SECTION 5

SUSTAINABLE DEVELOPMENT

Chapter 11 - Forestry, climate change and sustainable development

Chapter 12 - Forestry and climate change: a socio-economic perspective

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FORESTRY, CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT

Chapter 11

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Key Findings

Forests and timber offer many sustainable credentials through their capacity to generate economic, social and environmental benefits. The contribution of forests to tackling climate change must not be seen in isolation from other benefits provided by sustainable forest management. Integrated approaches are needed, since managing forests with the main objective of reducing net carbon emissions may imply trade-offs with other socially-desirable objectives of forestry. Local and regional conditions and knowledge are required in developing forest management solutions that help to tackle climate change while meeting the needs of sustainable development.

Sustainable development[1] is one of the principal objectives of the UK Government. It is vital, therefore, that policies and actions in the forestry sector on climate change mitigation and adaptation contribute to the objectives of sustainable development, and to the principle of sustainable forest management.

At the same time, the imperative of tackling climate change means that changes may be required in the coming years both to the balance of forest policy objectives and to the management practices that underpin them. The introduction of a Climate Change Guideline supporting the UK Forest Standard (see 1.5.1, Chapter 1) demonstrates the importance of this issue.

The Government's approach to sustainable development is set out in its strategy, Securing the Future, published in 2005. The UK and devolved administrations have developed a common conceptual framework for sustainable development. This is shown in Figure 11.1. The framework is supported by separate strategies for each administration that reflect their priorities and specific needs.

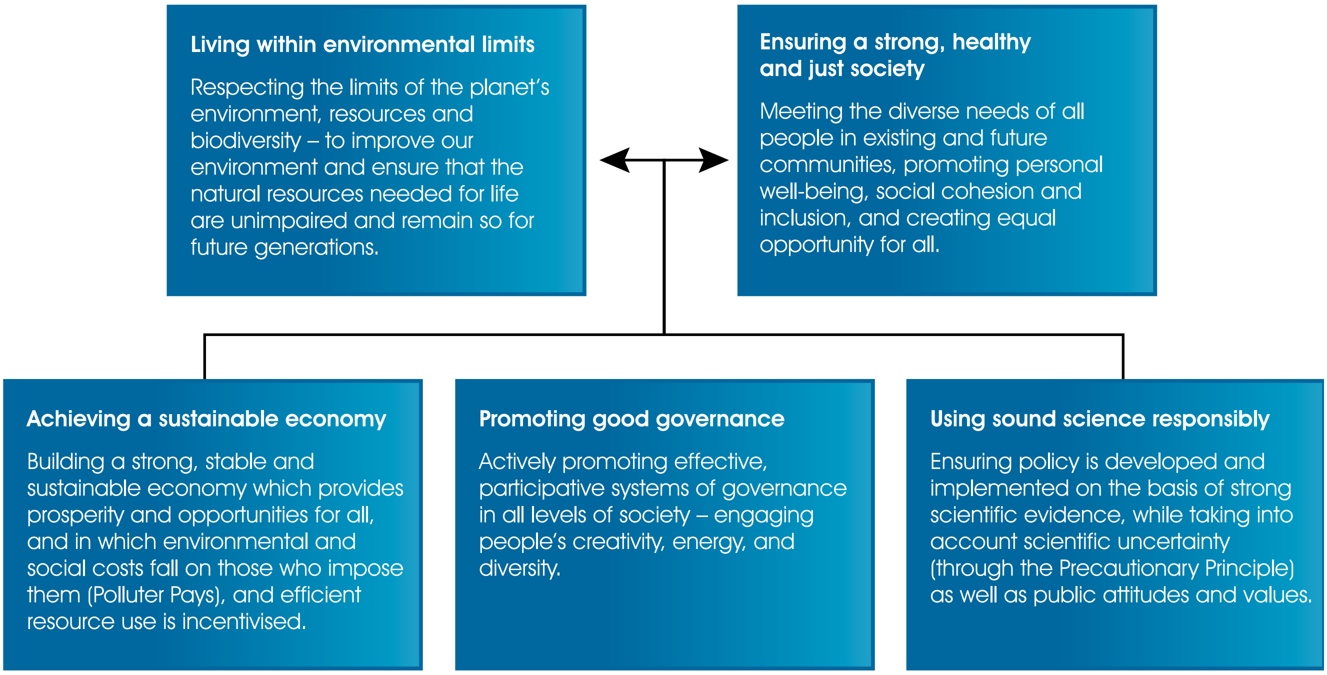
The framework identifies two outcomes; first, '*living within environmental limits*' and, second, '*ensuring a strong, healthy and just society*'. Arguably, the development of forest policy and practice in recent decades has done much to support these outcomes through, for example, the contribution of woodlands to biodiversity, recreation and amenity and through an increasing focus on woodland creation in and around towns and cities (see Forestry Commission, 2009). The forestry strategies for England, Scotland, Wales and Northern Ireland, and the environmental and social objectives of the UK Forestry Standard, show this contribution at a strategic level. Both of these outcomes can be consistent with managing forests for climate change. For example, protecting forests as environmental assets is integral to the analysis of climate change impacts and adaptation as shown in Section 2 and Section 4 respectively, while the social contribution of woodlands is made clear in the examination in Chapters 10 and 13 of how woodlands help society to adapt to climate change.

The sustainable development framework identifies three actions for achieving the outcomes.

- **Creating a sustainable economy.** This action envisages an economy that attaches a full value to the natural environment (including full pricing of carbon) and to the benefits that it provides for people. Economic prosperity is seen within the framework as a way of achieving target outcomes above rather than an end in itself.
- **Promoting good governance.** This action seeks to

[1] A widely-used definition of sustainable development is 'development which meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, 1987).

Figure 11.1
The UK's shared framework for sustainable development.



(Further details on the framework are available online at: www.defra.gov.uk/sustainable/government/publications/uk-strategy/index.htm).

incorporate the knowledge and aspirations of different stakeholders in policy development and to put in place clear principles to guide decision-making.

- Using sound science responsibly. This action relates closely to this Assessment report. Scientific evidence should be used responsibly in a rounded way, taking account of uncertainties, and considering public attitudes and values.

11.1 Sustainable forest management

The importance of managing forests in a 'sustainable' way was formally recognised with the adoption of the Statement of Forest Principles at the United Nations Conference on Environment and Development (the Earth Summit) in 1993 (see 1.5.1, Chapter 1). At a European level, the EU, its member states and other European countries have made high-level commitments to sustainable forest management through the Ministerial Conferences on the Protection of Forests in Europe (MCPFE).

Sustainable forest management thus requires multiple objectives to be considered in an integrated way. This is recognised in Article 2.1 (a,b) of the Kyoto Protocol in which signatories agreed various ways of considering potential impacts of mitigation options and of establishing common approaches to promoting sustainable development through forestry actions. The issue is also underlined in the IPCC's 4th Assessment Report by Nabuurs *et al*. (2007) who stress the importance of understanding the many functions of forest ecosystems and the effects of human activities, and of not treating different socioeconomic and environmental outputs in isolation:

> 'Important environmental, social, and economic ancillary benefits can be gained by considering forestry mitigation options as an element of the broad land management plans, pursuing sustainable development paths, involving local people and stakeholders and developing adequate policy frameworks' (p. 574).

A further implication of sustainable forest management is the need for local and regional institutions and people to play an effective role in shaping management practices. In the UK, this has been recognised in forest planning and consultation procedures, and in processes for the disbursement of planting and management grants through the Rural Development Programmes in England, Scotland, Wales and Northern Ireland. Guidelines under the UKFS also highlight the importance of regional and local biogeographical conditions in determining appropriate management practices. The importance of spatial differences emerges strongly in the analysis of climate change impacts in Section 2, mitigation in Section 3 and adaptation in Section 4. The UKCP09 projections illustrate that the impacts of climate change will vary substantially across different parts of the UK. Forest management practices will, therefore, need to be carefully tailored in future to reflect the suitability of different species and management regimes to different locations (see 1.6, Chapter 1 and Section 2).

11.2 Implications of climate change mitigation and adaptation for sustainable forest management

It is of critical importance for policy to evaluate whether different actions to achieve climate change mitigation and adaptation are compatible with sustainable forest management. High-level, collaborative work, such as by the Collaborative Partnership on Forests (CPF) (2008), has advocated sustainable forest management as the appropriate framework for actions on climate change in all types of forest.

> 'It [sustainable forest management] can be applied to forests in which wood production takes place, including planted forests, as well as to protected forests and to degraded forests in need of restoration' (p. vii).

A particular strength of sustainable forest management is that it stresses an adaptive approach, through which forest management practices can change as conditions change. This will be particularly important if climatic changes result in significant alterations to growing conditions and to the suitability of different species and management practices (Section 2). In keeping with an integrated approach, mitigation and adaptation practices should not be seen as necessarily being mutually exclusive. In many cases, forestry actions (e.g. planting on floodplains) bring benefits both for mitigation and adaptation.

As noted above, properly managed forests have many properties which are consistent with sustainable development. This is shown in their capacity to generate economic, social and environmental benefits. Firm evidence of the magnitude of these benefits was provided by Willis *et al*. (2003). However, many of these benefits (e.g. carbon sequestration, biodiversity conservation) are not typically rewarded by the market. Adequately reflecting these benefits in financial incentives would produce more efficient forest management in a broad economic sense. Work by Moxey (2009) has begun to examine the incentives that are currently in place in the forestry sector (see 1.5.1, Chapter 1) and how further analysis could ascertain whether changes to the suite of policy instruments are needed in future.

A summary of the effects in terms of sustainable development of different forestry actions on climate change mitigation and adaptation is shown in Table 11.1. This Table illustrates potential effects rather than providing definitive statements. Building on evidence from earlier chapters (particularly Chapters 6, 8 and 9,), Table 11.1 shows that the high-level actions on climate change identified for forestry have many synergies with the objectives of sustainable development. However, trade-offs may also need to be faced in some instances if other forestry objectives (such as timber production, or biodiversity conservation) are not to be unduly compromised by the pursuit of climate change objectives. For example, managing forests solely for their carbon mitigation potential is unlikely to be always consistent with managing them for biodiversity conservation. The precise effects of any action depend on the type of woodland, the characteristics of the site and the specific management activities employed.

Two important points arise from this consideration of multiple outcomes. First, 'conventional' planted conifer forests tend to be the most cost-effective in securing carbon abatement whereas native woodlands are in general the most highly valued for biodiversity benefits. (These two woodland types equate broadly to the Forest Management Alternatives described in Section 3 as 'Intensive even-aged forestry' and the 'Close-to-nature forestry', respectively.) Cost-effectiveness here means that forests offer an opportunity to reduce net emissions at a lower relative cost than other options (which includes other forestry management options, other land-use changes, and emission reductions from, say, industry or transport). Second, any assessment of cost and benefits from using forests as mitigation options should take account of the whole forest life cycle, including the use of timber after harvesting: the 'carbon footprint' of forest management.

However, a fuller understanding of the scale of synergies and trade-offs between mitigative and adaptive actions and the other benefits provided by forestry requires further

Table 11.1
Sustainable development implications of forestry actions for mitigation and adaptation.

Action	Economic	Social	Environmental
Planting new woodlands	Depends on any displacement of other land uses, on rotation lengths and on opportunities for carbon payments. Financial opportunities through generating carbon credits. Employment creation (if replacing less labour-intense activity).	Tree planting to improve urban temperatures and surface water conditions provides favourable living and working environments.	Depends on the 'forest management alternative'. Benefits highest in native woodlands but sequestration levels will tend to be lower. UK Forest Standard to support appropriate planting (e.g. avoiding deep peat soils).
Protect and manage existing forests	Increased long-term employment in managed woodlands, both direct and indirect.	Amenity and recreation values arise. Forests offer a resource for anticipated higher visitor numbers in a warmer climate.	Protection of forest carbon stocks may reduce sequestration rates. Biodiversity and landscape benefits. Protects watersheds and soils. Adaptation measures protect the ecosystem service functions of woodlands.
Use wood for energy	Income for woodland owners. Employment opportunities. Provision of renewable energy. Increased local income.	Potential competition with other land-uses.	Reduced use of fossil fuels. Short rotation plantations may reduce environmental values (depending on previous land-use). Loss of deadwood habitat. Less carbon locked up in soils.
Replace other construction/ manufacturing materials with wood	Potential economic diversification. Income for woodland owners and timber suppliers.	Potential competition with other land-uses.	Avoided GHG emissions associated with the manafacture and use of those materials replaced by wood.
Plan to adapt to a changing climate	Reduced economic damage from extreme weather events. Reduce risk of pest outbreak.	Enhanced living and working environments. Protection against environmental hazards. Reduced impacts of climate change, particularly on urban populations.	Enhanced habitat networks. Impacts from possible use of non-local provenance species.

Adapted from Nabuurs *et al.* (2007).

research and analysis. Research is needed to strengthen scientific understanding in this area and then to apply economic analysis to this understanding of trade-offs and synergies. Research and analysis of this type will provide important evidence in helping decision-makers to re-evaluate current policy and practice so that mitigation and adaptation are firmly embedded in sustainable forest management alongside the other benefits that forests provide.

11.3 Research priorities

- Forestry actions can, in many cases, bring benefits in terms of both mitigation and adaptation. These benefits must be properly incorporated into the concept and practice of sustainable forest management. Integrated approaches are needed.
- Local and regional institutions and knowledge are required in developing forest management solutions that

help to tackle climate change while meeting the needs of sustainable development.

- Further scientific and economic analysis is required to understand the nature and scale of synergies and trade-offs between forestry mitigative and adaptive actions and other outputs from forestry.
- Further effort is needed to re-design policy incentives so that adequate reward is given to the provision of non-market benefits, including those relating to the mitigative and adaptive functions of forests.

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FORESTRY AND CLIMATE CHANGE: A SOCIO-ECONOMIC PERSPECTIVE

Chapter 12

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Key Findings

Economic analysis reveals that forestry projects involving carbon capture and storage have the potential to postpone climate change, reduce net emissions, while allowing time for adaptation and technological innovation. Implementation requires policy measures to be cost-effective, ecologically sustainable and socially desirable. Appropriate public investment, economic incentives and institutional and governance capacities are required to bring about such projects.

There is evidence in support of cost-effective woodland creation programmes on marginal land where opportunity costs are lowest. The choice of location for forestry development, and the choice of management regimes to be applied, are important factors in determining economic costs. Overall, new tree planting is deemed to be economically viable either when SRC and SRF are established for bio-energy, or when afforestation provides environmental and/or social co-benefits.

Adaptation and mitigation activities are linked together, and the knowledge built up in the UK and beyond should be used to facilitate more successful mitigation–adaptation interactions in the forestry/land use sectors in the wider context of sustainable development and promoting rural livelihoods.

Problems with the inclusion of carbon credits from forestry into regulatory emission trading schemes arise as a result of the perception that forestry sinks are temporary and from issues such as 'leakages', double-counting and high transaction costs associated with measuring, assessing and monitoring of carbon. Opportunities to increase the cost-efficiency of climate change mitigation will arise if solutions to these problems are found.

This chapter provides an economic perspective of forestry and climate change in the UK. A growing body of literature has developed on this subject, particularly in Europe and overseas.

This literature suggests that the mitigative and adaptive roles of forests can be enhanced by both new planting and forest management (IPCC, 2007). However, forests' roles will be mediated and shaped by market signals, policy frameworks, and governance approaches as well as by attitudes and behavioural patterns. All will be considered in this chapter.

Major studies have been carried out in recent years into economic aspects of climate change generally. Foremost among these has been the Stern Review (Stern 2006) which placed scientific observations and policy choices in an economic framework, and did much to increase awareness of the costs of failing to take adequate action now on climate change.

12.1 The economics of carbon sequestration and storage through forestry

From an economic perspective, it is important to compare the cost-effectiveness of different approaches to GHG abatement. This requires data on the cost, for each abatement activity, of removing a tonne of CO_2 equivalent. From an economic viewpoint, it makes sense to choose those mitigation options with relatively low costs, as then, GHG reduction targets can be met at a lower overall cost to the economy[1]. Since forest management involves costs and benefits which extend over time, discounting is used

[1] Indeed, some sources may face negative costs for carbon mitigation: investments in household energy efficiency being one example.

to calculate the net present value of forestry management options per tonne of carbon equivalent abated. In particular, economists have focused on the marginal costs of carbon abatement through forest management and forest creation: how much does it cost, in net terms, to sequester one more tonne of CO_2? We would expect these marginal costs to vary across forest management options, and to vary spatially for a given option (because, for instance, of variations in growing conditions and in the price of land).

Various studies have examined the cost-effectiveness of forestry as a carbon sink, relative to other mitigation options (Crabtree, 1997; Newell and Stavins, 2000; Stavins and Richard, 2005; Nijnik 2005; Enkvist *et al*., 2007; Nijnik and Bizikova, 2008; Moran *et al*., 2008). Such work is vital in assessing the economic feasibility of forestry in tackling climate change. These studies have identified substantial variability in marginal costs in different countries and in different settings. A meta-analysis of 68 studies (Van Kooten *et al*. 2004), with a total of 1047 observations worldwide, identified costs varying between €35 and €199/tC and, when opportunity costs (see Glossary) of land use were taken into account, between €89 and €1069/tC.

Tree planting is costly, and opportunity costs exist for converting existing non-forest land into new forests. Marginal cost estimates of carbon mitigation by forests can be compared with market prices of carbon, for example prices in the EU's Emissions Trading Scheme (ETS): these currently (August 2009) stand at around €15/tCO_2. However, it is important to remember that prices in carbon markets do not necessarily reflect the true social value of carbon reductions, but rather current demand and supply within carbon markets, and the institutional aspects of such markets (Defra, 2008). EU ETS prices are expected to rise over time, implying an improving competitive position for forests as a mitigation option, although carbon price volatility will also be important to forest managers (Turner *et al*., 2008).

It is argued by Van Kooten and Sohngen (2007) that if carbon sequestered through tree planting was to be traded in markets alongside credits through emissions reductions, it would be relatively economically attractive if traded at US$50/t$CO_2$. Assuming a threshold of about US$30/t$CO_2$, tree planting activities are generally competitive with emissions reductions, particularly in tropical and boreal regions (Table 12.1). The costs of carbon sequestration in forestry also compare well with those of emerging technologies for carbon capture and storage. However, if the opportunity cost of land is fully taken into account (and if emissions reduction credits can be purchased for US$50/t$CO_2$ or less), tree planting appears less attractive. Hanley (2007) shows that forests are cost-effective sources of mitigation for Scotland, relative to wind energy investments, but agricultural land-use changes are also relatively cost-effective.

Preliminary work has been commissioned by the Department for Environment, Food and Rural Affairs (Defra) to examine marginal carbon abatement costs for a range of land-use activities in the UK (Moran *et al*., 2008). Carbon sequestration costs through forestry were estimated to range from £8 per tCO_2 (afforestation of sheep grazing areas) to £48 per tCO_2 (for afforestration of agricultural land), using a discount rate of 3.5%. The implications of such results are that there is evidence to support woodland creation on some marginal land rather than for afforestation on a larger scale, although much depends on whether agricultural subsidies continue to hold up land prices. Ongoing reforms (de-coupling) of the Common Agricultural Policy may have significant effects on agricultural land prices, which will change the net cost of woodland creation as a mitigation option. World food price changes will also have major effects. More complete costings have recently been estimated by ADAS (2009) and are described in Chapter 8.

Tree species and management regimes are also important factors in minimising economic costs. Prioritisation of areas

Table 12.1
Sustainable development implications of forestry actions for mitigation and adaptation ($/t$CO_2$).

Activity	Global	Europe	Boreal	Tropics
Planting	22–33	158–185	5–128	0–7
Planting and fuel substitution	0–49	115–187	1–90	0–23
Forest management	60–118	198–274	46–210	34–63
Forest management and fuel substitution	48–77	203–219	44–108	0–50
Forest conservation	47–195	N/A	N/A	26–136

Source: Adapted from van Kooten and Sohngen (2007).

that offer the most potential for sequestration through forestry would be greatly assisted by the development of maps providing indicative figures of how such costs vary spatially across the UK. Such an approach would provide the basis for a spatial cost-benefit analysis of forestry-based policy options on climate change. The analysis could identify:

- which options are economically sound for implementation, and where and how; and,
- which regions are likely to benefit most from forestry development, as well as those regions that may be adversely affected by forestry projects.

Key scenarios that merit attention are:

- carbon sequestration and storage in forests;
- production of wood for energy (when trees are cut and wood is used to substitute for fossil fuels – see Chapter 7);
- the use of wood products as substitutes for more carbon-intensive materials; e.g. in construction and furniture (see Chapter 7);
- tree planting for adaptive purposes such as on floodplains; and,
- tree planting/growing for the provision of multiple ecosystem services, including carbon.

The analysis of these scenarios should take account of relevant price signals including those in the agricultural and emissions trading sectors because these prices will affect the relative returns to forestry projects. The economically optimal level of mitigation through forestry, and the actual uptake of mitigation by private forest owners, will depend also on what we assume about the global price of carbon (Van't Veld and Plantinga, 2005).

Longer rotations can delay opportunities for using wood for energy generation or/and substituting wood for materials whose production is more intensive in GHG terms (Pajot and Malfait, 2008; Nijnik *et al*., 2009). Studies in Canada (Van Kooten and Bulte, 2000; Van Kooten, 2004) have suggested that a continual forest cycle in which trees are harvested and re-planted or regenerated, and in which substitution benefits are provided through the use of wood fuel and wood products, provides a sustainable means of sequestering carbon, storing it and avoiding emissions from other more damaging activities. The benefits of wood products and wood energy scenarios in the long-run are higher than under a strategy of carbon sequestration alone.

Analysis by Van Kooten (2009) has found that cost-effective emissions reductions might be created when short-rotation plantations are established for bioenergy. Evidence for this was earlier provided in Canada where hybrid poplar planted on marginal land appeared to be cost-effective (Van Kooten *et al*., 1993). An economic assessment of willow production in the UK (Boyle, 2004) also demonstrated that this can be economic if planting takes place on set-aside land with grants of £1600 per hectare and annual yields above 10 tonnes (oven-dried) per hectare ae obtained. Work by Dawson *et al*. (2005) and Galbraith *et al*. (2006) provides similar findings.

There is also evidence that forestry projects combined with use of wood products and renewable energy strategies offer economic opportunities in rural (and urban) areas through innovation, employment and the development of markets (EC, 1997; Van Kooten, 2004; Freer-Smith *et al*., 2007; Brainard *et al*., 2009). It is imperative, therefore, that measures for carbon sequestration in forests are considered within the context of policies for spatial planning, and of forestry, agricultural and rural policies and sustainable energy systems (Nijnik and Bizikova, 2006). This may save costs and assist in dealing with environmental problems associated with the changing climate.

12.2 Institutional aspects of forest carbon markets

The institutional framework relating to forest carbon markets is complex. The flexible mechanisms under the Kyoto Protocol (UNFCCC, 1998) – the Clean Development Mechanism and Joint Implementation – provide opportunities for countries to tackle climate change while making judgements on the economic feasibility of different courses of action. However, evidence suggests that the CDM and JI mechanisms are unlikely to create credit and permit (allowance) trading on a large scale, despite the growth of trading in CDM and JI credits globally (IPCC, 2007). Some studies suggest that such regulatory trading schemes fail, not because of a lack of interest, but primarily because of high transaction costs (Chomitz, 2000; Van Kooten, 2004). It appears that the complexity of the institutional arrangements for the flexible mechanisms have been a disincentive for action. To date, there have been only eight forestry projects approved under the CDM (see: http://cdm.unfccc.int).

A critical element of the institutional arrangements concerning carbon trading is their capacity to ensure that carbon benefits are delivered as stated. This applies to both regulatory and voluntary markets. In the UK, the Government has established a Quality Assurance Scheme for Carbon Offsetting that allows consumers to identify good quality offsets in voluntary markets (Defra, 2009). However, apart from the CDM, forestry is currently excluded from international regulatory markets in carbon. Therefore, at this time, voluntary markets are the principal means of generating carbon benefits from forestry in the UK. As described in Chapter 1, the Forestry Commission is establishing a Code of Good Practice for Forest Carbon Projects to ensure appropriate standards of delivery. This and the Government's Quality Assurance Scheme are intended to provide a framework to support the development of robust, transparent, reliable and timely carbon benefits that offer consumers genuine value for money, as well as achieving carbon savings.

The inclusion of forestry in regulatory emissions trading schemes has been impeded by a number of factors. These have been widely examined (see Chomitz, 2000; Marland *et al*., 2001; Subak, 2003; Van Kooten, 2004 and Nijnik *et al*., 2009) and include:

- establishing baseline emissions data;
- coping with 'leakages' (these may arise where the CO_2 emissions that a project is meant to sequester are displaced beyond its boundaries[2]);
- providing assurance of 'additionality' and of permanence of projects;
- establishing reliable measurement and monitoring of carbon sequestration and of costs;
- verifying that carbon sequestration has taken place;
- avoiding double counting;
- devising a process for certifying carbon credits and 'converting' them into emission permits;
- establishing property rights and institutions for exchanging carbon credits;
- putting in place appropriate legal arrangements and data requirements to allow schemes to operate.

Many of these challenges are also pertinent to voluntary carbon projects. However, the voluntary carbon market is less regulated and thus tends to have lower transaction costs. Some have argued that voluntary carbon trading is relatively successful (Taiyab, 2006). For example, it can comprise 37% of total voluntary transactions by the forestry sector (Hamilton *et al*., 2007). Across the world, schemes have been founded by governments, NGOs, businesses and individuals. Types of projects include tree planting and conservation of forests, and in the majority of cases they offer 'cheap' carbon savings (House of Commons, 2007).

Uncertainty also plays a key role in the development of carbon markets for forestry. This is underlined in work by Turner *et al*. (2008) on forests in New Zealand. Estimating future benefits of carbon sequestration and storage is complicated by uncertainties in forest carbon dynamics. Estimates must determine how much carbon is sequestered and stored (and for how long) and assess how much carbon will be sequestered in the future under a changed climate. These uncertainties affect how many carbon credits a forest investment will earn. Uncertainties also exist in relation to carbon prices, the permanence of forest carbon stocks (their susceptibility to wind or fire risk for example), and concerns over double-counting and additionality of carbon credits. Assuring market confidence in the capacity of forestry investments to deliver mitigation benefits is essential if the future potential of forestry in this area is to be fulfilled. The Code of Good Practice for Forest Carbon Projects (see 1.5.4, Chapter 1) is intended to provide this assurance. For example, one way of dealing with uncertainties of fire or wind damage is to establish 'buffers' whereby a proportion of the anticipated carbon is set aside as an insurance. The Code also sets out proposals for proper procedures for registration, monitoring and verification of forest carbon projects. Private sector instruments for offsetting risks in carbon markets can also be expected to develop without government intervention.

12.3 Rural policy signals

Our review of the evidence indicates that the potential for the UK's forests and woodlands to contribute to climate change mitigation and adaptation is shaped by wide-ranging factors. These include important influences beyond the control of forestry policy. Some of these have an international dimension, such as the EU's Common Agricultural Policy (CAP), EU directives on the natural environment and multilateral climate change agreements (see 1.5.2, Chapter 1). Others have a domestic focus, such as UK designations on the natural environment. The breadth of factors that influence forestry's role in helping to tackle climate change show that a more integrated approach to planning involving forestry, agriculture and other land uses would bring benefits.

[2] It is possible to cope with 'leakages', for example by expanding the scope of the system to 'internalise' the 'leakages' or to design the project so as to be 'leakages' neutralising (Chomitz, 2000).

In the UK, forestry and farming have become competing land uses. According to Taylor *et al*. (1999), agricultural subsidies have been a significant deterrent to new forest planting, due to their effects on relative returns and thus on land rents. Recent reforms of the CAP have de-coupled support from production, leading to a large change in returns from certain farming activities, particularly in the uplands (Acs *et al*., 2008). These changes – such as falling returns from livestock grazing – can be expected to increase incentives at the margin to convert land to forestry, especially if Single Farm Payment is retained on planted land.

Policy support for renewable energy that increases the demand for wood energy and taxes on non-renewable forms of energy may also influence planting and management practices in forestry. Indeed, there is policy support for the development of woody biomass, with grant aid (Defra Energy Crop Scheme) currently available in all parts of the UK for household and community schemes (LUPG, 2004; see also the Bioenergy Infrastructure Scheme, Defra, 2007). As indicated in 1.5.3, Chapter 1, the UK Renewables Obligation (RO) also provides an incentive for the development and use of wood energy.

Forestry delivers a greater range of ecosystem services than carbon sequestration alone, and many of these benefits are highly spatially variant. This creates not only a need for accurate assessment of non-market benefits, but also for the design of policy instruments that take the full array of forest services into account. Again, it is important to examine the extent to which maximising the carbon sequestration benefits of forestry is consistent with delivering other ecosystem services. Government incentives for providing multiple ecosystem services including sequestration will also impact in complex ways on decision-making by private forest owners (see Caparros *et al*., 2009, for an example relating to new forest planting in Spain).

Apart from maximising monetary returns from land, land-use change decisions involve long-term investments that bring uncertainty (Schatzki, 2003) and are affected by other unquantified benefits and costs of alternative land uses (i.e. aesthetic values and recreation) (Ovando and Caparros, 2009). They may also be affected by liquidity constraints and decision-making inertia (Stavins, 1999). These considerations merit attention in the UK, as they could constrain the amount of new land that can be devoted to forestry based climate mitigation, and consequently the carbon sequestration benefits obtained.

12.4 Stakeholder attitudes

Economic analysis of forestry and climate change has been complemented by analysis of stakeholder attitudes (including land managers and the general public). For example, various cultural values affect the propensity of land managers to plant trees and to develop forest-based activities to tackle climate change.

Public attitudes to forestry in the UK are assessed in biennial surveys commissioned by the Forestry Commission. The 2007 and 2009 surveys include a section on climate change and forests. They tend to show growing awareness of and support for the role of forests in tackling climate change. General support for afforestation has been shown. A significant proportion of respondents wishing to see twice as many forests in their part of the country, primarily in the form of broadleaved and mixed forests. The proportion of people emphasising the role of forests as a source of renewable energy rose from 20% of the sample in 1999 to 50% in 2009. In the 2009 survey, 68% of respondents thought that using public money to manage existing woodland 'to help tackle climate change' was a good reason for such spending. The surveys also suggest that other forest amenities and benefits are important and, therefore, should be considered when forest strategies are to be implemented.

Studies of farmers' attitudes to trees and land conversion to forestry show reluctance to plant trees (Tiffin, 1993; Williams *et al*., 1994). Some of the work in this field is dated, although the findings are consistent with more recent work (see Burton, 2004 and Towers *et al*., 2006). Other authors have argued that there are important psychological, cultural and institutional barriers to afforestation in the UK. In particular, it is argued that the UK has a weakly developed forest culture (Mather *et al*., 2006; Nijnik and Mather, 2008). Land tenure has also been cited as a barrier to afforestation (Warren, 2002).

12.5 Conclusions

The acceptance of sustainable development as an over-arching objective requires forestry measures to be cost-effective, ecologically sustainable and socially desirable. Appropriate economic incentives and institutional and governance capacities are required to achieve this.

Forests can play a cost-effective role in a country's overall mitigation strategy, although the costs of CO_2

sequestration vary over a considerable range, according to land quality, alternative land uses, forest management option, and costs of alternatives.

Overall, tree planting for carbon mitigation is economically desirable either when combined with bio-energy production, or when afforestation provides environmental and/or social co-benefits.

Adaptation and mitigation activities are linked together, and the knowledge built up in the UK and beyond should be used to facilitate more successful interaction between mitigation and adaptation in the forestry and land-use sectors, and in the wider context of sustainable development and rural livelihoods.

Major problems arise concerning the inclusion of carbon credits from forestry into regulatory emission trading schemes because of the temporary nature of terrestrial carbon sinks, and issues such as 'leakages', double-counting and high transaction costs associated with measuring, assessing and monitoring of carbon. Opportunities to increase the cost-efficiency of climate change mitigation via the private sector rest in finding solutions to these problems.

The extent to which additional private sector forests are planted as part of a UK mitigation strategy will depend on the evolution of agricultural and renewable energy policy, as well as on the extent to which landowners can be rewarded for carbon sequestration.

12.6 Research priorities

- More research is needed to develop our understanding of the circumstances under which the forestry sector can offer sustainable, socially acceptable and low-cost opportunities for carbon sequestration. This includes analysis of the cost-effectiveness of forest-based carbon sequestration and storage and comparison of the marginal costs of carbon mitigated through different forestry management options (in different localities) compared to other possible alternatives for reducing net emissions (e.g. in agriculture, in housing, transport or industry).
- Further analysis is needed of the trade-offs and synergies between managing forests for carbon, compared with other public goals such as managing for biodiversity and recreation. This research should aim to quantify these trade-offs and synergies, and to design mechanisms to maximise net benefits. This will help to provide a more thorough assessment of the effects of managing forests for carbon on indicators of sustainable development.
- Further work is needed to investigate the barriers (economic, institutional and cultural) to large-scale afforestation projects in the UK.
- The economics of forests for bio-energy needs further work. Moreover, it is important to improve understanding of the behavioural, social and economic barriers to the development of wood energy supply chains and the relative advantages of different wood energy supply systems (chip, pellet, CHP).
- Spatially explicit modelling of carbon and other non-market benefits of forests and woodlands including, *inter alia*, habitat networks and flood alleviation remains a research priority. This should include spatial modelling of both cost-effective mitigation, and the cost-benefit analysis of management alternatives.
- Further investigation is required into the nature of risk and uncertainty in developing forest carbon credit markets, and how this risk can best be managed.

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HUMAN BEHAVIOURAL AND INSTITUTIONAL CHANGE

Chapter 13

A. Lawrence and C. Carter

Key Findings

Human behaviour needs to change, to both mitigate and adapt to climate change. There is a scarcity of social science research into climate change and much of the section draws on findings from relevant research linking social values, beliefs and knowledge with attitudes and behaviour towards the environment or sustainable consumption.

Many people find it hard to make sense of information about climate change, with its complexity and uncertainty. The ways in which people understand the role of trees and forests in this varies within society. Information and knowledge are not in themselves sufficient to change attitudes and behaviour, as personal and cultural values, experiences and beliefs also have a strong influence. If intervention is desired to bring about behavioural change, this will need to be tailored to the knowledge, values and experiences of specifically defined groups; one single approach will not suit all.

Change at the individual level is not adequate without institutional change. Institutions need to be adaptive. Characteristics of adaptive organisations are that they incorporate organisational learning, enhance social capital through internal and external linkages, partnerships, and networks, and make room for innovation and multi-directional information flow.

It appears that trees and forests can have a strong role in the way that people make sense of their environment and how it is changing. This suggests a particularly significant role for woodland management and the engagement of forestry with the public, in contributing to societal understandings and responses to climate change.

The success of a climate change policy in which forests play an important part will depend, to a degree, not just on economic issues – as outlined previously – but also on public attitudes and behaviour, and on institutions.

Institutions can be laws, conventions, cultural practices and/or organisations. Institutions affect how we think about, frame and regulate problems and how society and lifestyles develop. In order to facilitate an individual's ability to adapt, institutions also need to adapt.

Specific research on the social and institutional aspects of climate change in the UK is only slowly emerging, so this review of the evidence also draws on studies conducted in Europe and further afield. Even less research has been specifically conducted on the perceived role and significance of trees, woodlands and forests in climate change from a socio-cultural perspective. The need for social research has been highlighted by experts (see Box 13.1).

This chapter first reviews evidence on people's attitudes and beliefs and highlights the fact that changing behaviour needs more than improved information and knowledge. This leads us to look at the wider context for adapting societal structures and behavioural patterns by looking at the role of institutions in directing, facilitating or constraining change. The concepts of adaptiveness and resilience are as important in the social and policy arena as they are in forest management. Finally, we review evidence that trees, woodlands and forests have a symbolic role which makes them potentially a powerful means of helping people understand and adapt to climate change.

BOX 13.1 The need for social science in climate change research

The eminent climate change physicist Hans Joachim Schellnhuber of Potsdam Institute for Climate Impacts Research, after a daunting rundown of climate change threats, 'urged social science to take the front seat on the problem'. 'Speaking as a natural scientist', he said, 'I think 90% of research [on global change] will have to be done by the social scientists'. It's up to social science, he says, to figure out how we bring about massive economic and social transformation on a tight deadline. But, he says, 'I don't think the social science community has grasped the scope of the challenge' (Barnett, 2009).

13.1 Attitudes and beliefs

Several, largely quantitative, studies exist on the public's knowledge and perceptions of, and attitudes to, climate change (Defra, 2001–2008; Downing, 2008; Downing and Ballantyne, 2007; Maibach *et al*., 2008). The findings generally indicate a high level of awareness of terms such as 'climate change' but not a clear understanding of the processes and causes of climate change. In particular, recent studies show a lack of understanding of how trees may contribute to climate change mitigation (Forestry Commission, 2007a,b,c) although a recent study with young people and children showed that they had a good understanding of the potential of trees to reduce levels of carbon dioxide in the atmosphere (Lovell, 2009).

Data from the Public Opinion of Forestry survey data for 2007 (Forestry Commission, 2008) show a modest level of awareness of forestry's value in the context of climate change (51%). Awareness is higher among rural and ethnically white British people than others. The data also show that there is variation among economic classes in terms of their knowledge about causes of climate change and mitigation, and beliefs about the future impact of climate change. This variation also correlates with frequency of woodland visit – those who visit more often tend to be more knowledgeable and less pessimistic. This variation reflects a more general disparity between social classes and ethnic groups in terms of access to and appreciation of woods and forests (Forestry Commission, 2008).

13.2 Information, experience and behavioural change

More information does not necessarily change people's behaviour, especially where complex issues are concerned such as climate change (Sturgis and Allum, 2004; Ockwell *et al*., 2009). Instead we need to better understand and consider the role of different influences affecting choices and behaviour. Without the appropriate emotional, cultural or psychological disposition, information will make no difference.

For example, research in Australia found that public understanding of global environmental issues drew not only on scientific information, but also on local knowledge, values, and moral responsibilities (Bulkeley, 2000). People who lack immediate, sensual engagement with the environmental consequences of their actions display greater destructive tendencies; again, awareness is not enough to curb destructiveness (Worthy, 2008). Emotional connection to the environment tends to be greater amongst those who have grown up in rural areas than in urban (Hinds and Sparks, 2008; Teisl and O'Brien, 2003). Engendering greater empathy towards nature tends to increase the level of connectedness people feel towards it (Schultz, 2000). Emotional affinity with nature is able to predict nature protective behaviour, such as public commitments to environmental organisations and the use of public transport (Kals *et al*., 1999). Some of these links are stronger than others and all bear further research.

More specifically in relation to trees and forests, Nord *et al*. (1998) found strong correlations between frequency of visits to forest areas and self-reported pro-environmental behaviours. Emotional connection has been rated as more important than knowledge, in forming attitudes to environmental issues such as logging native forests (Pooley and O'Conner, 2000). A survey of nearly 2000 Swedish private individual forest owners showed that strength of belief in climate change and adaptive capacities were found to be crucial factors for explaining observed differences in adaptation among Swedish forest owners (Blennow and Persson, 2008).

13.3 Adaptive capacity

Adaptive capacity can be defined as the characteristics of organisations, communities, or societies which enhance their ability to adapt to environmental change. Adaptive forest management is an approach which recognises that complexity and uncertainty require us to treat forest management as experimental, requiring enhanced monitoring and feedback to decision makers. Given the range of forest and woodland ecosystems, and uncertainty about how climate change will affect them, no single approach to mitigation and adaptation will suit all situations. Forest managers, therefore, need to have sufficient flexibility to choose locally appropriate management practices, and to work with other stakeholders, especially local people, to systematically improve these practices by means of observation, analysis, planning, action, monitoring, reflection and new action (Seppälä *et al*., 2009).

Studies of the social and institutional requirements for adaptive forest management are scarce compared with more technical studies. One such in Ontario, Canada (MacDonald and Rice, 2004) showed that:

- institutional barriers are more limiting than technical barriers;
- most conflict is in the assessment and design steps of the adaptive management cycle;
- the process needs flexibility, trust, and consensus-building;
- wider application of active adaptive management requires staff retraining, cooperation among management agencies, encouragement of innovation and regular adjustment of policies and practices.

This last point links to the need for adaptive capacity in the wider context in which forest management takes place. Work on adaptation published by IUFRO notes that:

> 'The predominant hierarchical, top-down style of policy formulation and implementation by the nation state and the use of regulatory policy instruments, such as forest laws, are likely to be insufficiently flexible and may stifle innovative approaches in the face of climate change… Given the uncertainties surrounding the impacts of climate change, a more flexible and collaborative approach to forest governance is needed that can respond more quickly to policy learning. Policies will need to place greater emphasis on financial incentives for individual and cooperative/partnership to forest management, supported, where necessary, by appropriate regulations.' (Seppälä *et al*., 2009)

An adaptive policy context will not focus on forestry alone but recognise that many drivers of change originate in other sectors (agriculture, energy, transportation and land use). The IUFRO report argues that market-based instruments such as forest certification, and approaches such as criteria and indicators for the monitoring and reporting of sustainable forest management, are more likely than regulatory approaches to serve this purpose (Seppälä *et al*., 2009). However, economic incentives and regulation are not mutually exclusive and in the UK context with a legacy of regulatory approaches (Kitchen *et al*., 2002), it may be necessary to build in an adaptive approach to regulation. Others also argue that the separation of mitigation and adaptation in policy processes may be counterproductive (Swart and Raes, 2007).

Finally, if more adaptive communities also have more in-built ecological resilience, there will be a need for higher levels of tree planting in urban, peri-urban and targeted privately owned rural areas. This means that the literature on motivations for tree planting, and engaging with spatial planning systems, is relevant (Götmark, *et al*., 2009; Hauer and Johnson, 2008; Pauleit *et al*., 2002; Ross-Davis *et al*., 2005; Saavedra and Budd, 2009; Siry *et al*., 2004; Van Herzele and Van Gossum, 2008).

13.4 Need for new approaches to knowledge generation and use

The high profile of climate change knowledge means that knowledge claims become politically contested (Bäckstrand and Lövbrand, 2006). The result is a lack of consensus about knowledge, methods and ethics around climate science (particularly in the context of forestry) (Lövbrand, 2009), and a perceived split between technocratic knowledge ('science can fix the problem') and locally relevant knowledge (Adger *et al*., 2001). Such situations can provide governments with the scope for a more participatory interpretation and assessment of knowledge, credibility and authority, and some authors argue that this makes climate change knowledge potentially more inclusive and open-ended (Demeritt, 2006; Lövbrand, 2009). This is supported by citizen science networks recording changes in seasonal behaviour of species in connection with climate change, which suggest that reflexivity (awareness of own basis for knowledge) and credibility (awareness of others' basis for knowledge) contribute to personal and societal meaning-making around climate change. Public knowledge about climate change can include training in environmental monitoring (Lawrence, 2009a,b) as well as involving interest groups and others in consultation and decision-making on land use planning and management.

Forest management has for centuries relied on a linear model of knowledge generation and communication (i.e. research and extension). Adaptiveness requires a different approach which responds to complexity by drawing on a range of knowledge types, and which builds in monitoring for learning in the face of uncertainty. North American literature in particular indicates that this requires a radical adjustment of knowledge and strategies to adequately plan and enhance the uses of trees and forests in line with ongoing and future climatic changes (McKinnon and Webber, 2005; Ohlson *et al*., 2005; Spittlehouse, 2005). This requires forest managers to embrace a more process-based management approach that balances careful long-term 'design' with maintaining the capacity to 'adapt' (Fürst *et al*., 2007).

13.5 The particular role of trees and forests in social change

Trees and woods have a significant role in many people's life and could thus potentially help in people's understanding of climate change. For example Henwood and Pidgeon (2001) found that woods are key features in defining place, and people see them as symbolic of nature itself. Many people value the contribution of woods to human well-being (through knowledge, experience and sense of relationship with woodlands) more highly than other forest ecosystem functions (Agbenyega *et al*. 2009). This suggests a particularly significant role for woodland management and the engagement of forestry with the public, in contributing to societal understandings and responses to climate change.

13.6 Conclusions

The evidence given above suggests the following:

- Many people find it hard to make sense of scientific information about climate change, and the associated complexity and uncertainty.
- Factors other than knowledge or the simple provision of information are important in achieving behavioural change in relation to global warming.
- Social behaviour is influenced by institutions. These institutions need to be able to change and to continue to be able to do so; in other words, to be adaptive.

These findings come largely from areas other than forestry or woodland management. We can hypothesise that they are relevant to forestry, but these hypotheses need to be tested. The following conclusions can be drawn specifically in relation to trees woods and forests:

- Knowledge about the role of trees in climate change mitigation and adaptation varies within society, and is often confused.
- Trees, woods and forests have a special symbolic value in many people's sense of place and understanding of the environment.

These findings emphasise both the potential and the need for further research.

13.7 Research priorities

- We can hypothesise that trees have a significant role in influencing people's understanding of and responses to climate change. This needs to be further tested across wider geographical areas and among different social groups, and through action research, which explores the effects of developing people's experience of and emotional connection with trees and forests, for example through art or education activities.
- The climate change debate presents a particular opportunity for forestry experts to engage people in environmental analysis. Research highlights the gulf between expert and local knowledge. Given the special symbolic value of trees and forests in the climate change debate, forestry knowledge could be received and trusted differently from some other forms of technical expertise. This needs to be tested.
- Research in other countries suggests that adaptive forestry organisations need to develop new approaches to using knowledge (research and innovation). This needs to be tested in the UK forestry context, for example by understanding how forest managers make sense of new information about climate change/species suitability/silvicultural practices, and how this affects decision-making. Such adaptiveness also includes working co-operatively with other organisations, and the processes and outcome of such partnerships needs to be researched in the UK context.

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