WOODLAND TRUST

# Adapt or die?

*Climate change and woodland*

The Woodland Trust

*Campaigning to keep woodland alive*


*Boscastle flood*

**The Woodland Trust believes that climate change is the biggest threat to the UK's native woodland. This booklet summarises for those actively engaged in climate change and environmental policy the complex interdependencies between forests and climate and why our view of forests and woods must change. It describes the adaptive measures we believe are necessary for woodland in the UK to remain resilient in the face of climate change and to offer a higher quality, more sustainable environment for everyone.**

## INTRODUCTION

Climate change, driven by human induced greenhouse gas emissions, has now moved from a deeply contested theory to a universally accepted reality. The signs of a changing climate are all around us, from rising average global air and ocean temperatures, increased frequency of extreme weather events, retreating glaciers, and shrinking ice sheets, to changing patterns in plant and animal lifecycles and ranges.

While acknowledging these changes, society is grappling to respond. Climate change is a problem of global scale and intergenerational consequences, which requires us to view the world in a new light. It challenges our faith in institutions which regulate the environment and it confronts our view of science as a source of definitive answers. It also demands that we work within uncertainty and occasionally with intuition, as individuals and collectively.

Climate change has also highlighted, often dramatically, our dependence on and deeply embedded place within the natural world. Storms, droughts, floods, changing patterns of nature, and shifting seasons affect human society and culture, no less than they affect the rest of the biological community. Climate change challenges our view of nature and our place within it.

Society's response to climate change must include measures to mitigate the factors causing it, most particularly emission of greenhouse gases. But, even if the emission targets within the Kyoto protocol (which has still yet to be universally agreed) were met, optimistic projections still envisage a warming climate and with it unprecedented environmental changes.[1] We have long moved beyond the point where mitigation alone can save us from the impacts of climate change.[2] We must face the fact that change is inevitable and develop measures for adaptation.



## THE PROGRESS OF CLIMATE CHANGE

The arguments and projections for climate change are now widely acknowledged. Global average temperatures have increased from 13.7 degrees centigrade to 14.3 degrees centigrade in the last 100 years; the 1990s was the warmest decade in the last 1,000 years; worldwide, many ice sheets and glaciers are retreating; the frequency of floods, droughts and storms is increasing; populations, ranges, migration patterns, and the seasonal and reproductive behaviour of animals and plants are all changing. Evidence that the principle cause of these changes is greenhouse gases, released by human activity, is now overwhelming.[3]

The Intergovernmental Panel on Climate Change (IPCC), predicts that atmospheric carbon dioxide ($CO_2$) levels of the main greenhouse gases, will rise from pre-industrial levels of 280 parts per million (ppm) to between 540 ppm and 970 ppm by 2100. A doubling of atmospheric $CO_2$ is projected to increase global average temperatures by 3.5 degrees centigrade, with a 90 per cent probability that warming will be between 2.4 and 5.4 degrees centigrade.[4] The Royal Commission on Environmental Pollution recommended a 60 per cent reduction in $CO_2$ emissions by 2050. But, even if this were achieved overnight, the accelerated warming of the last 50 years would continue. This means that adapting to climate change has to be a priority.

Projections for climate change for the UK indicate that, during the 21st century, the temperature will increase by 0.1 – 0.3 degrees centigrade per decade with more rapid warming in the South East compared to the North West. There will be fewer frosts and, as the temperature rises, the growing season will lengthen. One of the warmest years on record was 1997, but nearly all years are projected to be warmer than this by 2080. Winters are likely to become wetter, with a greater incidence of very heavy rainfall, whilst summers may be drier, particularly in the South East of the UK.[1]

Forecasts of the progress of climate change are characterised by uncertainty.[4] Climate models used to estimate ecological and socio-economic impacts can only provide a range of outcomes with associated probabilities. The uncertainty inherent in the models, and in the responses of ecological factors, mean it is hard to foretell what these changes might mean for wildlife, agriculture, forestry, health, flood control and business. In particular, it is an increase in the frequency of extreme events, rather than average projections of change, that are likely to cause the greatest impacts and pose the greatest difficulty in the development of adaptation strategies.

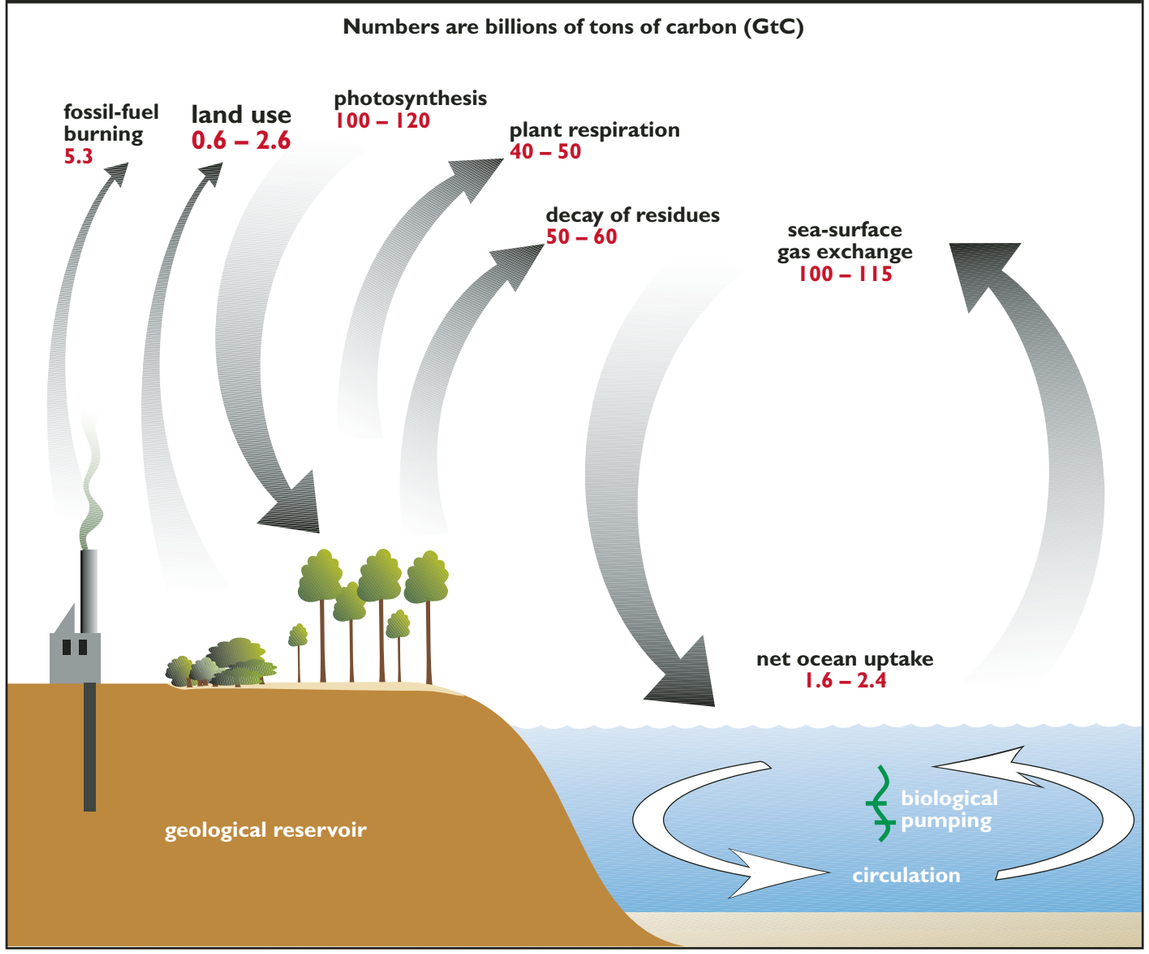
*Barrow, Alaska*

# CLIMATE CHANGE, TREES AND FORESTS

## Forests and the global carbon cycle

Carbon is continuously cycled between reservoirs in the ocean, on land and in the atmosphere, where it is present as carbon dioxide ($CO_2$). On land, it is tied up in forests, other plants and fungi, animals, soil micro-organisms and decaying organic matter. While the largest store of carbon is in the deep oceans, it cycles with upper ocean waters over centuries. In contrast, atmospheric, terrestrial and upper ocean $CO_2$ elements are closely linked and cycle rapidly.[6]

**THE GLOBAL CARBON CYCLE**




*Source: www.esd.ornl.gov/iab/iab2-2.htm*

Natural transfers between parts of the carbon cycle are twenty times greater than those due to human activity, but releases from carbon sources more or less balance those absorbed, or 'sequestered' by the carbon 'sinks'. It is the carbon from human-induced sources, mainly because of the exploitation of fossil fuels – oil, gas and coal – and deforestation, which has led to the increase in atmospheric $CO_2$ over the last 150 years.[6]

Global deforestation accounts for 30 per cent of total greenhouse gas emissions.[3] Between 1980 and 1995 the area of the world's forests decreased by 180 million hectares.[7] Levels of deforestation in the Amazon rainforest in 2004 were the second highest ever, according to the Brazilian government's own figures. Such major deforestation releases massive amounts of stored carbon into the atmosphere.



Forests are of crucial importance in the global carbon cycle, both as sources and sinks for atmospheric $CO_2$ because they are estimated to contain around 80 per cent of all above ground and 40 per cent of below ground terrestrial carbon.[8] The way in which we treat the world's remaining forests, and the response of forests to climate change, has complex interactions with the carbon cycle and effects on atmospheric carbon levels.

In addition, changes in the climate will have impacts on forests which in turn affects the carbon cycle. As parts of the tropics become warmer and drier, large areas of tropical rainforest will be transformed to open savannah woodland, grassland or even desert, releasing the carbon currently stored in the forests.[9] Changes in the distribution of insect pests and the frequency of pest attacks, particularly due to the spread of 'exotic' pest species, such as Asian Longhorn beetle,[10] can lead to a net loss of carbon from forests. Increases in droughts in southern and central Europe are already leading to an increase in forest fires, such as those in 2005, liberating carbon and reducing soil organic matter.

*Illegal deforestation and land grabbing (grilagem) in the Middle Land, State of Parai, Brazil*

© Greenpeace/Pedro Armestre

*Climate forest fires Portugal 2003*

However in the northern hemisphere and particularly in temperate areas, increases in $CO_2$ may enable forests to grow faster because of increased photosynthesis, leading to additional uptake of carbon by forests. But hopes that climate change could mean increased forest productivity may be misplaced since an increase in temperature also increases respiration by plants and can speed breakdown of soil organic matter, both of which release $CO_2$ to the atmosphere. In addition, where climate change leads to changes in rainfall and lower available water during the growing season, plant photosynthesis is restricted, reducing the amount of carbon sequestered.

In addition to $CO_2$ absorption, forests have other impacts on the climate. The dark canopy of northern boreal forests absorbs the sun's heat, compared to the reflective surface of snow and ice. A northward progression of boreal forests would reduce the reflective surface area and could lead to increased heat absorption at the earth's surface, which may at least partially offset the gains made through increased carbon absorption. [11]



WTPL/Steven Kind

*Mature woodland*

## Sequestration – forests as carbon sinks

Trees sequester carbon from the atmosphere using roots as well as leaves and needles. Undisturbed forest soils also accumulate organic matter that in turn stores carbon. Creating new forests as carbon sinks, as a method of mitigating climate change, is consequently a potentially attractive option.

During the early stages of the growth of a new forest, the uptake of carbon is relatively rapid. This slows as the forest matures, until it reaches the point where the amount absorbed annually is in equilibrium with the amount lost through respiration and decay. At this point, whilst there is no further net loss of carbon from the atmosphere, the forest is storing large amounts of carbon. The maximum potential for carbon storage in UK woodland is around 200 tonnes per hectare for undisturbed ancient woodland. However, for the UK to become carbon neutral, through forestry planting alone, would require an area of 50 million hectares. This is twice the land area of the UK. [12]

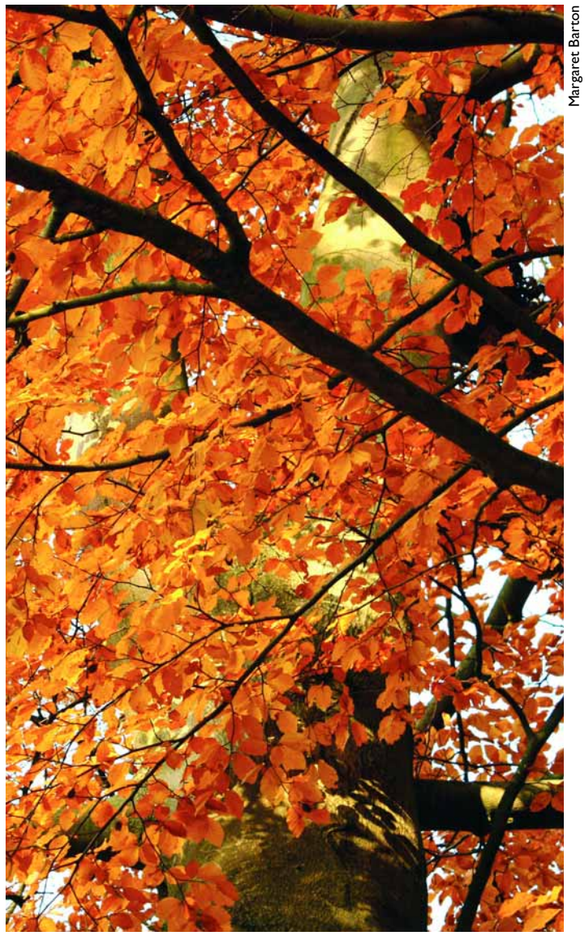
WTPL/Adrian Tucker

The planting of new forests as carbon sinks is a contentious area of climate change mitigation. Even if deforestation was rapidly reduced and most of the available land for forestry worldwide planted with trees, this would only delay the doubling of $CO_2$ concentrations in the atmosphere by 20–30 years, assuming fossil fuel consumption continues to rise as expected. Preventing deforestation and planting more forests are a vital part of the struggle to tackle climate change, but they do not provide a defence for avoiding urgent action on reduction of $CO_2$ and other greenhouse gas emissions.

## Future impacts of climate change on biodiversity

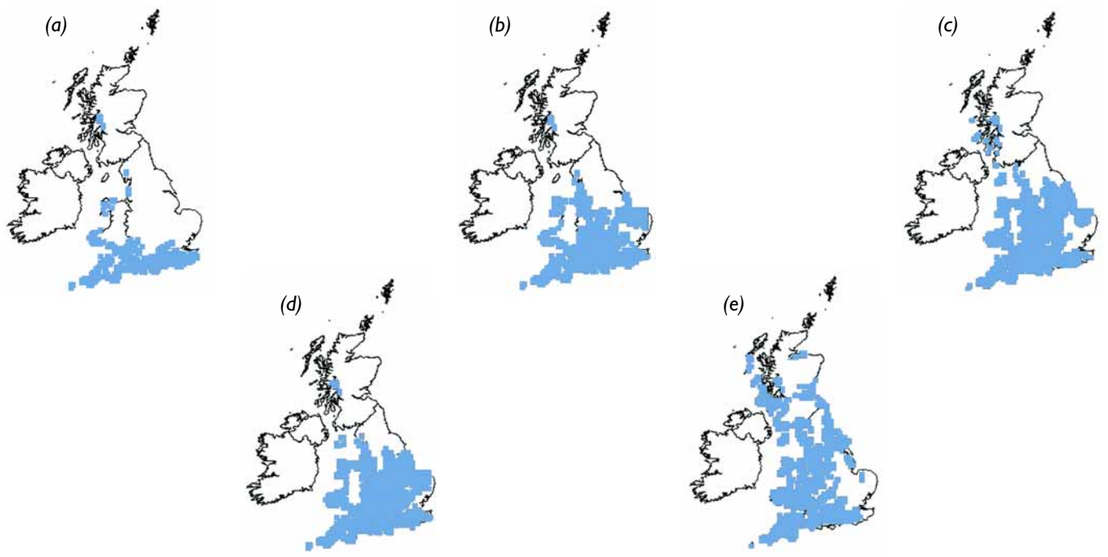
Climate change will impact upon forest habitats and the species they support, by disrupting species life cycles, altering interactions between species, and necessitating species either adapt or move to more suitable climatic and habitat conditions. Examples of climate-induced impacts that can already be observed include beech trees suffering from increased periods of summer drought stress, particularly in South East England, while oak is generally coming into leaf three weeks earlier than the 1950s with knock-on effects on the insects and birds it supports.

The cumulative impact of climate-induced stress on the future composition of our woods is uncertain, but they will certainly be different from today and may well be less diverse as the wildlife they support struggles to adapt to rapid change. Research programmes like MONARCH (Modelling Natural Resource Responses to Climate Change), undertaken by the Environmental Change Institute at Oxford,[14] have used models to analyse the impact on future locations of suitable 'climate envelopes' for a number of species. Results indicate how species will need to move in response to climate change, in order to remain in suitable climatic conditions. When this is coupled with the problems of a drastically altered and fragmented landscape, the future for wildlife looks troubled.



Margaret Barton

*Records show autumn colours are being seen earlier*



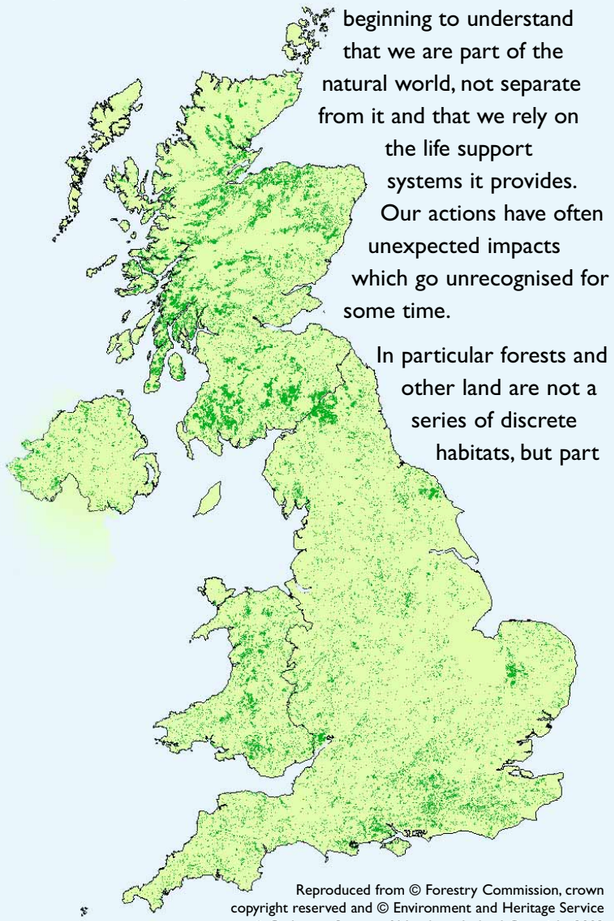

*Distribution of beech modelled using two different future climate scenarios: (a) simulated current distribution (1961-90); (b) 2020s Low scenario; (c) 2020s High scenario; (d) 2050s Low scenario; and (e) 2050s High scenario.*



# CHANGING THE WAY WE THINK ABOUT THE NATURAL WORLD, FORESTS, AND TREES AND OUR INTERACTION WITH THEM

Climate change is starting to teach us that the Earth's environment is not a series of self-contained machine-like systems that can be manipulated simply to provide human needs. The systems that support the global biosphere are part of a complex and interconnected web. We are also beginning to understand that we are part of the natural world, not separate from it and that we rely on the life support systems it provides. Our actions have often unexpected impacts which go unrecognised for some time.

Reto Stöckli
NASA Goddard Space Flight Center



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In particular forests and other land are not a series of discrete habitats, but part of the interconnected web of ecosystems, which operate across landscapes; they both contribute to, and are affected by, the global ecosystem. This understanding should change the way we think about conserving the natural world and forests in particular.

While protected areas will continue to play a crucial part in safeguarding existing biodiversity as seed corn for the future, these must form part of a more comprehensive conservation strategy. We cannot think of individual woods or nature reserves without consideration of the wider landscape. Furthermore, protective measures and management based on a static view of species at a given location, will be confounded by species movements in the face of climate change.[2, 15] We must promote opportunities for movement and adaptation of species within the landscape, and create new landscapes that make this possible.

## Woodland area in Britain

**As a result of centuries of clearance, woodland in Britain covered just 5 per cent of our land area at the beginning of the last century. Even today, Britain is one of the least wooded areas of Europe with less than 12 per cent woodland cover.[16] In England the figure is just 8.6 per cent.[17] This compares to a European average of 46 per cent (37 per cent for EU). Much of the increase in forest area in Britain is a result of the rapid expansion of commercial forestry in the uplands during the second half of the 20th century. Although it is problematic to put an accurate figure on the total amount of ancient woodland plus 'native' woodland planting, it is estimated to be less than four per cent of land area.[18]**

## Sustainable societies?

As well as giving wildlife a better chance of survival, creating and restoring a more sympathetic landscape will improve the environmental services on which humans depend and reduce the impacts of climate change.

Photograph courtesy of Bracknell Forest Borough Council

*A sustainable urban drainage system in Bracknell.*

For example, experience overseas shows that when water catchments are denuded of their vegetation cover in winter through the intensification of land use, flash flooding and soil erosion are often the result. By working with nature, adaptation strategies attempt to reduce the frequency and intensity of these events, for instance, by planting woodland and re-creating grassland. In a country like Britain with such low woodland cover,it is ironic and almost negligent, that there is not more research underway to investigate the potentially positive impacts that afforestation of water catchments and floodplain woodland would have in relieving flood risk and benefiting both wildlife and society.

Surface drainage water from the built environment is normally discharged into the public sewers, flooding the system at times of high storm flow. Sustainable Urban Drainage Systems (SUDS) allow the water to be collected in features where it can drain away naturally, while also adding to the visual interest and biodiversity value of urban areas.

Photograph courtesy of City of York Council

*York, 2000.*

# DEVELOPING ADAPTIVE STRATEGIES

## Adaptation for wildlife and for people

Adaptation strategies aim to reduce the damage from climate change and increase the resilience of ecosystems and society to its unavoidable effects. Adaptation strategies are not an alternative to mitigation; indeed, they should add to the urgency for action, by recognising the inevitability of climate change. However, they can be implemented without the need for international agreement and they can realise short-term benefits as well as longer-term advantages;[13] for instance, it may be that the creation of floodplain woodland can bring almost immediate biodiversity and flood management gains.

A frequent response to the call for adaptation action is that it is difficult to plan future action in the face of uncertainty. However, any hope that we can create models that allow us to predict climatic changes with certainty and design predictive responses with precision is illusory. What is important is to act in a way that allows for uncertainty.[15]

This in turn means reducing or avoiding actions which cause jeopardy, and increasing or maintaining those which increase stability within the ecosystem, to increase its ability to adapt to uncertain change. Adaptation should involve developing natural systems that can absorb and respond to change. By making natural systems more resilient, not only will biodiversity gain, but human society can also benefit from the 'services' which natural ecosystems provide, such as flood relief, healthy soils, carbon pools and future sequestration, improved water quality and renewable natural resources.

Facing the challenges in this way, rather than responding to the fears associated with climate change, can help change attitudes which will assist in both mitigation and adaptation. The development of adaptive strategies can be a catalyst for technological, institutional and societal innovation. It demands integration and communication amongst scientific disciplines, economic sectors, government departments, landowners, communities and citizens.

### The ecosystem approach

**The ecosystem approach is a holistic strategy for the integrated management of land, water and living resources, that promotes conservation and sustainable use in an equitable way.[19] The emphasis is on long-term sustainability, integrating human activities and conservation of nature, including political, economic and social values. The ecosystem approach is intended to balance the three objectives of the Convention on Biological Diversity, namely; conservation, sustainable use and the fair and equitable sharing of genetic resources.**

**In 1995 the Conference of the Parties of the Convention on Biological Diversity adopted the ecosystem approach as the primary framework for action under the Convention.**

**The ecosystem approach requires that the conservation of ecosystems structure and functioning should be a priority since it will help to protect the goods and services that they deliver to human beings.[20]**

Woodland, as the most widespread semi-natural habitat in the UK, is uniquely placed to act as a key component for a more sympathetic and receptive landscape for wildlife and for society in the face of climate change. To ensure its future value for wildlife and for society, the following steps must form part of an adaptation strategy based on an ecosystem approach –

- Preventing any further loss of semi-natural habitats, not just conserving a representative sample. Any further loss of forest or other habitat is likely to add to atmospheric $CO_2$ and will destroy the immediate opportunities for species to expand from their current range as the climate changes.
- Restoring all woodland and other semi-natural habitats, which have been planted with non-native conifer plantations, through sensitive management to predominantly broadleaved woodland or other previously extant semi-natural habitat.
- Targeting habitat creation in areas where there is the greatest potential for woodland biodiversity to expand and survive. Initially this will be in areas with the greatest existing concentrations of ancient or semi-natural habitats.[21]
- Reducing the negative effects of intensive land use on semi-natural habitats by creating protective 'buffers' of new habitat and extend their area rather than simply physically link them.
- Reducing the intensity of the land-use between semi-natural habitats, increasing the ability of wildlife to move through the landscape.[21, 22] This includes reductions in diffuse pollution, improved soil management, fewer herbicide and pesticide inputs, reductions in grazing pressure to deliver more sympathetic management of existing habitats, re-establishing more transitional habitats and more natural green space within urban environments.[22]


WTPL/Fiona Grainger

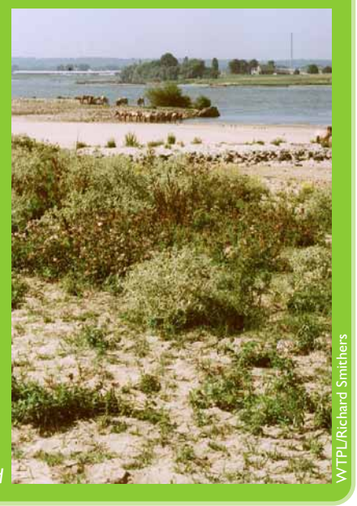
- Continuing to regenerate woodland or create new woodland with 'native' or naturalised species. Attempts to predict which non-native species might be better suited to a projected change in climate are too speculative and their deliberate introduction may only compound the rate of change with which the ecosystem has to contend.

## Climate adaptation action in the Netherlands

**In the Netherlands, the risks of flooding from the sea and from peak discharge levels from the Rhine, Meuse and Scheldt rivers almost led to disaster in 1993 and 1995, when dykes were nearly overtopped and thousands of people were evacuated as a result. However, the response to this near catastrophe has not been to build the flood defences even higher, an approach which the Dutch public rejected. Instead a 'living with water strategy' was developed which aimed to accommodate extreme weather events, rather than fighting them with heavy infrastructure. Occasional flooding is accommodated in designated areas where, with the co-operation of farmers along the main river systems, land use has been changed to a more natural state.[23]**

**This ecosystem approach is now being adopted across the Netherlands including places such as Millengerwaard near Nijmegen,(see photograph). Economic benefits accrue from these 'soft engineering' options which absorb peak flows, reduce flooding risk, increase biodiversity and reduce the cost of construction and maintenance of hard defences such as dykes. Whereas previous land use in intensive agriculture was a major source of $CO_2$ emissions, the new land use can, in some circumstances, become a carbon sink. It has been suggested that this could allow farmers to be compensated using carbon credits.**

**In addition to reducing the risk of flooding, wildlife has benefited from the transformation of floodplain to a more natural habitat; which then forms part of the larger ecological network being developed in the Netherlands to aid the dispersal of species.[24]**


WTPL/Richard Smithers

*Konik Ponies, Millingerwaard*



# MAKING IT HAPPEN

We believe the Government, and all those in a position to influence land use policy, must take the following steps to deliver adaptive action with great urgency:

- Continue the process of reform of the Common Agriculture Policy (CAP) to help reduce intensity of land use. The new Rural Development Programme offers opportunities for extending semi-natural habitats and shielding them from some of the impacts of neighbouring land use. Cross-compliance already offers the chance of making payment of subsidies dependent on achieving minimum environmental standards and could be increased, for example, to reduce the input of chemical pesticides and fertilizer, themselves a product of fossil fuels and contributors to climate change.
- Ensure that regional and national spatial planning protects the environment and takes account of climate change, while maximising the opportunities for creating landscape scale changes to benefit both wildlife and humankind. In particular, use Strategic Environmental Assessment and sustainability appraisals within the planning process as the climate changes.
- Ensure that the delivery of the Water Framework Directive, which focuses on managing whole catchments rather than individual water bodies, helps to create landscapes which benefit both wildlife and human society, for example, the development of floodplain woodland and Sustainable Urban Drainage Systems (SUDS) which incorporate trees and woodland.
- Make best use of incentives for forestry, to prioritise action for woodland creation and the restoration of semi-natural habitats planted with non-native conifers, which both offer opportunities for the movement of wildlife in response to climate change. Woodland creation provides the win-win-win of carbon storage, less intensive land use and increased biodiversity.
- Ensure the review of the UK Biodiversity Action Plan sets challenging targets and actions that can accommodate uncertainty and the reality of changing species assemblages and habitats.
- Achieve full protection of all ancient and semi-natural habitats and target resources to best effect by concentrating efforts initially on the expansion of existing concentrations of semi-natural habitats.
- In line with the Convention of Biological Diversity, implement management practices which recognize the uncertainty and complexity of the ecosystem and proceed in the absence of complete knowledge.[15]

In addition, it is vital that Government policy is consistent. In the same way that it is a mandatory part of the policy process to 'rural proof' policy developments, it is essential that all policies are 'climate proofed'. This should ensure that adaptation strategies are not hindered, but are fully supported and improved by policy development. This will require 'vertical proofing', within Government departments, and 'horizontal proofing' across different departments within Government.

Policy makers should systematically:

- Consider whether their decisions are likely to have an impact on strategies for adaptation to climate change.
- Make proper assessment of those impacts, if these are likely to be significant.
- Adjust the policy, where appropriate, with solutions to the needs of climate change adaptation.
- Ensure climate proofing applies to all policies, programmes and initiatives, and to both design and delivery stages.

# CONCLUSION

The Earth is going through a period of unprecedented environmental change as a result of human activity. This has brought us to the point where our own future and that of the rest of biodiversity is threatened. To ensure a habitable future for both wildlife and people we must take action to adapt to the inevitability of climate change. Despite the urgency, to date there has been an almost complete failure, in the UK and abroad, to match the rhetoric with political action. One thing is certain. Without international co-operation it will not be possible to tackle spiralling $CO_2$ emissions. Collectively and individually, we have a responsibility and an obligation to respond to this great challenge, both in mitigating climate change and adapting to its impacts.

Trees and woodland provide scope for ameliorating some of the worst effects of a changing climate. They can also help to reawaken our relationship with the rest of the natural world and to reassess our attitude and approach to the environment we all share. We have outlined some practical steps, which we believe can be taken now, to begin this transition. The Trust believes that restoration and expansion of native woodland in the UK, can create a landscape that will help the adaptation of wildlife to the changes we now surely face and that will benefit us all. This is a necessity not an option.

## Time for action not rhetoric

**'It is not axiomatic that pollution causes damage. But it is likely. I am a strong supporter of proceeding through scientific analysis in such issues. But I also, as I think most people do, have a healthy instinct that if we upset the balance of nature, we are in all probability going to suffer a reaction.'**

**Tony Blair:** speech on climate change, The 10th anniversary of His Royal Highness' Business and the Environment Programme, 14 September 2004.

**'We now have sufficient evidence that human-made climate change is the most far-reaching – and almost certainly the most threatening – of all the environmental challenges facing us.**

**'Environmental issues – including climate change – have traditionally been placed in a category separate from the economy and from economic policy. But this is no longer tenable. With a global average rise of 2 degrees centigrade above pre-industrial levels or more, the consequences – for agricultural productivity, water stress, ecosystems and human health – become potentially devastating.**

**'Here, as elsewhere, we must live up to the ideal of an international community acting for the public good - for the present generation, and for generations to come.'**

**Gordon Brown**: Speech to Foreign and Environment Ministers of the G8, 15 March 2005.

**'The need to tackle climate change is urgent. Here in Britain, it is still seen by too many people as a rather distant concern - distant in terms of time, and distant geographically. But the effects of climate change are being felt right here, right now.**

**'This piecemeal policy-making must change; the challenges facing us are too great for such lazy government. It is not just about ticking off a few boxes – it is about changing our political system and changing our lifestyles.'**

**David Cameron**: Change our political system and our lifestyles, Independent online, 1 November 2005



# GLOSSARY

**Adaptation** Those strategies or options which focus on reducing the expected damage caused by rapid climate change by combating or averting the detrimental effects.

**Afforestation** The conversion of land that has not been forested for a period of time (the definition in the Kyoto Protocol is 50 years) to forested land through human activities such as planting and seeding.

**Ancient woodland** Ancient woodland is a term used in the United Kingdom to refer specifically to woodland dating back to at least 1600 in England and Wales, (or 1750 in Scotland). Before this, planting of new woodland was uncommon, so a wood present in 1600 was likely to have developed naturally.

**Boreal forest** A broad band of mixed coniferous and deciduous trees that stretches across northern North America, Europe and Asia; its northernmost edge, the taiga, intergrades with the arctic tundra.

**Carbon cycle** The term used to describe the flow of carbon through a system. The forest carbon cycle refers to the flow of carbon through a forest ecosystem. The global carbon cycle refers to the flow of carbon through the Earth's atmosphere, oceans, forests, and other terrestrial ecosystems.

**Carbon pool** A system having the capacity to accumulate or release carbon. Examples of carbon pools are forest biomass, wood products, soils, and the atmosphere.

**Carbon sink** Opposite of a carbon source. A carbon pool can be a sink for atmospheric carbon if, during a given time interval, more carbon is flowing into it than out of it.

**Carbon source** Opposite of a carbon sink. A carbon pool can be a source for atmospheric carbon if, during a given time interval, more carbon is flowing out of it than into it.

**Climate change** A statistically significant variation in either the average state of the climate or in its variability, persisting for an extended period of time (decades or longer).

**Deforestation** The conversion of forested land to non-forested land as a direct result of human activities.

**Forest** A vegetation type dominated by trees. Many definitions of the term forest are used throughout the world, but for the purposes of the Kyoto Protocol, a nation must choose to define a forest as being any land area covering at least 0.05-1.0 ha that has at least 10-30per cent tree crown cover, and trees that have the potential to reach 2-5m height at maturity.

**Greenhouse gases** Greenhouse gases are those gaseous constituents – both natural and anthropogenic – of the Earth's atmosphere that absorb infrared radiation emitted from the Earth's surface, the atmosphere, and clouds. By absorbing infrared radiation, these gases trap energy in the Earth's atmosphere and cause the greenhouse effect – the trapping of heat in the lower atmosphere – and influence the global climate. Water vapour ($H_2O$), carbon dioxide ($CO_2$), methane ($CH_4$), and ozone $O_3$) and nitrous oxide ($N_2O$) are the primary greenhouse gases in the Earth's atmosphere.

**Kyoto Protocol** The Kyoto Protocol to the United Nations Framework Convention on Climate Change is an agreement under which industrialised nations will reduce their collective emissions of greenhouse gases by 5.2 per cent compared to the year 1990 calculated as an average over the five-year period of 2008-2012. It came into force on 16 February 2005 when countries emitting 55 per cent of the total carbon dioxide emissions for 1990 of the Parties included in Annex I had ratified the agreement.

**Mitigation** Those strategies or options which reduce the net emissions of greenhouse gases into the atmosphere, either by reducing greenhouse gases emissions or by increasing the sinks for greenhouse gases

**Photosynthesis** The process in which organisms, with the aid of chlorophyll (green plant enzyme), convert carbon dioxide and inorganic substances into oxygen and additional plant material, using sunlight for energy.

**Respiration** The process occurring within living cells of plants and animals by which the chemical energy of organic molecules is released in a series of metabolic steps involving the consumption of oxygen and the liberation of carbon dioxide and water.

**Sequestration** The process of increasing the carbon content of a carbon pool other than the atmosphere.

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## Where to find out more

The Woodland Trust is the UK's leading woodland conservation charity. We are committed to:

- **No further loss of ancient woodland**
- **Restoring and improving the biodiversity of woods**
- **Increasing new native woodland**
- **Increasing people's understanding and enjoyment of woodland**

Established in 1972, the Woodland Trust now has over 1,100 sites in its care covering over 19,000 hectares (47,000 acres) of woodland. It offers free access to nearly all of its sites.

The Woodland Trust aims to conserve, restore and re-establish the UK's woodland. To carry out our work, we rely on the generosity of the public, industry, commerce, and agencies. If you would like to support us or would like more information about our work and membership details, please contact your nearest Woodland Trust office.


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# The Woodland Trust

*Campaigning to keep woodland alive*