Climate Change and the European Countryside: Impacts on Land Management and Response Strategies

Summary Report of the CLIO Project 2006

“Climate Change is a critical matter facing all of us today. All sectors of society have a responsibility to reduce their greenhouse gas emissions and to think carefully about the potential impacts that climate change may have for them and how they may have to adapt.

“I am therefore delighted that the Country Land and Business Association, and the University of East Anglia, thanks to grant aid from the East of England Development Agency, have engaged with other organisations, public and private, British and Continental, to conduct this study. It is an important initiative and the report contains a great deal of detailed information at ground level gleaned from Estates across Europe, which will be used to inform Estate managers in the East of England and beyond.

“Land managers truly have a unique role in combating climate change because they offer the possibilities of storing carbon in soil and trees, and in supplying carbon-saving renewable energy and building materials. On the other hand farming is a major source of methane and nitrous oxide, two powerful greenhouse gases, which must be reduced. I welcome the focus of this report on landowners and managers playing their part in combating climate change. It shows some important first steps towards devising practical actions for our land managers to cope with and help mitigate the worst effects of climate change.”

David Miliband - Secretary of State for Environment, Food and Rural Affairs

This report, part of the wider CLIO (Climate Impacts and Options) project, is based on a detailed study of 21 rural estates, representing a broad range of biogeographical regions across Europe. It documents the different ways in which climate change is already affecting each estate, considers strategies to adapt to the changes and looks at ways in which rural estates can use carbon management to mitigate climate change and considers necessary policy actions.

The overall impression from the estates studied is that the likely negative impacts of climate change popularly discussed are being, if anything, understated. Although an increase in atmospheric CO₂ implies a theoretical increase in crop growth and greater efficiency in water use, in practical terms, these potential advantages are likely to be outweighed by water stress and an increase in extreme weather events. Any increase in crop yields is therefore likely to be associated with northern Europe and to take place only where there is no water limitation.

Considering the opportunities for estate managers to adapt to climate change leads us to conclude that this is going to be more limited and difficult than is often supposed. Adaptation to the changing climate will include increased winter storage of water, earlier sowing of crops, introduction of more heat-tolerant crops, increased vaccination of livestock, development of a more balanced fire, pest and storm resistant forest structure, improved soil cover, more effective coastal management and greater protection of vulnerable species and habitats.

The results of our calculations of the carbon accounts on the estates suggest that the best opportunity for estates to help mitigate climate change is by: energy substitution through the provision of more renewable energy, followed by material substitution of wood for concrete, brick and steel in construction, followed by increasing carbon sinks.

However, these strategies need coherent government encouragement. The current gaps in the policy framework must be addressed so that rural estates can play a crucial part in a fully integrated climate policy, helping the economy achieve the transition to the low carbon future which is in the best interests of agriculture, forestry, biodiversity and society as a whole.
Documenting the impacts of climate change

Rising temperatures
Average temperatures across the estates are showing a marked increase, with summers getting hotter and drier, and winters milder. Nine out of 14 estates for which average annual temperatures could be compared before and after 1990 showed a decadal rate of increase of between 0.5 and 0.7°C. The speed of these changes is difficult for many plant species to adapt to. Crops and trees, fish in shallow waters and animals kept indoors are all likely to suffer increasing heat stress.

Changes in rainfall
Changing precipitation patterns and their interaction with increasing temperatures will have the most severe effects on estates. Heavy rains are causing increased flooding and erosion. Rivers will reach peak flows earlier or later in the winter, with consequences for winter abstraction. Particularly in southern and eastern Europe, there is likely to be an increase in river basin areas suffering severe stress. At the same time, groundwater recharge rates are falling, particularly in lowlands and areas of low effective rainfall, while recharge in chalk aquifers is likely to be reduced further as the start of the recharge period in late autumn is delayed.

An increase in spring and summer droughts
Spring drought represents the greatest climatic threat to cereal crops on estates that are predominantly arable and will have a serious impact on estates without irrigation, or where irrigation is unlikely to be permitted. The impact will be exacerbated in seasons when groundwater recharge is inadequate, with a consequent threat to existing irrigation. Summer droughts are likely to become more frequent and start earlier: in France and central Europe the longest dry spells would potentially increase by up to 50%. They will be most severe in the Mediterranean region and the Iberian peninsula.

Threats to forestry
Storm, wind and snow are the biggest source of damage to European forests, with many of the estates having experienced large storms in recent years. The second largest source of damage is pests, which are likely to increase as a result of summer drought and milder winters. Increasing populations of spruce bark beetle are particularly associated with hot summers and consequent damage to stands of Norway Spruce. Another threat is fire; forest fires occur annually in almost all European countries, although most seriously in the Mediterranean region.

All the estates in this study contain significant carbon stocks. The forest sinks are of particular importance, and the annual growth in the carbon stock after harvest currently outweighs the estates’ agricultural greenhouse gas emissions in many cases. However, rising temperatures are expected to reduce the capacity of soils to store carbon, which, from 2050, could outweigh the effects of increased afforestation in Europe. Peat sinks, with their higher volumes of carbon, are likely to be particularly susceptible to drying out and consequent fire risk.

Late frosts and hail – threats to other crops
The increased frequency of late frosts occurring after mild winters presents a risk to fruit and other growing crops, while the increased intensity of spring and summer hail, combined with an extension of the growing season, is potentially damaging to all crops.

Sea level rise
Sea level rise represents a direct threat to most coastal estates and storm surge levels will increase. There will be an increasing loss of coastal wetlands, with a corresponding need to manage land loss. Where the beach and dune system is currently in equilibrium, its management will come under increasing pressure, while the standard to which adjoining public defences are maintained is often critical.

Biodiversity
Migratory bird species, particularly those reliant on tundra or mountain habitats and coastal wetlands, are likely to be affected by changes on migration routes, as well as in breeding and wintering habitats.

Fish stocks are likely to be adversely impacted, especially Atlantic salmon, whose metabolism is altered by higher sea temperatures, with the result that the fish are often unable to meet an increased need for food. A rise in river temperatures may also adversely affect spawning.

An analysis of 1,350 plant species, some 10% of European flora, suggests that by 2080 more than half the species considered could be endangered or extinct.

There is likely to be a continuing increase in invertebrate pests, like ticks, and resultant tick borne diseases with implications for livestock health. The sheep (deer) tick, which transmits the louping ill virus, is expected to impact on northern British Isles estates.

As impacts become more severe and unforeseen effects develop, it will be important for estates to monitor a range of environmental measures for management purposes. Monitoring will help estates manage sensitive species in a more consistent manner and also allow for scientific investigation into observable impacts of climate change.
Strategies to adapt to the effects of climate change

Water resources
The building of estate reservoirs offers an obvious means of adapting to reduced water availability. Storage of winter rain is particularly important in areas where the groundwater resource is limited. But the increasing uncertainty of winter rain in some regions raises concern over any planning policy which would allow additional extraction for the competing domestic or industrial sectors in areas with low groundwater recharge.

Cropping
Individual estates must either adapt their cultivation practices or change the crops and varieties they grow in response to climate change. In northern Europe, cereals will be harvested earlier, but yields of winter cereals will depend on the scope for early establishment in potentially wetter drilling seasons. The introduction of more heat-tolerant Mediterranean crops will become an option, but expansion of the areas under fruit and vegetables or irrigated maize would have implications for water use, while the movement of arable crops further north in Sweden and Finland would frequently be frustrated by soil types or would require major land-use change from forest to agriculture.

Livestock management
Livestock management will require greater emphasis on prevention of heat stress and disease. Vaccination of domestic livestock, and some wild populations, may become increasingly important because of globalisation.

Soil erosion
The main way to control soil erosion is to maintain vegetation cover, although soils under annual cropping systems will remain vulnerable to heavy rainfall between harvesting and planting. With hotter summers and earlier harvests, the ground may be left bare for longer periods before autumn drilling. In more extreme climate conditions, maintenance of year round vegetation though woodland and permanent pasture may be the only option.

Forestry
Conversion to uneven-aged, mixed species forests with continuous cover, and the replacement of individual tree species by those better suited to the site and climate, will enhance stability and resilience against gale damage and pests. Much of the financial impact of gale damage can be overcome by the provision of storage for potential windblown timber. The substitution of broadleaved species for conifers is already occurring but implies a lengthening of rotations to achieve similar timber volumes.

If forestry is to be used as a carbon sink and continuing source of renewable materials, it is essential to minimise fire risk. This can be achieved through a combination of fire breaks, public awareness, regular patrols at times of high risk and the provision of local reservoirs to give fire-fighters ready access to water.

Coastal zones
Greater investment in sea defences and coastal management techniques will be necessary for estates in coastal zones, including dune management, the creation of stable headlands along their frontage and beach nourishment.

Biodiversity
While there is little scope for managing biodiversity in the face of temperature increases, other than enhanced site protection for plants moving to higher altitudes, there is scope for the management and creation of habitats at lower altitudes, including wetlands, and along migration routes, where coastal zones are likely to be of key significance. Climate change will increase the need for careful management of native biodiversity and effective control of alien invasive species.

Economic and sectoral diversification
Many estates will seek to adapt to climate change through economic diversification, although this indicates the relative inadaptability of their traditional core functions. Tourism is an obvious choice, and most of the participating estates have already taken steps in this direction, driven partly by the historic decline in agricultural and forest income.
How rural estates can use carbon management to mitigate climate change

In order for estates to obtain a standardised measure of their carbon impact, an assessment tool based on current Intergovernmental Panel on Climate Change (IPCC) methodology has been developed: CALM (Carbon Accounting for Land Managers).

This makes use of normal data available on most farms of their energy and fertiliser use, the cropping, and livestock production and systems, to calculate the Greenhouse Gas Emissions converting them to carbon dioxide, and then carbon equivalents. The other side of the accounts, the annual carbon stored (or sequestered) in trees and soil is calculated from information on the areas of forestry and the type of trees, their age and other factors. The detailed assumptions and technical coefficients used are reported in detail in the main report.

The idea behind the CALM analysis is to enable farmers and land managers to assess what impact their activities are having by constructing a carbon account from readily available data. This then enables them to assess what they can do about the climate impacts of their activities and help to mitigate climate change.

The experience of this study is that these calculations are feasible. The data requirements for estimating carbon storage are the more demanding part of the calculation because it needs quite detailed information on the tree inventory. In countries where timber production is a commercial activity this is usually available, but this is not the case in countries, such as the UK where much woodland is under-managed. For farmers to see the relative magnitudes of emissions and sequestration from the activities on their land is in itself a vital part of beginning to think about what, if anything, they can do about it.

The results of our study lead us to the broad conclusion that the three main mitigation routes for land managers are: energy substitution, material substitution and then increasing carbon stocks and sinks. These are explained below.

Reducing greenhouse gas emissions – energy substitution

There are considerable opportunities for estates to reduce greenhouse gas emissions by converting estate use of energy from fossil fuels to renewable energy sources such as biofuels, biogas and biomass, as well as by using energy more efficiently. Estates can also introduce the production of biofuels and biomass crops. Wheat or sugar beet can be used for bioethanol and oilseed rape for biodiesel. Perennial grasses such as miscanthus, and wood, either from specially grown coppice, or in the form of waste from existing timber production, can be used either alone or for co-firing, locally or in power stations. Potential savings in greenhouse gas emissions to other sectors have been estimated ranging from 38 to 61 tonnes carbon equivalent per 100ha for oilseed rape, 72 to 107tC equivalent per 100ha for bioethanol from wheat, 154 to 525tC equivalent per 100ha for bioethanol from sugar beet, 449 to 929tC equivalent per 100ha for miscanthus and 104 to 264tC equivalent per 100ha for short-rotation coppice.

Land currently in set-aside is already available for these crops and biofuels can be introduced into existing rotations by substitution for existing root and break crops or by changing the use to which an existing crop is allocated. Sometimes (and most obviously in the case of sugar) the present use is expected to decline following trade agreements and there is an opportunity to integrate trade, energy and climate policy. Other land-based renewable energy sources include wind (which is outside the scope of this report) and hydroelectric power.

Reducing greenhouse gas emissions – material substitution

Another opportunity for reducing greenhouse gas emissions is the use of timber instead of other materials for construction. The emissions avoided by replacing one cubic metre of red brick or heavy concrete with sawn timber have been calculated as 4,000kg CO₂ and 2,900kg CO₂ respectively. On this basis, annual emissions savings in the range of 4.6tC/ha and 3.3tC/ha could be achieved by the most productive European forests.

There is a considerable surplus of forest available for wood supply as annual fellings are currently estimated to be below increment in temperate and boreal forests. The substitution would mostly occur after maturity in 60 to 80 plus years, with the new forest providing earlier benefits as a carbon sink and a source of biomass and small-scale substitution from thinnings.

Increasing carbon sinks and stocks

The other contribution estates can make to carbon mitigation by source is through the management of carbon sinks and stocks. Woody biomass offers the greatest possibilities on a per hectare basis, either by afforestation or by better management of existing forest. Most small woodlands in Europe are under-managed and fail to achieve optimal standing volumes of timber.
The importance of government policy

Although adaptation measures will be required to cope with the degree of climate change that is already inevitable, without effective mitigation, adaptation will fail. Adaptation policies will have implications for public funding, while effective mitigation is likely to depend on a combination of societal changes: reducing consumption, greater efficiency in energy use and technology. Policy actions are required to internalise the pollution costs of existing fossil-fuels. A reduction of 66% in 1990 levels of greenhouse gas emissions would be required to stabilise atmospheric carbon by 2150. This would in turn imply a target reduction of 8% to 8.5% for 2013 to 2017 to follow the first commitment period under the Kyoto Protocol. However, for the last two years, EU emissions have actually risen.

Current government incentives

A number of instruments are already in use to promote renewable energy:

- Within the EU, tariffs have been introduced to encourage the supply of renewably generated power to the national grid in Austria, France, Germany and Portugal
- In Denmark, there is a settlement price for energy generated from biomass, biogas, waste or wind
- A number of countries offer tax exemptions
- Investment subsidies are available in Austria, Finland, Germany, Poland, Spain, Sweden and the UK
- Renewable energy certificates are employed in Denmark, coupled with mandatory obligations in Italy, Sweden and the UK
- In Sweden, consumers will be required to buy certificates equivalent to 17% of electricity use by 2010
- In the UK, licensed electricity suppliers are required to source a percentage rising from 4.9% in 2004-05 to 10.4% by 2010-11 by acquiring Renewable Obligation Certificates or paying a buy-out price per megawatt hour.

The opportunity

Current targets for renewables are unambitious. For example, the UK could achieve a 10% biofuels target, based on current land use, simply by employing set-aside and the wheat surplus. But clear policy decisions are required if the necessary levels of investment are to be achieved.

In the EU renewable energy from biomass and wastes rose from 40 million tonnes of oil equivalent (Mtoe) in 1992 to 58Mtoe in 2003 (EUROSTAT). In the heat sector, the use of biomass in new combined heat and power and district heating installations has risen by nearly 50% since 1990 in Finland and by nearly 40% in Sweden, where 25% of central heating is now produced by woodchip.

Even applying strict environmental constraints on agriculture and forestry, the EU could produce 190Mtoe from bioenergy by 2010, rising to 295Mtoe, or 15% to 16% of the projected energy requirement by 2030. Of this, bioenergy crops from agriculture are estimated to contribute 47Mtoe by 2010, rising to 142Mtoe by 2030, with a more or less constant 40Mtoe from forest waste (European Environment Agency).

Carbon trading

Since the changes in carbon stocks will form part of national inventories, it would be logical for the woodland giving rise to the credits under Article 3.3 of the Kyoto Protocol to be eligible for carbon trading, which could be on the basis of five-year certificates, renewable as appropriate.

Sustainability

Sustainability is understood as a balance of environmental, economic and social interests. The pressures of globalisation demand a level playing fields in terms of freer trade and basic legal rights, thereby making ever more necessary the internalisation, wherever possible, of social and environmental costs and an effective global climate policy. There is a corresponding need to validate locality, increasingly understood in terms of traceability and, a preference for local food and energy, as well as the need to conserve local communities with their built and cultural heritage, and the local environment.

Towards an integrated climate policy

Adaptation to climate change is local, but mitigation, while the investment is delivered locally, must be global. The landowner, who produces for both world and local markets, is at the fulcrum of these forces, and at the same time fully exposed to climate change as he seeks to plan (and to plant) for his children and grandchildren.

A fully integrated climate policy will harness agriculture, forestry and land use as a single sector, encouraging the production of biofuels, biomass and timber, and the management of carbon sinks and stocks, while liberating land from direct, taxpayer-funded food support as other sectors internalise their environmental costs. The landowner's role is then not only to reduce his own emissions, assuming increasing responsibility for managing water, habitats and biodiversity as he does so, but to help enable the rest of society and the economy achieve the transition to the low carbon future which is in the best interests of agriculture, forestry, biodiversity and society as a whole.
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The work reported herein was carried out with grant aid paid by EEDA.

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