

Bush Telegraph

The House Magazine of the Edinburgh Consortium for Rural Research

SCIENCE FOR A CHANGING CLIMATE

The theme of this edition is most timely, coming when the impending issues of Climate Change are climbing rapidly up the political and scientific agenda in the UK. The UK's Stern report, published in October has concluded that we need to spend 1% of global GDP in slowing down and arresting the warming, to save as much as 20% in impacts later. Such a conclusion from the chief economist carries weight, and he is talking about £500 bn per year of spending.

However, that this is not all doom and gloom was the thesis of an ECRR Seminar held on 1 November, principally for our graduate students looking to pursue careers utilising the sciences and engineering represented in ECRR. Usually, where there is a threat, there is also an opportunity. Many of those opportunities will be in Energy, from cleaning up after the more traditional base load suppliers to embracing the renewables in a way which is acceptable to communities.

Food security will become an issue, with Scotland not immune given wetter winters and drier, hotter summers. Elsewhere, the issue will be critical without rapid adaptation policies, strategies and science. The poorest will be hit worst and require the greatest help. Africa's temperatures will outpace the 2°C average global increase which is now inevitable.

On the other side, the natural resource which will be most influenced by climate change is fresh water. Rainfall patterns will change; there will be a new emphasis on groundwater (and its protection). Rivers, such as the Ganges, which are fed by meltwaters may fail. Health impacts on farm animals and humans will be driven by new opportunities for disease vectors that emerge with a changing climate. The Blue-Tongue virus (affecting sheep and deer) is already migrating out

of Africa into southern Europe borne by an insect related to the Scottish biting midge.

In preparing these thoughts, I had the benefit of discussions with many colleagues in the ECRR fraternity, and I thank them for the wisdom, insight, and the examples they have provided. A summary of our conclusions is that there are enormous challenges, as well as opportunities, emerging for our Life and Earth Sciences.

This Bush Telegraph issue on the Climate Change theme sets the scene for the next ECRR Forum which is on Scottish Energy: its environmental and social impacts. It will be hosted at the SNH Battleby Conference Centre on 30 May 2007.

Chris Browitt
ECRR Scientific Director

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River Teith at Callander – Source: SEPA

Scottish Natural Heritage



Dr Noranne E Ellis

Scotland lies close to the boundary, the polar front, between cold polar air flows and warmer westerly winds. Latitudinal shifts in the polar front determine whether polar or more maritime weather prevails across Scotland. Usually westerlies predominate, their characteristics affected by the warm ocean current, the North Atlantic Drift, over which they pass. This ensures that Scotland has a more temperate climate than other places at these latitudes.

Cycles in the Earth's orbit and axis have caused global glacial and inter-glacial periods. About 10,000 years before present (bp), the Earth emerged from the latest glacial period. Scottish temperatures in January probably rose by 1°C with July temperatures rising by 5°C over a timeframe of about 500 years. By 5,000 year bp, annual temperatures in Scotland were possibly 1–1.5°C higher than those of the mid-20th century. Since then Scotland's average winter and summer temperatures have fluctuated by small amounts, one warmer period being between 1150 and 1300 AD when summer temperatures increased by 0.5–0.9°C and winters were mild. However, this warmer period was still cooler than the

TRENDS IN SCOTLAND

Increases in greenhouse gas emissions and various climatic variables have occurred since the 19th century.

- During the 20th century countries in latitudes north of 55°C (which includes Scotland) experienced a temperature rise greater than the global average, for example Europe warmed by 0.8°C. Within Scotland, the diurnal temperature range decreased with a spring temperature rise of 0.5°C having occurred between 1960 and 2000.
- During the 20th century, precipitation over land increased in the high latitudes of the northern hemisphere, contrasting with a decline in rainfall in the sub-tropics. By the early 1990s, Scotland was

witnessing some of the wettest years on record. Since 1995, countries north of 55° latitude in the northern hemisphere have had annual precipitation totals exceeding the 1961 to 1990 average.

- Although there has been little evidence of any increase in mean annual wind speed or maximum gust strength within Scotland, westerly air flows and the frequency of days with gales have both increased.
- Over the 20th century, cloud cover has increased in many parts of the World, including Scotland. Days with bright sunshine in Scotland have decreased in winter since the 1970s, particularly in the west.

late 20th century. Previous temperature fluctuations across the British Isles were not synchronous around the globe.

Between 1900–1950 Scotland's average annual temperature was 0.4°C warmer than at any time since the 15th century and increased by a further 0.4°C by 1996. The climatic trend across Scotland by the end of the 20th century was of a rapid warming.

Naturally occurring gases in the atmosphere

absorb thermal radiation without which the average temperature of the Earth today would be -6°C instead of about 15°C. These are termed 'greenhouse gases' and include water vapour, carbon dioxide and trace quantities of methane and nitrous oxide. The concentration of these, and other greenhouse gases, has increased over the last two centuries. There is now firm evidence that these are responsible for the current climatic changes rather than the natural changes in the Earth's orbit.

Scotland & N. Ireland Forum for Environmental Research



Ruth Wolstenholme

The Scotland & Northern Ireland Forum for Environmental Research (SNIFFER) has been managing climate change research for the past six years, but over the past eighteen months it has become one of SNIFFER's key topic areas.

SNIFFER also acts as coordinator for 'SCCIP' – the Scottish Climate Change Impacts Partnership. SCCIP has been established with the support of the Scottish Executive and the UK Climate Impacts Programme (UKCIP) to highlight the need to address the inevitable consequences of a changing climate and to build capacity amongst Scottish stakeholders to meet this imperative. These aims are encapsulated in SCCIP's mission "to increase the resilience of organisations and infrastructure in Scotland to meet the challenges and opportunities presented by the impacts of climate change".

SCCIP is working to deliver through a programme of activity which includes commissioning new research, sharing knowledge of new initiatives, hosting training events and seminars and participating in UK-wide consultations. To inform the work of SCCIP, SNIFFER has published studies on the business risks of climate change to Scottish public

sector organisations and on local authority activities to adapt to changing climate impacts. Both of these reports can be found at www.sniffer.org.uk/search.asp and by searching for project codes CC02 and CC05 respectively.

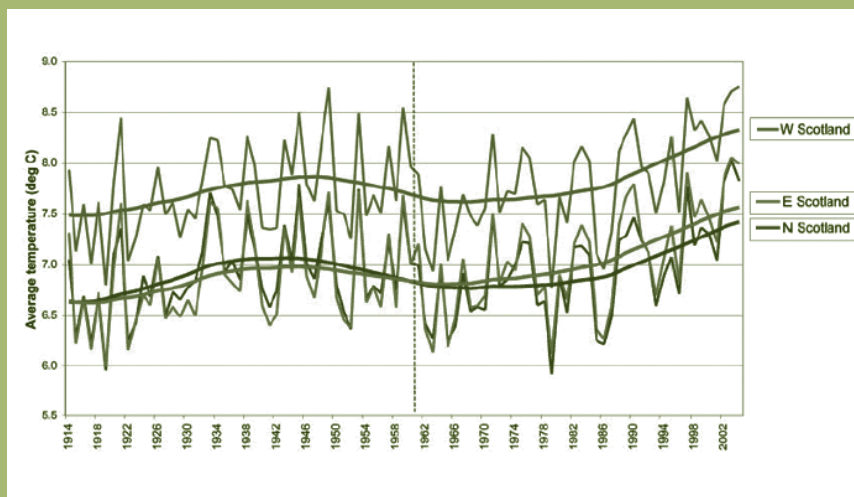
In the past year SCCIP has led a consultation events to feed into both the UK's Adaptation Policy Framework and to give Scottish stakeholders a chance to communicate their requirements to the development of the next set of UKCIP climate change scenarios due to be published in 2008. SCCIP is also working with the Sustainable Scotland Network chaired development group supporting local government climate change activities. It is planned that 2007 will see SCCIP events addressing the adaptation challenges to both the business and transport sectors.

May 2006 also saw the joint SCCIP / SNIFFER launch of 'A Handbook of Climate Trends across Scotland'. This work was commissioned by SNIFFER on behalf of SNH, The Scottish Executive, SEPA and the Forestry Commission. The Handbook presents the changes in twenty-four climate variables across Scotland over the last century. The trends examined provide benchmarks against

which future change can be measured. This resource is designed to be of value to users across a wide range of sectors and disciplines who are developing strategies to prepare for adapt to the impacts of a changing climate in Scotland. The Handbook presents the highlights in a simplified way; there is also a detailed technical report available. Both of these and a web version, identical in content to the Handbook, but offering greater flexibility of use and access to larger format maps and images, can found on the SNIFFER website www.sniffer.org.uk by searching using project code CC03.

The climate trend figure reproduced here has been provided by SNIFFER from Barnett C, Hossell J, Perry M, Hughes G (2006), *A Handbook of Climate Trends Across Scotland* (SNIFFER project CC03).

For more information please contact
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The average temperature (in °C) each year for Scottish regions, from 1914 to 2004 with smoothed curves to show a running average. The vertical dashed line marks 1961.
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Scottish Agricultural College



Jamie Skinner

FARMING IN A CHANGING CLIMATE

Anyone wandering through the Surgeons' Hall garden in central Edinburgh in November would have been surprised to see the geraniums still flowering. But winters are now warmer and the experts tell us that this trend is set to continue. For example in West Lothian winters are now 1.5 or 2 degrees warmer than they were only 40 years ago. That may not sound much, but climate change has considerable implications for Scottish farmers. On the plus side, higher winter temperatures mean that crop growth is less slowed by frost and snow.

On the negative side, pesticides and herbicides break down more quickly in warmer weather so more applications will be needed to keep down the weeds that also benefit from warmer winters, and the sharp frosts of yesteryear no longer kill the insect pests so effectively.

Climate change is a mixed bag for the farmer and the Scottish Executive has recently set up a working group to look not only at how to mitigate the greenhouse gas emissions from farming, that constitute around 12% of total Scottish emissions, but how to assist the agricultural community in adapting to future change. The group will report in March 2008.

Warmer average temperatures throughout the year may increase yields, but the wetter winters will bring greater threat of flooding and water-logging. Drier summers in the east will stress valuable crops such as potatoes, while perhaps increasing harvesting efficiency and reducing the need to dry cereals, as in 2006. Perhaps the most significant impacts will occur in world markets where major droughts in other grain growing countries, like Australia or Spain may raise world prices, as they already have done this year.

Scotland would probably escape the worst consequences of sea level rise as the land mass is still rising slowly every year, whereas parts of South East England have been naturally subsiding. But coastal farmers



River Forth at Kildean – Source: SEPA

in Scotland may still be affected by the increased frequency of storm events and tidal surges that are widely expected to accompany a warmer planet, especially in Scotland's estuaries.

The working group will look mainly at the medium term Scottish Executive policies that can support producers in adapting to a changing world and changing markets. Farmers have already shown their capacity to do that over many decades and as long as Edinburgh gardens have winter flowering geraniums rather than desert cacti, they will doubtless meet that challenge.

For further information please contact Jamie Skinner, Environmental Services Group Manager, SAC and member of Scottish Executive Working Group

Scottish Crop Research Institute



Dr Adrian C Newton & Professor Peter J Gregory

SCRI has a strong track record in responding to climate and environmental change, particularly in the development of appropriate agronomy and deployment of genetic resources to combat new pest and pathogen problems, and abiotic stresses. Specific areas of research include:

- Analysis of long-term climate records measured at Invergowrie to determine climate trends in the Dundee region. This analysis will be extended to examine crop yields and outbreaks of emerging diseases to quantify the existing impacts of climate change on current practices.
- The environment of soft fruit crops is an excellent example of where SCRI has developed solutions to cope with the new disease problems that arose first with machine harvesting and more recently with the change to growing in polytunnels. Perennial problems of root rots in soft fruit, late-blight on potato, and abiotic stresses such as frost tolerance have been tackled with genetic solutions involving considerable investment in germplasm resources and genetic and molecular mechanism research leading to durable resistance solutions.
- SCRI is developing an understanding of the resilience of cropping systems in response to environmental changes. A solid framework for understanding the functional interactions of crop ecology, essentially the biodiversity of the arable environment, has been developed. The key processes driving carbon and nitrogen cycling in these systems are being studied, and together these data have been used to refine research programmes that will better define sustainable arable systems.
- Roots are key to a plant's success, particularly in the more water-limited environments forecast and given the need to improve the efficiency with which nutrients are used. Their interaction with the soil community and structure, and the genetic and environmental control of root growth and activity, has been the focus of much of our work. Variation in root

PLANNED CLIMATE CHANGE RESEARCH AT SCRI

In addition to on-going studies on the impacts of projected climate change on crops, SCRI research is evolving to include more activities on mitigation and adaptation. New areas of research include:

• MITIGATION

- The role of plants in effecting carbon transfer to soils. SCRI is a partner in the SAGES consortium providing expertise in plant-mediated transfer of carbon to soils.
- Improving nutrient use efficiency of crop plants to reduce gaseous and leaching losses. New research programmes will be instituted to achieve multiple policy objectives related to climate change, water, waste, soils and biodiversity.

• RESEARCH ON ADAPTATION

- Mechanisms and sources of durable disease resistance. SCRI's experience with long-standing issues such as root rots in soft fruit and late-blight on potato have been tackled with genetic solutions involving considerable investment in germplasm resources and genetic and molecular mechanism research leading to durable resistance solutions. These resources will be deployed on the problems of new and emerging diseases.
- Development of new crops (including energy crops and those producing molecules of high value) to take advantage of more favourable growing conditions.

In continuing to develop its research relevant to climate change, SCRI will develop partnerships with universities (e.g. the SAGES project) to enhance knowledge that can inform mitigation policies and practices and with commercial bodies to ensure that knowledge and innovation which can benefit adaptation finds its way to market expeditiously.



architecture is a resource which has been developed as part of the barley Tilling population whereby useful genes (alleles) for adaptation to specific environments can be identified.

- Climate change and biodiversity interact in many important ways. The biodiversity of model crops (barley and potato) has been documented using molecular markers. This approach has become the keystone for collaboration in barley, allowing the demonstration of gene flow, the origins of important traits, and forming the basis of international resources for breeding for response to climatic and other changes. Similarly in potato, the Commonwealth Potato Collection provides a diverse source of germplasm that can be utilized to incorporate traits giving tolerance to biotic and abiotic stresses.
- Pest and pathogen problems shift their range as the climate changes. SCRI's development of diagnostics and markers has given us detailed knowledge of pest and pathogen epidemiology, geographic distribution and population structure which has, in turn, enabled us to develop informed strategies for crop protection and resistance breeding.

School of Geosciences, University of Edinburgh



Dr Stuart Simmons

SAGES

The Scottish Alliance for GeoScience Environment and Society (SAGES) has received a £6.5 million boost from the Scottish Funding Council as part of a £22 million initiative. SAGES pools academic resources from Scotland's universities and research institutions in a coordinated approach to understanding the Earth System, ensuring Scotland remains at the forefront of Climate Change research.

The scientific agenda tackles three major and interrelated components of the Earth System:

- *Theme 1, Landscape dynamics* will extend our current expertise in measurement of Earth processes and enable us to predict future sensitivity in the context of climate change. Research in this theme will create new levels of understanding and capability in numerical modelling of surface processes and landscape sensitivity.

- *Theme 2, Terrestrial carbon cycle*, builds on our current world leading capabilities in this field to identify and characterise global, regional and local carbon sinks and sources, thus enabling parameterisation of predictive models of the carbon cycle on these scales.
- *Theme 3, 'Atmosphere, oceans and climate'*, Scotland's premier research groups in palaeoclimate reconstruction, ocean and atmospheric dynamics come together to provide a platform on which to develop a modelling capacity to help predict future climate change driven by changes in atmospheric-ocean system.

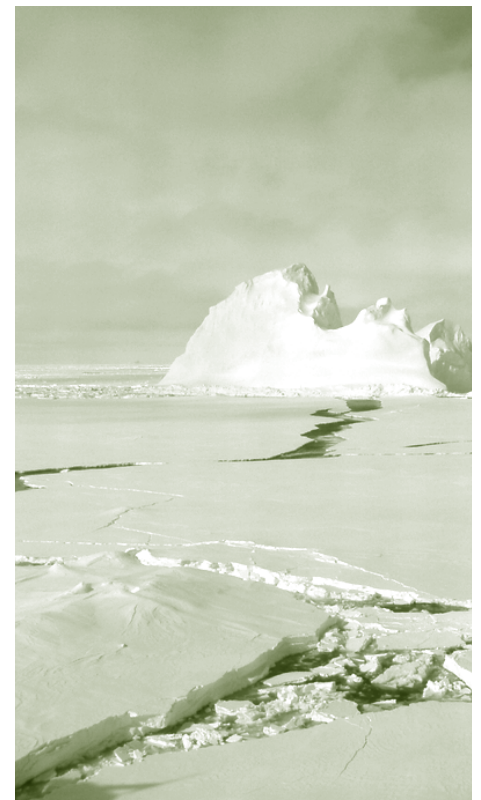
The three themes will be linked by the creation of three integrative programmes; the first is the **Centre for Earth System Modelling**, capable of predicting climate change and assessing its impact at a variety of scales. The second is **Knowledge Transfer** for the dissemination of findings and

research and thirdly a Graduate Programme focusing on cross disciplinary post graduate training.

SAGES is a partnership of nine Scottish Higher Education Institutions and the Scottish Universities Environmental Research Centre (SUERC)

- University of Aberdeen
- University of Abertay Dundee
- University of Dundee
- University of Edinburgh
- University of Glasgow
- University of Paisley
- St Andrews University
- Scottish Association for Marine Science (SAMS UHI)
- SUERC
- University of Stirling

To find out more please visit www.sages.ac.uk or email: stuart.simmons@ed.ac.uk



Royal Botanic Garden Edinburgh



Shauna Hay

CHAMPION FOR CLIMATE CHANGE RESEARCH



In recognition of its intensifying role as a key communicator on issues relating to climate change, the Royal Botanic Garden Edinburgh (RBGE) has appointed Chris Ellis (left) as its first official champion on the subject.

Dr Ellis has been charged with a remit which involves underpinning the organisation's taxonomic expertise by collating existing scientific material with other geo-referenced data to build a picture of past distribution of plant species and demonstrate how patterns have changed over the years. The aim is to provide large-scale datasets with which to model the differing response to climate change of the various species.

The Garden is also coordinating evidence gathered from international surveys – for example, altitudinal and climatic gradients in tropical diversity – and, closer to home, sensitive species and habitats including Scottish snow-bed ferns. Projects will be undertaken to reconstruct past vegetation change and the impact of historic climate change on a variety of plant species and vegetation types. These will lend themselves to the construction of predictive models to project the potential impact of current and future climate change scenarios at home and abroad.

Much of the work is being undertaken in partnership with outside bodies and dovetails with ongoing research, including the examination of the potential for non-native invasive species, such as Spanish bluebells, to threaten Scottish species during periods of climate change. There will also be research into the potential for evolutionary responses: investigating the potential of threatened species learning to adapt to climate change in situ, for example.

Far from seeing this as a new direction, RBGE takes the view that Chris Ellis' role will further consolidate the various strands of environmental research and conservation already undertaken by the organisation. As Regius Keeper Professor Stephen Blackmore explained: "Rather than changing the focus of our research, the new emphasis on climate change, brought together through Chris Ellis' new role, reflects the fact that one cannot study plant diversity without taking into account the changing world around us. People and plants are already being affected by climate change and as well as undertaking research we also recognise the need for wider public engagement and communication on this increasingly crucial subject".

The RBGE has an international reputation as a centre for excellence in plant taxonomy, systematics and biodiversity science. When the Garden was founded in 1670 the challenge was to discover new plants for medical purposes, to name and cultivate

them, and to train physicians and apothecaries to recognise them. Today there is even more urgent need to continue this work of discovery, communication and education for the purposes of conservation and sustainable use.

Staff in the Science Division carry out botanical research in four main areas:

- Tropical Diversity
- Major Floras
- Genetics & Conservation
- Cryptogamic plants and fungi

RBGE staff work on projects in over 40 countries worldwide. RBGE also has a major commitment to work on Scottish biodiversity and to supporting the delivery of the Scottish Biodiversity Strategy.



Dawyck Botanic Garden, near Peebles, in November 2006.

Royal Society for the Protection of Birds



Dr Jeremy Wilson

INTRODUCTION

The RSPB works on ways of limiting climate change at several levels. We devise and advocate policies that will cut emissions in the UK, EU and internationally, focusing mainly on energy and transport because they cause most emissions. We also try to cut our own emissions by, for example, operating a renewable energy scheme for our members and, installing renewable generation on our reserves and encouraging staff to travel by train rather than by road or air. We work to understand and reduce the impacts of climate change on birds and other wildlife and we develop strategies for adaptation to climate change.

POLICY OVERVIEW

RSPB considers climate change to be the greatest threat facing our environment and has given high priority to addressing this issue.

The RSPB works on policies both to reduce the greenhouse gas emissions that cause climate change (mitigation policy) and to allow wildlife to adapt to the degree of climate change that will inevitably occur (adaptation policy). Our work also looks for responses to climate change which are sustainable and avoid further harming the environment. We also conduct research into the present and projected effects of climate change on birds and other wildlife, both at home and abroad much of which has been published in the scientific literature.

One strand of work has involved mapping species distribution as a function of climate. Climate predictions are then used to predict the future distribution of this 'climate space' towards the end of this century, and the degree of overlap between these two distributions used to assess the likely vulnerability of different species to climate change. Second, we have examined the likely sensitivity of particular species to climate change in more detail by modelling variation in population size, survival rates or productivity as a function of climate.

UK

Activity on climate change has been hectic in the UK in 2005 and 2006. We actively participated in the G8 process in 2005, which focussed on climate change and on Africa, having several meetings with both Mr Blair and Mr Brown.

With development groups, as well as environment groups, we formed a coalition to press for more action to combat climate change, called Stop Climate Chaos (www.stopclimatechaos.org). With the same groups, we issued a series of publications, including one called 'Africa: up in smoke' with a forward by Archbishop Desmond Tutu, which we launched at the Gleneagles summit.

It is imperative to try to influence Government policy before it is made. In 2006, we participated actively in the recent review of all UK climate change policy and the separate review of energy policy. We also provided input to the Stern Review on the economics of climate change. In spite of much activity on climate change in the UK, it increasingly looks as though the government will miss its target to reduce carbon dioxide emissions by 20% by 2010 from 1990 levels. In Scotland, where much of Government's climate remit is devolved, we work closely with the Scottish Executive on its climate change programme and with key sectors such as energy, transport, forestry and agriculture to encourage greater progress in reducing greenhouse gas emissions. An important part of our work is in demonstrating the vital role of biodiversity conservation in helping with emissions reductions and in providing adaptive solutions such as restoring wetland habitats to address flooding problems.

EUROPEAN UNION (EU)

Much UK legislation on the environment now flows from EU legislation and so we try to engage with the EU Parliament, Commission and Council. For example, we worked with the Commission and Parliament on the Directive establishing the EU emissions trad-

ing scheme, which encompasses about half of all EU, and UK, carbon dioxide emissions. In 2005, we initiated discussion within the EU on adapting nature conservation policy to cope with climate change. In early 2006, we sat on two expert groups reviewing the EU Climate Change Programme: on emissions from aviation and from agriculture and forests. In summer 2006, we worked with the EU Parliament on a resolution concerning emissions from aviation.

INTERNATIONAL

Because climate change is caused by emissions from all around the world, we work on the international treaties that provide the framework for international action: the Climate Change Convention and its Kyoto Protocol. At present, the key issue is to conclude global agreement on country's emission reduction commitments for the period after 2012, when the first 'commitment period' ends. We are also working with others on including commitments to allow developing countries with tropical forests to claim credit for maintaining them, rather than cutting them down. If this can be done, it would have huge benefits for both climate change and biodiversity.

RAISING AWARENESS

The RSPB develops briefing material to help inform people across all areas of society of the importance of climate change and why we need to act, as well as offering advice on the action people can take as individuals. Through our education work we are also helping to engage with young people.

On our reserves we are helping both in the mitigation and adaptation of climate change. Our biodiversity work managing habitats can provide carbon sinks and stores and in helping make habitats more robust and expanding habitats we assist with adaptation. With large visitor numbers our reserves also enable us to demonstrate techniques for restoring habitats such as peat lands as well acting as showcases to interpret and demonstrate renewable energy technology such as solar panels.

Institute of Aquaculture, University of Stirling

Neil Handisyde, Lindsay Ross, Marie-Caroline Badjeck, Eddie Allison

CLIMATE CHANGE AND WORLD AQUACULTURE

A study by the Institute of Aquaculture, sponsored by the UK Department for International Development, examined the potential effects of climate change on world aquaculture. A report on the investigation titled, "The Effects of climate change on world aquaculture: a global perspective" gives an overview of issues surrounding potential climate change impacts on the globally significant aquaculture sector. The mechanisms by which climatic variables may affect aquaculture systems are considered, along with their potential social and economic consequences.



A team from the Institute's Geographical Information Systems and Applied Physiology Group, led by Professor Lindsay Ross, developed models which indicate vulnerable areas at the global scale using a broad range of social, economic and climate data. These provides a strong starting point for assessment of future climate change effects and a useful guide for both more localised, and issue specific studies.

Aquaculture plays an important role in the livelihoods of people from wide areas of the globe but it is in Asia where it is of greatest importance with an estimated 9.5 million aquaculturists.

The GIS models were used to indicate areas where livelihoods are likely to be vulnerable to climate change impacts on aquaculture. The models applied the concept that vulnerability is a function of exposure to climate change, sensitivity to climate change and adaptive capacity.

Making a distinction between climate trends, such as gradual changes in mean temperature and precipitation levels, and climate shocks, for example, floods and cyclones, is considered important when assessing potential impact pathways. The categories of fresh brackish and salt water culture are used to give some indication as to the location and type of aquaculture likely to be taking place within a country.

Asia featured highly in the vulnerability assessment with the large aquaculture-producing countries such as Bangladesh, Cambodia, China, India, The Philippines, and Vietnam, indicated as vulnerable under most scenarios. Although aquaculture production in Africa is low compared with

Asia, nevertheless many African countries are considered to have a very low adaptive capacity and are therefore considered vulnerable in some instances. A number of Central and South American countries are considered vulnerable with Nicaragua and Guatemala being areas of most concern.

Case study: Bangladesh

Bangladesh is one of the world's most densely populated countries with nearly half of its 138 million population being considered to live below the poverty line. With over 3 million fish farmers aquaculture is highly significant both in terms of food security and economic income.

Within Bangladesh sea level rising with associated land loss and salination of ground water as well as risk from storm surges and inland flooding would appear to represent the greatest potential climate related risks to aquaculture. The potential for water shortages during winter as a result of decreased precipitation combined with an increasing population is a concern.

Further research in the following areas is needed:

- Improved awareness of climate predictions for Bangladesh
- Analysis of the suitability of areas for aquaculture based on: predicted changes in climate; risk from extreme events; socio-economic evaluations; availability of seeds, inputs and support networks
- Development of a broad range of species
- Production and distribution of quality seed
- Cost-benefit analysis of species and culture methods in relation to climatic and environmental variables

Forest Research



Dr Mark Broadmeadow

INTRODUCTION

Many of the modern approaches to forestry, including provenance selection and silvicultural management are based on long-standing knowledge of the relationships between climate and forest productivity. It is therefore not surprising that there is concern over the implications of a changing climate to the forestry industry, particularly since much management practice has been honed to recent and current climate. Some species and communities of importance in ancient and semi-natural woodlands may be close to or at their climate limits, and thus conservation and biodiversity benefits may be threatened. Among the questions that need to be answered (and asked in some cases) are:

- Will the species and provenances currently planted survive under a changed climate?
- Will forest productivity change (for the better or worse)?
- Are there new biotic or abiotic threats?
- Do management practices need to change?
- What are the consequences for conservation plans?
- Can forestry play a significant role in counteracting climate change?

SCENARIOS

It is expected that the climate of the UK will become milder and wetter in winter, and significantly hotter and drier in the summer months over the coming century. These changes to our climate are predicted to be larger and more rapid than any since the last ice-age, posing real problems for trees, woodland and forestry.

RESEARCH

The FR research programme is improving our understanding of how woodland will respond to the many environmental drivers associated with climate change. This knowledge is being used to provide predictions of future changes to tree survival and growth and the functioning of woodland ecosystems, and to develop guidance on how best to adapt

to the impending challenges presented by climate change. It is becoming apparent that the impacts of climate change are relevant to almost all avenues of forest and woodland research, and we are developing a cross-programme approach.

Guidance on climate change impacts and adaptation is being developed from a number of approaches, including impact studies, process and empirical model development and the interpretation of forest monitoring data. Specific research areas at present include – meteorology; phenology; monitoring of woodland condition; predicting future species suitability using an ecological site classification; process model development and interpretation; impact studies; assessing and modelling the impacts of ground-level ozone pollution; and considering interactions with other aspects of environmental and socio-economic change.

STATUS

This research programme was established in 1993, addressing both climate change impacts and greenhouse gas balance research. Two separate research programmes were subsequently created in 2002, Forest carbon dynamics and a Climate change impacts programme, highlighting the importance of both subject areas in their own right.

Further information

The publication Climate change: Impact on UK Forests (www.forestresearch.gov.uk) describes current thinking on the most likely effects of climate change on UK forests and woodlands. It is recommended reading for forest managers and advisers, students and all those with an interest in the consequences of global change to our forests.

Further information is also provided in our member's contribution to this edition of Bush Telegraph.

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British Geological Survey



EVIDENCE OF CHANGING CLIMATES

Climatic records going back hundreds of thousands of years are being extracted from lake and ocean sediments. For example, a sediment core taken from a lake in Ethiopia, showing 9000 years of monsoonal history, has provided clear evidence of a dramatic change 5200 years ago when the climate turned arid. BGS scientists are engaged in several research projects aimed at extracting the past history of global climate changes from the geological record.

CAUSES OF CLIMATE CHANGE

The causes of climate change are many. However it appears that most climate change is driven by nature and not human society. For instance, the eruption of the Mount Pinatubo Volcano in 1991 caused a drop of 0.5°C in average temperature. Much atmospheric carbon dioxide has natural sources. In the past it may have been caused by the release of methane gas from natural deep-sea gas hydrates. There is evidence to suggest that massive releases of methane from hydrates may have influenced global climate change in the past. The BGS is engaged in research into the impacts of past volcanic events and decomposition of deep-sea methane hydrates.

MAJOR IMPACTS OF CLIMATE CHANGE

Water: it is highly likely that global climate change will affect Britain's groundwater resources. The BGS is modelling historical groundwater levels in order to be able to predict them on the basis of future rainfall.

Saltwater intrusion into coastal aquifers in small island states can make groundwater unusable for drinking and irrigation. We have developed models to simulate saline intrusion in several countries.

Tsunami: an increase in temperature could release methane gas from hydrates beneath the sea floor leading to an increase

in submarine landslides and subsequent tsunamis.

Landslides: landslides are frequent following periods of intense rainfall. Rising sea levels and rougher seas will increase the rate of coastal erosion.

Land surfaces: in areas underlain by naturally occurring clays that shrink and swell depending on how much water they contain, an increase in summer droughts and winter rains may cause greater shrinkage and swelling. Damage may be done to older property, whose foundations were not designed to accommodate such ground movements.

Flooding: increased rainfall in winter may have serious implications for flooding in Britain. There are practical limits to building ever-high flood defences. Other options for coping include the excavation of flood reservoirs, afforestation of the catchments, and reversion to natural floodplain functions and environments. It is also possible to mitigate flood risk, while enhancing recreational opportunities and biodiversity, by creating wetlands in the natural, low-lying basins within the natural floodplain.

Coastal change: coasts are vulnerable to sea-level changes resulting from climate change. The BGS carries out a wide range of geological survey, environmental monitoring and strategic research projects that relate to the various effects of climate change on coasts.

MITIGATION

If the world continues to use fossil fuels as it does now, annual global emissions to the atmosphere of the powerful greenhouse gas carbon dioxide will be 50% greater in 2030 than they are at present, and the average global temperature could rise 4.5°C above pre-industrial levels by 2100. This would have catastrophic socio-economic and environmental effects including an increasing frequency of extreme and damaging weather, shifting of climate belts, changing agriculture, a rise in sea level and changes in the distribution of plants, animals and diseases.

A potential solution to the carbon dioxide problem, at least while renewable energy capacity is being brought online, is to capture it from power stations and store it deep underground in suitable porous rock layers, such as depleting oil and gas fields, so that it never reaches the atmosphere or the ocean. The BGS leads European R&D in underground storage of carbon dioxide.

Editor's note: this contribution is a summary of a longer article which appeared in the June 2003 edition of the BGS newsletter 'Earthnews Notes.'

Centre for Ecology & Hydrology



Centre for
Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

Heath Malcolm

INTRODUCTION

The Centre for Ecology & Hydrology (CEH) is the UK's Centre of Excellence for research in the land and freshwater environmental sciences. CEH research is organised in core programmes and research themes, one of these being the Climate Change Theme.

BACKGROUND

The Earth's climate has varied in the past over immense periods of time. At the moment we are in a mild interglacial period between ice ages. However it is clear that humans are changing the climate system by activities such as the burning of fossil fuels (coal and oil), which have increased the level of greenhouse gases in our atmosphere. This has started to put the climate system out of balance. Changes in temperature

and rainfall and extremes of weather will have major impacts on the ecology and the hydrology of the Earth's land surface.

The Climate Change Theme is multidisciplinary and harnesses CEH's expertise in biogeochemistry, water and biodiversity to tackle the key environmental issue of climate change. Current predictions on the size and speed of climate change suggest that the 21st century will see major impacts. The Theme will identify these key processes and the impacts, using an Earth System approach – which acknowledges the complicated interactions that control change in ecological and hydrological systems.

MAIN RESEARCH TOPICS:

Detection and Attribution of Change in UK and European Ecosystems: This

topic will maintain long-term datasets to monitor ecosystem responses to environmental change, from CEH's Biodiversity, Water and Biogeochemistry programmes. These long-term records will be available to CEH scientists and the external community through the Environmental Informatics programme.

Ecohydrological Impacts of Climate

Change: This topic will use models and statistical techniques to isolate the impacts of climate change in the long term records. It will use data from all CEH science programmes. The main output will be improved predictions of how climate change will affect ecology and hydrology.

Land Surface Feedbacks in the Climate

System: This topic will measure the role of land-surface feedbacks in the climate system through energy, water and carbon cycles utilising long term datasets. It will also provide state-of-the-art representations of the key processes in land-surface and earth system models.

RESEARCH TEAMS

The Climate Change Theme utilises expertise across all CEH's Science Programmes. The three research teams below have individual projects and research activities that are directly relevant to Climate Change research:

- Ecosystem Assessment & Forecasting
- Earth Observation
- Process Hydrology

USING THE THEME'S OUTPUTS

We will collaborate with the Met Office, the Hadley Centre, the Tyndall Centre and NERC-funded programmes such as QUEST and the Climate & Land Surface Systems Interactions Centre (CLASSIC). The Theme will generate new knowledge and products which are relevant to the wider community, including the public and policy makers such as Defra and the European Commission (DG Environment).

For further information please contact Heath Malcolm, (CEH Edinburgh). Email: hmm@ceh.ac.uk; Tel: 0131 445 4343



Forest Research



Dr Chris Quine

Head of Station

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A NEW STRATEGY FOR FORESTS

A new strategy for Scotland's forests has just been published (see <http://www.forestry.gov.uk/sfs>) in which climate change is one of seven key themes – specifically 'Using forestry, and adapting forestry practices, to help reduce the impact of climate change and help Scotland adapt to its changing climate'. Scientists at the Northern Research Station are carrying out supporting research into adaptation and mitigation. Specific topics include the application of an ecological site classification to identify changing tree species suitability, assessments of the risk of windstorm and drought damage and the potential for changes in silvicultural practice, methods of increasing carbon sequestration.

A FOREST SECTOR APPROACH

Forest Research scientists were recently heavily involved in organising and contributing to an OECD workshop co-organised by OECD and the Forestry Commission on "Forestry: a sectoral response to climate change". The event was hosted at the Foreign and Commonwealth Office agency of Wilton Park and attracted approximately 45 delegates from 5 countries. A report on the conference, published by the International Institute for Sustainable Development (IISD) can be obtained at <http://www.iisd.ca/YMB/FOREST/SRCC/>

GREENING OUR ACTIVITIES

Staff at NRS are actively engaged in assessing how to reduce the footprint of activities and are considering opportunities to reduce energy usage, change building management, and review methods of travel. This site-focussed action is linked with broader Forestry Commission initiatives. Our



Professor Maggie Gill, Chief Scientist, ERAD, in conversation with Dr Chris Quine at the ECRR reception in November 2006

staff group would be interested to hear from others involved in changing the business culture of their organisation to greener ways – please contact Dr Steve Lee steve.lee@forestry.gsi.gov.uk

CLIMATE CHANGE

For general information on research activities in the field of climate change, look at <http://www.forestresearch.gov.uk/climatechange>.

A NEW DEVELOPMENT STRATEGY

A new Development Strategy for Forest Research was approved by the Forestry

Commissioners in early autumn. Integral to this is the need to reduce dependence upon core FC funding and to evolve areas of research to align with policy priorities. There is particular interest in building on existing expertise in areas of climate change, biomass, biosecurity, urban greening, health and well-being, and sustainable timber wood-chain. Enquiries from partners and collaborators are always welcome.

For further details of work of Forest Research at NRS please contact Dr Chris Quine.

For further details of work of Forest Research throughout Britain, please visit our website <http://www.forestresearch.gov.uk/> or consider subscribing to our newsletter FR-Eye <http://www.forestresearch.gov.uk/freye>

In Brief...



Researchers in Residence comes to Edinburgh

The way that many subjects are taught in schools can sometimes seem a million miles away from cutting edge research. A great way to bring research closer to school students is to let them meet the people doing it. For several years, the UK wide Researchers in Residence scheme (funded by the Research Councils UK and the Wellcome Trust) has helped researchers (PhD students and Post docs) spend some time in schools so that they can carry out activities to excite and to enthuse students about their research.

Meeting a real researcher is a powerful way to dispel stereotypes about researchers, this is especially important in science where these stereotypes can be very negative. It can also encourage students to consider pursuing a career in research. Teachers benefit from contact with the researcher in that it can increase their knowledge of current of developments in their field. Researchers also gain a lot from the experience. They develop valuable science communication skills and get an insight into teaching as a career. It also can give them a new perspective on their field of research.

Recently, the contract to run Researchers in Residence was won by the University of Edinburgh and the scheme is now lead by Vice Principal Mary Bownes with Jan Barfoot as the project manager. Although based in

Edinburgh, the Researchers in Residence scheme will be delivered in partnership with 7 other regional partners that are Higher Education or Research Institutions around the UK. These are the Universities of Birmingham, Cardiff, Manchester, Sussex and York, the BB-SRC-funded John Innes Centre, Norwich and Imperial College, University of London. Each institution will host a regional co-ordinator for the scheme; the Scottish regional co-ordinator is Robin Andrews (robin.andrews@ed.ac.uk).

If you are interested in becoming a Researcher in Residence or would like to be an institutional representative for the scheme please get in touch with Robin Andrews (0131 650 5384, robin.andrews@ed.ac.uk), we would love to hear from you.

For more information visit our website: www.researchersinresidence.ac.uk

Innogen wins new funding

The Economic & Social Science Research Council has announced a further 5 years funding for the Innogen Centre at Edinburgh University and the Open University. The £5 million award will enable Innogen to continue researching how new technologies such as tissue engineering and food technology are developed and regulated and how they are influenced by public opinion. Professor David Wield will take over as director of Innogen in place of Professor Joyce Tait who will continue as scientific adviser.

SAC studies EU food supply chain

Farmers, processors, retailers and others in the 'barley to beer' and 'cattle to beef' industries are being encouraged to take part in the six-country FOODCOMM SURVEY, by completing a questionnaire on the web. The questionnaire can be found at www.food-comm.eu/survey_uk.html.

The main aim of the survey, which is being undertaken by SAC, in conjunction with partner institutions in five other European countries, is to examine the key factors that influence commercial relationships in the

New head of Macaulay Institute



Professor Richard Aspinall has taken up post as the new Chief Executive of the Macaulay Institute. He previously worked at the Institute

between 1987 and 1997 on a wide variety of land use topics. He returns to the Macaulay after nine years in the USA, where he has been Professor and Chair of the School of Geographical Sciences at the Arizona State University since 2004.

Professor Aspinall's research addresses the interdisciplinary aspects of land use and related change – particularly in rural areas – and set within the context of sustainable development. This has included a particular focus on an understanding of coupled natural and human systems.

Congratulations



Congratulations to Professor Mary Bownes, chairman of the ECRR Main Board, who was awarded an OBE in the Queen's birthday honours

list in June for her services to science. As well as her research role as Professor of Development Biology at the University of Edinburgh, she is also Vice-Principal for Widening Participation, Recruitment and Community Relations.

supply chain, from farmer to retailer. This survey will provide evidence-based policy recommendations and inform debate over further reform to the Common Agricultural Policy.

For further information on these surveys please contact SAC's Food Marketing Research team.

People & Events

ECRR DIARY 2007

Feb 12	Executive Committee	Venue TBA	10.30
Feb 12	Directors' lunch	British Geological Survey, Murchison House, West Mains Road, Edinburgh	12.30
Feb 13	Annual ECRR Lecture	"Does science matter?" by Professor Anne Glover. RSE, George St., Edinburgh	17.30
Mar 5	Directors' lunch	Napier University, School of Life Sciences	12.30
Apr 18	ECRR Main Board	Venue TBA	14.00
May 14	Executive Committee	SCRI, Invergowrie, Dundee	10.30
May 14	ECRR Directors' Lunch	Scottish Crop Research Institute, Invergowrie, Dundee	12.30
May 30	Biennial Forum	"Scotland's energy" – a one day meeting at SNH Battleby Centre	

ECRR ANNUAL PETER WILSON LECTURE 2007



Prof Anne Glover

Professor Anne Glover FRSE, Chief Scientific Adviser for Scotland will give the ECRR Peter Wilson Annual Lecture on Tuesday 13 February 2007, commencing at 17.30 hours. The title of her talk is "Does Science Matter?"

Science is international. It is fundamental to our understanding of the world we live in and how we respond to and interact with it. Throughout history science has enabled mankind to tackle some of the world's most pressing problems and its role as a force for change is growing in importance. Technology and innovation now impact greatly on our daily lives and the pace of change is quickening. The resulting benefits are enormous and wide-ranging. It is crucial that Scotland's science base is ready to take advantage of future global opportunities and that our young people are excited and engaged by science.

The lecture will take place at the Royal Society of Edinburgh, George Street, Edinburgh. Tickets can be obtained from the RSE or from the ECRR Secretary (email: m.talbot@bioss.ac.uk) until 31 January 2007.

ECRR Member Organisations

University of Edinburgh	www.ed.ac.uk
College of Science & Engineering	
College of Medicine & Veterinary Medicine	
College of Humanities & Social Science	
Scottish Agricultural College	www.sac.ac.uk
Research & Development	
Education & Training	
Napier University, School of Life Sciences	www.napier.ac.uk/fhls/lifesciences
University of Stirling, Institute of Aquaculture	www.aquaculture.stir.ac.uk
UHI Millennium Institute	www.uhi.ac.uk
University Marine Biological Station Millport	www.gla.ac.uk/centres/marinestation
Moredun Research Institute	www.mri.sari.ac.uk
Forest Research, Northern Research Station	www.forestry.gov.uk
Roslin Institute	www.roslin.ac.uk
Biomathematics and Statistics Scotland	www.bioss.sari.ac.uk
British Geological Survey	www.bgs.ac.uk
Centre for Ecology & Hydrology Edinburgh	www.ceh.ac.uk
DEFRA Lasswade Veterinary Laboratory	www.defra.gov.uk/vla
MRC Human Reproductive Sciences Unit	www.hrsu.mrc.ac.uk
National Museums of Scotland	www.nms.ac.uk
Royal Botanic Garden Edinburgh	www.rbge.org.uk
Royal Society for the Protection of Birds – Scotland	www.rspb.org.uk
Scottish Agricultural Science Agency	www.sasa.gov.uk
Scottish Crop Research Institute	www.scri.sari.ac.uk
Scottish Natural Heritage	www.snh.org.uk
Scotland & N. Ireland Forum for Environmental Research	www.sniffer.org.uk
Edinburgh Centre for Tropical Forests	www.nmw.ac.uk/ectf
Scottish Centre for Animal Welfare Sciences	

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FUTURE ISSUES

Contributions to the Bush Telegraph are welcomed. All contributions, comments and suggestions can be emailed to Mike Steele at mike.steele@sac.ac.uk.

DISTRIBUTION

For queries about Bush Telegraph distribution please contact Mike Talbot at m.talbot@bioss.ac.uk.

ON THE WEB

Back issues can be viewed at <http://www.ecrr.org.uk>

COPY DEADLINE

Deadline for copy in the next issue is 1 March 2007