moment in setting the trend. So the early 90s were marked with careful planning and management of forests. We are now restocking with faster growing conifer species to lock up carbon as carbon sinks."(17)*

> *"Climate change is a dominant influence in two ways: its impact on forests and how to adapt our forests to climate change; and how to manage forests to maximise benefit and maintain functions such as minimise flooding, temperature control in urban areas, soil, water, pests and diseases."(19)*

> *"There is a sense of nervousness that we are not doing everything that is expected of us. 100% of my staff in the district are aware of climate change, 70-75% of them actually want to do something about it because they recognise that it is something that we can help to address."(18)*

> *"It is all about common sense and best practices. We try to carry out best practices, but there is not very much we would do that, in terms of delivery in the field, we need to change dramatically to deal with climate change. (15)*

Policy staff

According to the policy staff interviewed, climate change has gained prominence in their agenda in the last 5-7years. In the last 3 years, it has become a key programme of specific focus for policy making. The Strategy document mentioned climate change as an overarching theme in 2006, which was the first time on the agenda. The result of this was the Climate Change Action Plan in February 2009 and the FE strategic plan, among other documents.

> *"From 2005 onwards is when people began to pay attention to climate change and what it meant for forestry and what forestry meant to Scotland."(21)*

> *"Everyone is in unfamiliar territory with regards to climate change adaptation and mitigation."(22)*

> *"The tentacles of climate change extend so wide and so far, that it has broadened people we are talking to. It has connected forestry with non-traditional areas, for example the role of trees and woodlands in urban climate control, or soils. It is too early to judge yet how effective it is. There is a lot of work involved which is a positive sign."(23)*

"We need sensible advice for something that is still very uncertain, without making an immediate reaction. We are proceeding in a fairly sensible and measured approach, changing our policy and advising when evidence builds. We are not hiding behind 'well, we haven't got the evidence therefore we are not going to give any policy direction' because that would not be good enough in the field."(20)

4.4.2.3. Wales

Implementation staff

In Wales, the four implementation staff considered the climate change agenda to be relatively new in their work. It has gained prominence between the last 3-5years, with the impacts being noticed earlier.

"The climate change agenda, in the life of a tree, is relatively recent, but we have been aware of the impact, over the last 5-7 years. In the last 3-5 years, it has become one of the most dominant drivers feeding into policy."(26)

"We are now focused on detail and a variety of species mixtures, as well as restoring ancient woodland sites." (25)

"One of the outcomes is a wood energy business scheme which promotes wood as a substitution for fossil fuels. Another outcome is the promotion of silvicultural systems such as low-impact silvicultural systems (LISS) and continuous cover forestry."(27)

Policy staff

Similarly, the four policy staff stated that climate change became important over the last 2-3 years. According to them, it was barely mentioned in the previous strategy and it has steadily come up the agenda.

"One only has to compare the strategy documents of 2004 and 2009 to realise the influence of climate change. The new format of the strategy is more climate change focused with themes such as adapting woodlands to climate change."(29)

"We need a sound evidence knowledge base from which to make recommendations and offer advice and contribute to the discussion. We need to pick up insight into how people are thinking in order to offer appropriate solutions; through monitoring and measuring performance."(30)

"Strategies are currently changing but this is taking place slowly. One of the outcomes of climate change is that it has placed forestry as a public policy solution on other stakeholders' agendas. Climate change has been a catalyst to get forestry on the radar of wider public policy outcomes. The Forestry Commission benefits from this increased profile and enhanced presence."(28)

4.4.2.4. Summary

Climate change appears to have gained prominence in the forestry agendas of the three countries at the same time. The respondents say that this was approximately 3-5 years ago, although sustainable development has always been on the agenda for 15-20 years. It has had an influence on their policy

making and implementation activities and the most prominent outcome of this is the inclusion of climate change in the Strategy documents for each of the three countries.

4.4.3. The policy process of the Forestry Commission

The third question posed to respondents was ***'How would you describe the policy process within the Forestry Commission?'*** This question aimed at seeking the views of the policy and implementation staff on the policy process within the FC in the three devolved countries. The purpose was to understand if they are satisfied with it in terms of efficiency and effectiveness.

4.4.3.1. England

Implementation staff

When asked about the policy process, the seven implementation staff described it with words such as *'sufficient', 'a good process', 'I am happy with it and would not make any changes', 'balanced and holistic'.*

> *"On a scale of 1-10 in terms of efficiency and effectiveness, I would give it a 7."(03)*

> *"It is a relevant but rigorous process, which is always changing and I try to keep up-to-date with it, but it is difficult to keep up with."(06)*

One respondent stated that it is a good process although it is marked by some bureaucracy.

> *"There is a need for clearer policy as the strategic objectives are not in harmony. We are getting there but there are still overlaps within the different publications on timing and responsibilities." (02)*

Policy staff

On the contrary, the seven policy staff interviewed were of the opinion that there is a divergence of policy to practice across the forest estate, with one respondent suggesting that there may be a need for more intermediary roles to join it up.

> *"The policy process is differentiated into two distinct levels. At the high profile level, there is close working with DEFRA and DECC, with keen interest from the ministers. At the operational level, internal FC decisions are made with guidance from FR."(09)*

> *"The people (practitioners) should feel a sense of ownership of what is being said to them. All people say is 'give us nice simple ways of dealing with the subject please'. At the end of the day, we are only as good as the people and the motivation of our staff."(12)*

"The policy process works poorly. Practitioners have their heads down trying to do their job in the field. FR seems to have lost its relevance (in the field) increasingly over the years because the contacts become less and less, despite creating a PAG (Programme Advisory Group) way of commissioning work. There is still a limited number of people talking, and the practitioners, or people on the ground are not actually involved in that process. It is still very much top-down driven policy, rather than a cross-feeding of information. So whilst we have a programme group of experts working on subjects, people in the field will say 'what do they do other than give us policies that are improperly tested with us?'"(10)

"It is a communication issue, not an intellectual issue or an issue of rights and wrongs. It is a question of finding the right ways to communicate it into practice; and not by producing strategy documents, but learning through experience and hands-on from those in the field. An important question to ask is, 'how do foresters learn and how do they therefore take on new concepts'? What makes them pick up information and what makes them move it forward?"(14)

4.4.3.2. Scotland

Implementation staff

Overall, the implementation staff considers the policy process to be a *'broadly effective process'*. They are fully engaged and involved in the process.

"It (policy making) is done at a national level - GB or Scotland level- motivated by a number of things such as political drivers - obviously politicians direct policy-, evolving science and research. It will flag up various actions and changes that are potentially desirable, for example, identification of renewables is informed by science and political will. Then policy is developed to try to deliver and articulate that and during that process, there is dialogue about implementation and effective measures to make the policy work, which may be through legislation, enforcement, and incentivisation -fiscal or otherwise. So the policy evolves through that sort of process and will ultimately end up in a scenario where we believe we have an effective policy."(15)

"Normally, when the policy is in a fairly early stage, the headline issues and mechanisms are explored internally to discuss problems that may arise with introducing a policy of a certain type, how it might best be done, what issues should be considered, in order to develop a framework or idea of where it is going. After this basic idea, we seek focused input from key stakeholders over a period of time, we seek their views. Then, the policy evolves progressively over a period of time into a fairly articulate idea of where it is going, and through broader consultation with public and wider stakeholders."(17)

"Overall, the policy creation process is good, people recognise the team and the consultation process they undertake is relatively good. The problem on the delivery side is due to lack of resources, continually loosing resources, and as more new initiatives come out, then the problem arises of how to deliver them. Policy is ahead and delivery needs to catch up."(19)

Policy staff

The four respondents in Scotland describe the policy process as *'time-consuming'*, and *'requiring a lot of effort'*, which is necessary in order to make it work. They also feel it could be more efficient.

"It is working well, but will work a lot better when we have rather more firm conclusions drawn from good evidence, then we can go out to people and say, 'these are the things you really ought to be doing', as opposed to 'it looks like these are the things that you might like to consider.' It's got a way to go yet, but it's inevitable in this early stage of really new science that it's taking time and things are not yet clear to people in the field. And that's because things are not yet clear in the policy field, it is not clear which direction to go in. In reality, we will need a spectrum of approaches to avoid putting all our eggs in one basket when we are dealing with uncertainty."(21)

"Forest policies are well intent and driven for the right reasons by scientific evidence and political will to improve or make something better. It is easy to make policy, the difficult bit is making sure that it happens and that the policy delivers what you want. It is easy to make 10 policies today, but where are those policies in 5years time? How effective have they been? Are there enough resources? The implementation is more challenging."(20)

4.4.3.3. Wales

Implementation staff

The four implementation staff describe the policy process as *'a fairly inclusive process'*. They play a role in delivery and also influence the content during policy development.

"It works well, although it could improve with smaller lines of communication." (26)

"There is a healthy culture between policy and activities, which is quite efficient and effective."(24)

Policy staff

The four policy respondents are of the opinion that the policy process is *'getting there but not yet complete'*.

"It is a messy and non-linear process. The machinery is all there, but it takes a lot of effort for it to all work. It does not just happen; you have to have people dedicated to it."(29)

"It is a developing process and once we get everything in place, it should be reasonably efficient. We only started 2-3 years ago and we are still developing our policies and policy positions."(31)

"It is still early days. The policy team was created 3 years ago, the strategy was re-developed, and programs developed under the strategy. We have not yet seen the impact of the programs or the change on the ground, therefore, there is no evidence of the benefit and that cycle is yet to be completed. A monitoring framework is necessary to achieve this, using indicators for success."(30)

"It is quite easy to write a new policy on something, it's a document and you go through a process of consultation and gathering of opinion and then you write it. And often people stop there with the new policy. But I think what is harder is to develop the implementation programs, which are also quite easy to write as they are documents again and you can take advice and write action plans which contain all sorts of ambitious things. But unless you have the budget to do it, and the people and the skills, and the will, then nothing will actually happen, unless you actually deliver funded programs. For example, changing species is fairly easy to write down in a document, but the implications on the ground are that we would probably reduce our income due to a loss of productivity or volume harvested. Therefore, because of our budget, we do not have the money to do some of the things we would want to do. People might argue that we cannot afford to implement our own program, these are nice programmes, but we need the money. Therefore, implementing some of these things is far harder than writing the document."(28)

4.4.3.4. Summary

In England and Scotland, implementation staff were of the opinion that policy tends to move at a faster pace than actions or delivery. The policy staff in Scotland feel they could improve it through a collaborative and learning relationship with the implementation staff. In Wales, there are Internal Policy Implementation groups, where policy and delivery teams discuss and debate proposals to agree on the way forward and embed policy in practice and delivery.

It is interesting to note that the policy staff in each of the three countries are critical of the policy process. This contrasts sharply with the implementation staff who felt that it is fairly effective and efficient and that they are engaged and involved in it.

4.4.4. Feedback and consultation in the policy process of the Forestry Commission

The fourth question posed to respondents was ***'Are there opportunities for consultation and feedback in the policy process of the Forestry Commission?'*** The purpose of this question was to determine if the respondents are able to consult or to give feedback during the policy process. It also sought to identify the channels and modes of communication for feedback and consultation which are important in the policy process.

4.4.4.1. England

Implementation and Policy staff
All implementation and policy staff interviewed stated that they are regularly consulted and have opportunities to give feedback.

"All regional directors are part of a Business Coordination group, which gives us the opportunity to comment on new policies before they are actually made into productive action. I am very comfortable with that."(02)

"I was fully consulted and fully immersed in the development of the ETWF. It is a reasonable document, I am quite happy with it and I understand it."(05)

"Consultation for high level policies takes place within the executive board with the Chief Executive of FEE. For major policy developments, then widespread internal and external consultation is held. It gives the wider views of the forestry sector in England and is able to influence policy in certain areas. I am able to comment where necessary."(09)

4.4.4.2. Scotland

Implementation and Policy staff

All implementation and policy staff interviewed stated that they are regularly consulted and have opportunities to give feedback.

"There is consultation on effective mechanisms, to explore broader issues associated with implementation of the policy in a given area. It ends up in articulation of the policy usually, and communication and information associated with the policy."(15)

"Consultation involves some internal input and also, if it is a significant policy, a period of broader stakeholder engagement and public consultation which would be facilitated by the Forestry Commission, to assist in engaging with stakeholders and the wider public to seek their views and feeding reviews back."(20)

"In the last 5-6 years, a new major policy initiative through the policy team uses consultation and feedback via workshops or focus groups, to enable people to comment."(23)

4.4.4.3. Wales

Implementation and Policy staff

All implementation and policy staff interviewed stated that they are regularly consulted and have opportunities to give feedback.

"Policy team distribute information and seek comments, and throughout the process, there is an opportunity for people to provide feedback and influence that. A range of stakeholders, both internal and external are involved."(28)

"The Woodlands Strategy Advisory Panel advises FCW on the development and delivery of the Strategy document, through its various representatives."(25)

"The grant application process has mandatory consultees who feed into the formal process. At a higher level, the Better Woodlands for Wales' stakeholder group gather information and feedback on the overall performance of the grants scheme and particular issues. At the highest level, the grants scheme forms part of the Welsh Rural Development plan, which undergoes an evaluation at the end and development of new plans at the beginning."(27)

"Feedback opportunities are there, but very few people do, which might be partly because they do not know how to. It is also time consuming, not feasible in all situations."(31)

4.4.4.4. Summary

Consultation and feedback are well-practised in the FC as stated by the respondents. The methods of consultation and feedback vary to include face-to-face or telephone meetings, internal and external seminars or events, local, national and regional meetings, fora, peer group meetings, monthly meetings of policy leads and regional directors/FMs, public consultation, use of the internet, and through the formation of strategy advisory groups.

4.4.5. Discussion

The main drivers of forest operations are the policy documents which provide clear guidance to the staff on what they need to do to achieve set goals and targets. However, the implementation staff, particularly in England, mention the challenge of striking a balance between the elements of flexibility and rigidity presented in these documents. This could mean that they have some room to be innovative and make their own decisions, while at the same time observing the guidelines.

On the other hand, the policy staff are influenced by thematic issues and international policies, such as climate change, sustainable forest management and renewable energy. The detailed manner in which they outline these could be representative of their understanding and acceptance of these motivating factors. This is particularly true of Scotland and Wales. Policy making is multi-disciplinary and broad in nature (Swart et al. 2009), and the focus by policy makers on thematic issues could be due to the fact that in making forest policies, they must address these various themes.

For the last 15-20 years, the sustainable development agenda has influenced forest policies and operations. The climate change agenda has come into focus in the last 3-5 years, although there has been a general awareness of it over a long period of time. The outcome of this is that climate change has become embedded in the forest policies of the three devolved countries, particularly the strategy documents. This can be attributed to the release of the Third Assessment Report by the IPCC in 2001 showing scientific consensus on the subject of global warming, and the subsequent UK and FC reports (Broadmeadow et al. 2005). Generally, the climate change agenda has been well received and has resulted in enhanced awareness of its impacts, and an understanding of mitigation and adaptation. Overall, it can be concluded that the climate change agenda is adequately addressed across the three countries, and as noted in Section 4.4.1, it is not the only factor influencing forest policies and operations, but there are others.

When asked to describe the policy process, the respondents gave varied responses. The implementation staff described it as:

- *'sufficient'*
- *'a broadly effective process'*
- *'a fairly inclusive process'*

In contradiction, the policy staff were more critical of the process:

- '*The policy process works poorly…it is still very much top-down driven policy, rather than a cross-feeding of information,'*
- *'It is easy to make policy, the difficult bit is making sure that it happens and that the policy delivers what you want'*

- *'It is a messy and non-linear process'*

These responses are of interest because it would be expected for the policy staff to have more affirmative opinions of the policy process, yet in this instance, they do not. One possible reason for this could be that the policy staff are well aware of the intricacies of the process and thus are able to comment on it fully. Whereas, it is likely that the implementation staff are not fully involved in the policy making and thus are not aware of its complexity.

Also of interest is the consensus between the policy and implementation staff that policy tends to move at a rate faster than implementation on the ground. As more new initiatives are started, problems arise of how to deliver them. One possible solution for this is for the policy makers to find the most efficient and effective ways of communicating policy to implementation staff, and allowing some time for a policy to be implemented before initiating another.

It was observed by both policy and implementation staff that there are ample opportunities for feedback and consultation in the policy process. These channels could be adequately utilised to solve the issues discussed above, for example the differing opinions on the policy process and the mismatch between policy making and implementation on the ground.

5. Conclusions and Recommendations

"The voyage of discovery is not in seeking new landscapes but in having new eyes." Marcel Proust

This Chapter presents the main conclusions of the research based on the research objectives and questions. It also presents recommendations following from the conclusions.

5.1. A factual understanding of anticipated climatic change and its likely impacts on forests

Objective 1: To identify how anticipated climatic change and its likely impacts on forests is perceived in Great Britain's policy and legislation documents and the Forestry Commission's research documents (a factual understanding)

From objective one, it can be concluded that there is a clear factual understanding within the FC of anticipated climatic change and likely impacts on forests:

- The UKCIP02 and the UKCP09 are the projections of climate change that have been developed for the UK
- Temperature in the UK is projected to become warmer by the 2080s, with annual temperature expected to rise by between 2ºC for the Low Emissions scenario and by 3.5ºC for the High Emissions scenario.
- Precipitation changes will be greatest for the High Emissions scenario and in the south east of the UK, where summer precipitation may decrease by 50% or more by the 2080s and winter precipitation may increase by up to 30%. Overall, the UK should expect drier summers and wetter winters all over the country.
- Forests may experience increased productivity as a result of rising CO_2 levels.
- The rise in temperature will result in longer growing seasons in some areas, and species competition in others.
- Precipitation will influence forest productivity in areas where productivity is water-limited, and also influence species composition.
- A change in the ranges of species distributions and competition between species is expected due to climate change.
- Abiotic disturbances caused by fires, wind, flooding and drought are predicted to increase in frequency and severity due to climate change, thus influencing the character and composition of GB forests

5.2. Perceptions of anticipated climatic change and its likely impacts on forests

Objective 2: To investigate how anticipated climatic change and its likely impacts on forests is perceived by key individuals in the Forestry Commissions of England, Scotland and Wales (an understanding of perceptions and attitudes)

Objective two reveals that the respondents seem to have a clear understanding of climate change. Furthermore, majority of the respondents are of the opinion that climate change is occurring, and the main reason they give is that 'there is significant evidence of it.' The respondents also believe that climate will change to a degree that will significantly impact on forests in GB. The impacts that they are experiencing correspond with the impacts mentioned in literature. The main sources of information that they use to base their perceptions on is key FC documents and FR publications, particularly the strategy documents, the UK Forestry Standard and the FC's interpretation of the UKCIP02. In conclusion, the respondents perceive climate change and impacts to be occurring in GB and influencing the forests. There was no major difference in perceptions between the three countries and between the policy and implementation staff.

5.3. Perceptions of adaptation strategies in response to climate change

Objective 3: To identify forest management adaptation strategies in response to climate change, as perceived by key individuals in the Forestry Commissions of England, Scotland and Wales

The respondents have a knowledgeable understanding of what adaptation entails, although none gave a definition that incorporated '*the moderation of harm and the exploitation of beneficial opportunities*' as stated by the IPCC. However, the practise of adaptation is marked by high levels of uncertainty and challenges in carrying it out in the three countries, for both implementation and policy staff. Therefore, due to this uncertainty, the practise is not fully implemented.

With regards to AFM, majority of respondents are not aware of it, and tend to confuse it with general adaptation strategies. Furthermore, they do not apply it in their work; what they practise is actually adaptation strategies and not AFM in its true sense. This applies for all three countries and between the policy and implementation staff.

The opinion of the respondents on adaptation within the FC is varied. Overall, the respondents in England and Wales believe that they '*are on the right track*' and are '*making progress'* with regards to their policies and practices on adaptation. However, they state that '*there is still a long way to go'* and mention the need for more research and greater evidence before they can adapt their practices fully. On the other hand, FC Scotland had different responses given by the policy respondents who stated that they have '*fully embraced adaptation'*. In contrast, the implementation staff of Scotland hold a different view to this, which is similar to the opinions of respondents in England and Wales.

5.4. The policy process

Objective 4: To identify the policy process and the main drivers and influences of forest policies and operations, as perceived by key individuals in the Forestry Commissions of England, Scotland and Wales

The main drivers of forest operations are the policy documents which provide clear guidance to the staff on what they need to do to achieve set goals and targets. However, the implementation staff, particularly in England, mention the challenge of striking a balance between the elements of flexibility and rigidity presented in these documents. On the other hand, the policy staff are influenced by thematic issues and international policies, such as climate change, sustainable forest management and renewable energy.

For the last 15-20 years, the sustainable development agenda has influenced forest policies and operations. The climate change agenda has come into focus in the last 3-5 years, although there has been a general awareness of it over a long period of time. The outcome of this is that climate change has become embedded in the forest policies of the three devolved countries, particularly the strategy documents. Generally, the climate change agenda has been well received and has resulted in enhanced awareness of its impacts, and an understanding of mitigation and adaptation. Overall, it can be concluded that the climate change agenda is adequately addressed across the three countries, and it is not the only factor influencing forest policies and operations.

When asked to describe the policy process, the respondents gave varied responses. The implementation staff described it as *'a broadly effective process'* and in contradiction, the policy staff were more critical of the process, stating *'it is a messy and non-linear process'*. These responses are of interest because it would be expected for the policy staff to have more affirmative opinions of the policy process, yet in this instance, they do not. One possible reason for this could be that the policy staff are well aware of the intricacies of the process and thus are able to comment on it fully. Whereas, it is likely that the implementation staff are not fully involved in the policy making and thus are not aware of its complexity.

Also of interest is the consensus between the policy and implementation staff that policy tends to move at a rate faster than implementation on the ground. One possible solution for this is for the policy makers to find the most efficient and effective ways of communicating policy to implementation staff, and allowing some time for a policy to be implemented before initiating another. It was observed by both policy and implementation staff that there are ample opportunities for feedback and consultation in the policy process. These channels could be adequately utilised to solve the issues discussed above, for example the differing opinions on the policy process and the mismatch between policy making and implementation on the ground.

5.5. Recommendations

- This research found that there are no major differences in perceptions between the three countries and between the policy and implementation staff. However, these opinions are only based on the 31 interviews conducted and the responses given. Further research might give a wider range of opinions, findings or conclusions if more respondents are contacted, across the hierarchy of the organisations.
- It would be beneficial to inform forest managers and policy makers on the difference between adaptation strategies and AFM, with particular relevance to tackling climate change impacts.
- FC research should incorporate UKCP09 projections to allow for more probability in expectations.
- There is a need to disseminate information and create more awareness of scientific evidence of climate change and adaptation strategies. There is significant evidence available and it would serve to reduce the uncertainty experienced, particularly among implementation staff.
- It is important to identify suitable ways of evolving policy into practice, using efficient and effective ways of communication within the three countries. The channels of feedback and communication within the FC organisations could be adequately utilised to solve the issues such as the differing opinions on the policy process and the mismatch between policy making and implementation on the ground.

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Appendices

Appendix 1: Questionnaire for the Implementation/Operational Staff

KEY QUESTIONS – IMPLEMENTATION/OPERATIONAL STAFF

GENERAL INFORMATION

1) Name

2) Location (Country, District, Region, Conservancy)

3) What is your current position and role in the organisation?

4) How long have you held this position?

5) How long have you worked at the Forestry Commission?

6) How do you implement activities/operations in the FC? How do new ideas become actual activities/operations?

7) What are the main drivers and influences on forest activities/forest operations at the moment?

8) How has this changed in the time you have been in forestry?

9) How has the climate change agenda influenced forest activities/forest operations? And since when? Are there any specific outcomes/results of this?

CLIMATE CHANGE

10) What is your definition of climate change?

11) Do you think climate change is occurring? Why?

12) Do you think climate will change to a degree that will significantly impact on forests in Great Britain? Why?

13) What sources of information are influencing your perceptions?

14) What strategies/plans and practices, if any, are you putting in place to manage the impacts that you mention/to respond effectively to the impacts?

ADAPTATION

15) Could you tell me what your definition of adaptation is?

16) Are you practising adaptation to climate change? If not, why?

17) Could you tell me what you understand by the term 'adaptive forest management'?

18) Do you apply this in your work? If not, why?

19) In your opinion, is the FC adapting to climate change? Ready for climate change?

POLICY PROCESS

20) Could you briefly explain the policy cycle within the FC, from creation to dissemination to implementation to feedback?

21) Are you consulted by the policy/planning group during the planning/policy making process?

22) How do you communicate with them? Method? Frequency?

23) Is there a channel for you to give feedback to the policy/planning group on the policies?

24) Overall, how would you describe the policy process within the FC?

Appendix 2: Questionnaire for the Policy /Planning Staff

KEY QUESTIONS - POLICY/PLANNING STAFF

GENERAL INFORMATION

1) Name

2) Location (Country, District, Region, Conservancy)

3) What is your current position and role in the organisation?

4) How long have you held this position?

5) How long have you worked at the Forestry Commission?

6) How do you implement policies in the FC? How do new ideas become actual policies/decisions?

7) What are the main influences on forest policies/forest decisions at the moment?

8) How has this changed in the time you have been in forestry?

9) How has the climate change agenda influenced forest policies/forest decisions? And since when? Are there any specific outcomes/results of this?

CLIMATE CHANGE

10) What is your definition of climate change?

11) Do you think climate change is occurring? Why?

12) Do you think climate will change to a degree that will significantly impact on forests in Great Britain? Why?

13) What sources of information are influencing your perceptions?

14) What strategies/plans and practices, if any, are you putting in place to manage the impacts that you mention/to respond effectively to the impacts?

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18) Do you apply this in your work? If not, why?

19) In your opinion, is the FC adapting to climate change? Ready for climate change?

POLICY PROCESS

20) Could you briefly explain the policy cycle within the FC, from creation to dissemination to implementation to feedback?

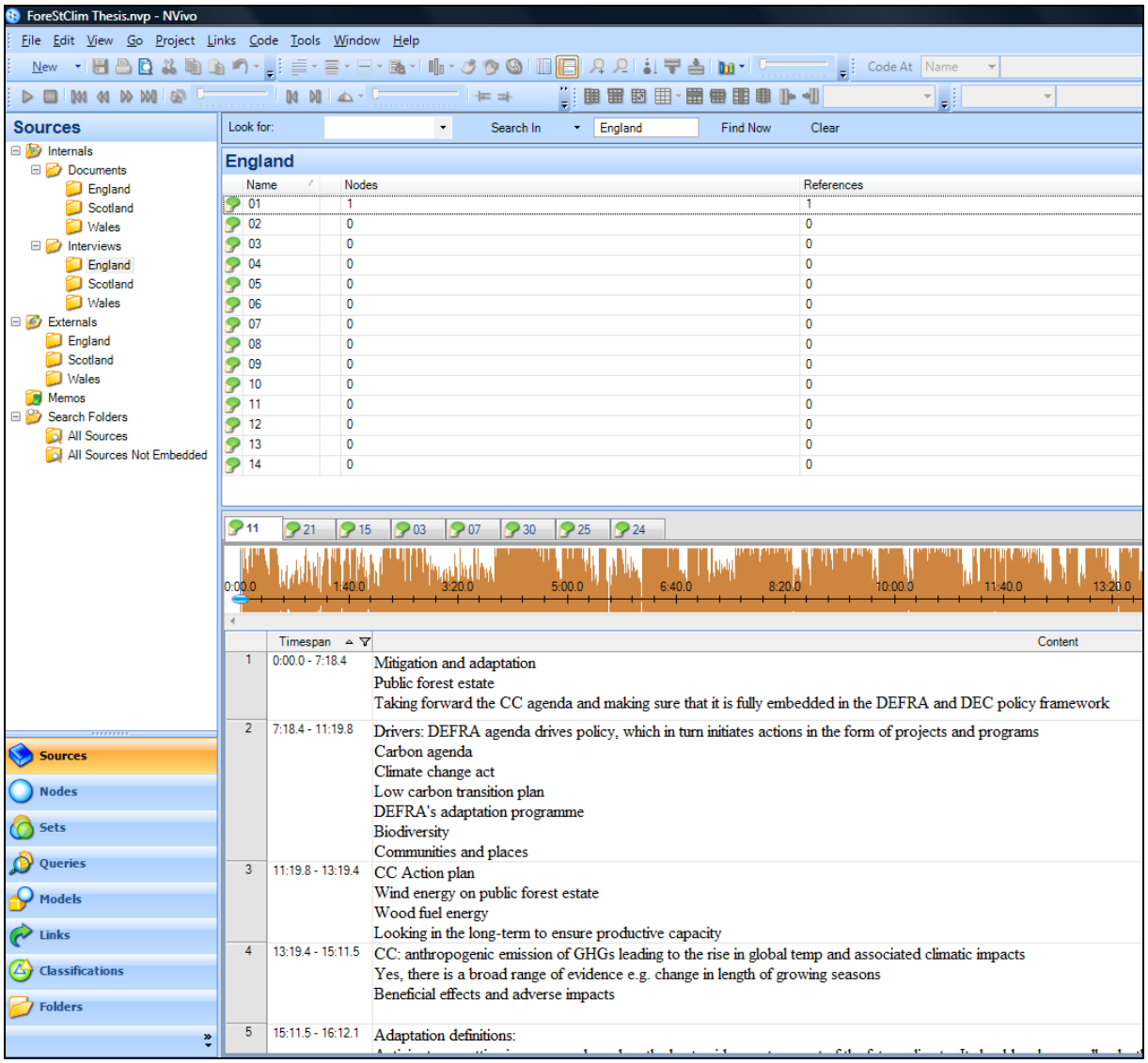
21) Do you consult the implementation/operations group during the planning/policy making process?

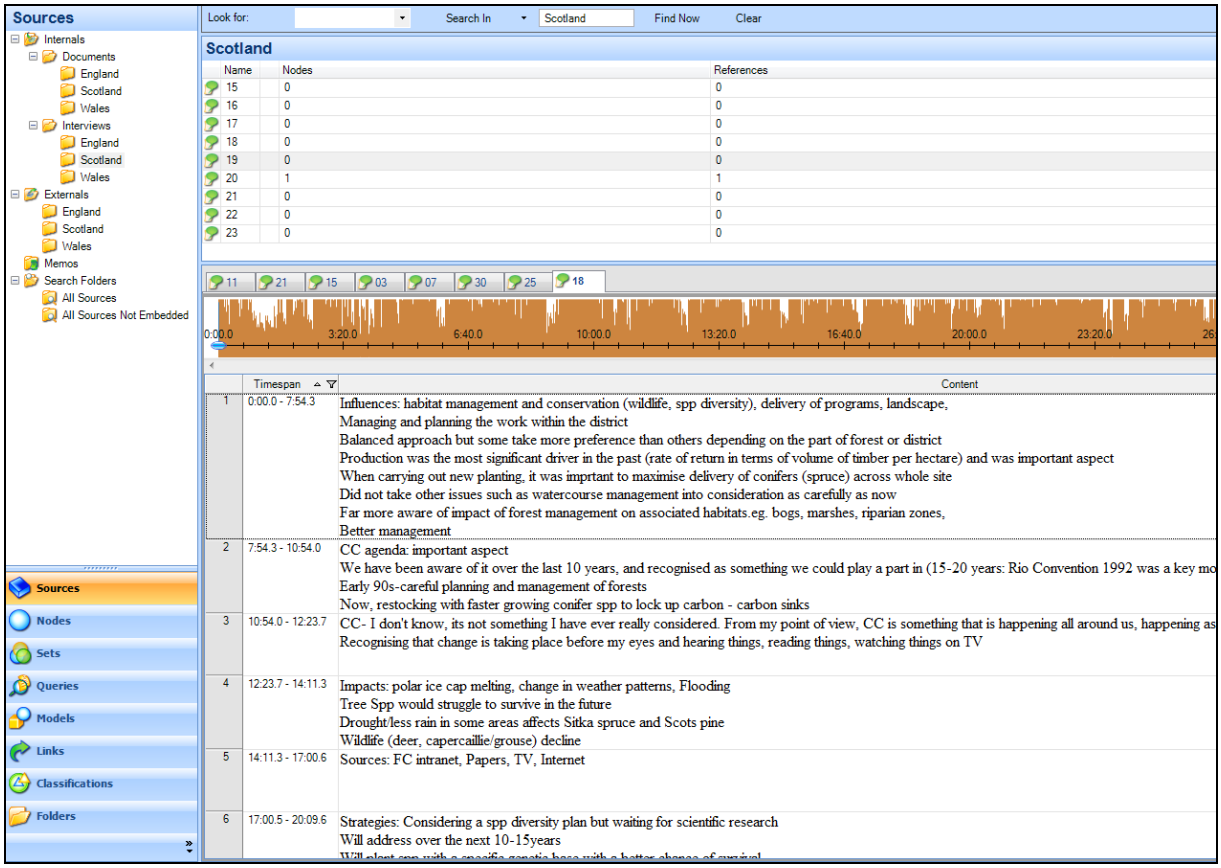
22) How do you communicate with them? Method? Frequency?

23) Is there a channel for the implementation/operations group to give you feedback on the policies you create?

24) Overall, how would you describe the policy process?

Appendix 3: NVIVO software screen shots




Sources
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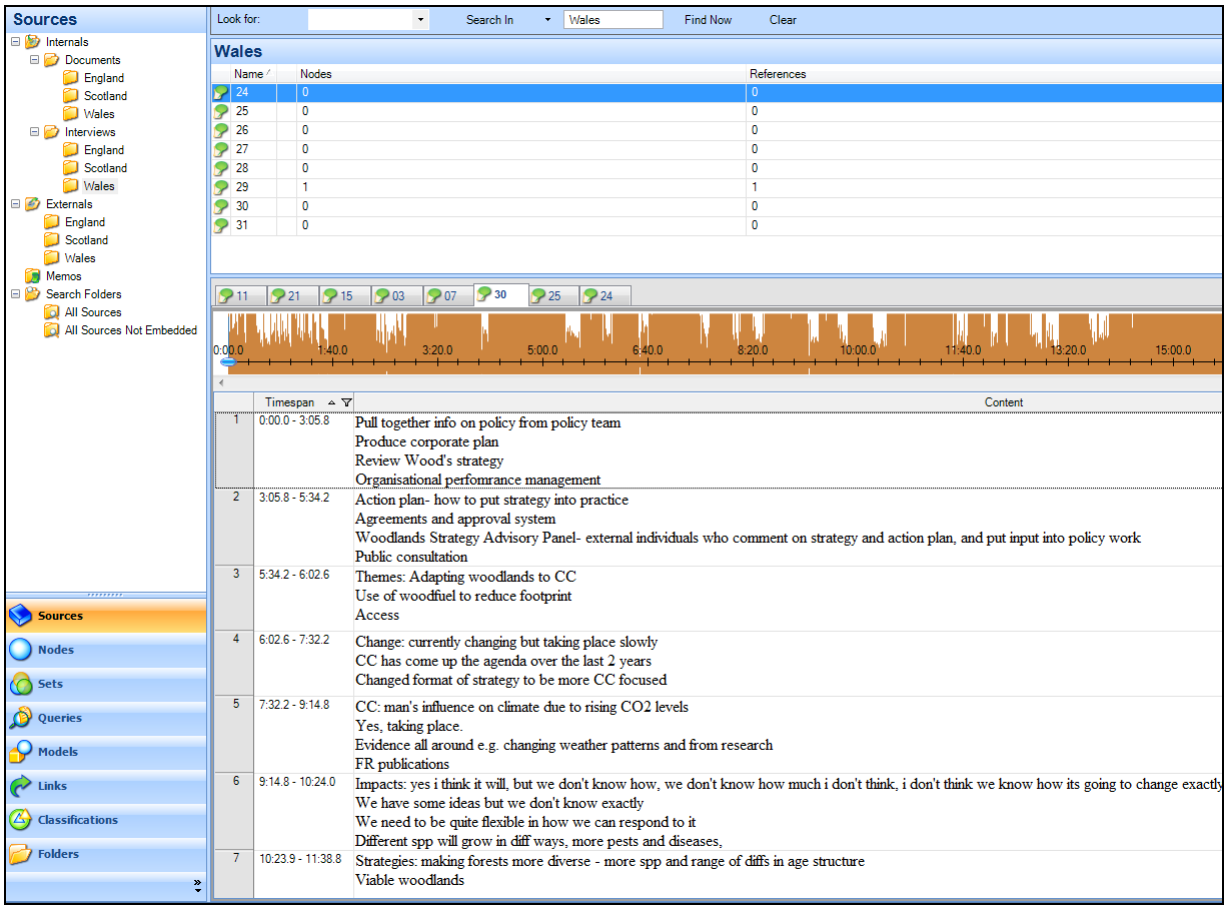
0:00.0 3:20.0 6:40.0 10:00.0 13:20.0 16:40.0 20:00.0 23:20.0
Timespan
Content
1 0:00.0 - 7:54.3
Influences: habitat management and conservation (wildlife, spp diversity), delivery of programs, landscape,
Managing and planning the work within the district
Balanced approach but some take more preference than others depending on the part of forest or district
Production was the most significant driver in the past (rate of return in terms of volume of timber per hectare) and was important aspect
When carrying out new planting, it was imprtant to maximise delivery of conifers (spruce) across whole site
Did not take other issues such as watercourse management into consideration as carefully as now
Far more aware of impact of forest management on associated habitats.eg. bogs, marshes, riparian zones,
Better management
2 7:54.3 - 10:54.0
CC agenda: important aspect
We have been aware of it over the last 10 years, and recognised as something we could play a part in (15-20 years: Rio Convention 1992 was a key mo
Early 90s-careful planning and management of forests
Now, restocking with faster growing conifer spp to lock up carbon - carbon sinks
3 10:54.0 - 12:23.7
CC- I don't know, its not something I have ever really considered. From my point of view, CC is something that is happening all around us, happening as
Recognising that change is taking place before my eyes and hearing things, reading things, watching things on TV
4 12:23.7 - 14:11.3
Impacts: polar ice cap melting, change in weather patterns, Flooding
Tree Spp would struggle to survive in the future
Drought/less rain in some areas affects Sitka spruce and Scots pine
Wildlife (deer, capercaillie/grouse) decline
5 14:11.3 - 17:00.6
Sources: FC intranet, Papers, TV, Internet
6 17:00.5 - 20:09.6
Strategies: Considering a spp diversity plan but waiting for scientific research
Will address over the next 10-15years
Sources
Nodes
Sets
Queries
Models
Links
Classifications
Folders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11 21 15 03 07 30 25 24
0:00.0 1:40.0 3:20.0 5:00.0 6:40.0 8:20.0 10:00.0 11:40.0 13:20.0 15:00.0
Timespan
Content
1 0:00.0 - 3:05.8
Pull together info on policy from policy team
Produce corporate plan
Review Wood's strategy
Organisational perfomrance management
2 3:05.8 - 5:34.2
Action plan- how to put strategy into practice
Agreements and approval system
Woodlands Strategy Advisory Panel- external individuals who comment on strategy and action plan, and put input into policy work
Public consultation
3 5:34.2 - 6:02.6
Themes: Adapting woodlands to CC
Use of woodfuel to reduce footprint
Access
4 6:02.6 - 7:32.2
Change: currently changing but taking place slowly
CC has come up the agenda over the last 2 years
Changed format of strategy to be more CC focused
5 7:32.2 - 9:14.8
CC: man's influence on climate due to rising CO2 levels
Yes, taking place.
Evidence all around e.g. changing weather patterns and from research
FR publications
6 9:14.8 - 10:24.0
Impacts: yes i think it will, but we don't know how, we don't know how much i don't think, i don't think we know how its going to change exactly
We have some ideas but we don't know exactly
We need to be quite flexible in how we can respond to it
Different spp will grow in diff ways, more pests and diseases,
7 10:23.9 - 11:38.8
Strategies: making forests more diverse - more spp and range of diffs in age structure
Viable woodlands
Sources
Nodes
Sets
Queries
Models
Links
Classifications
Folders