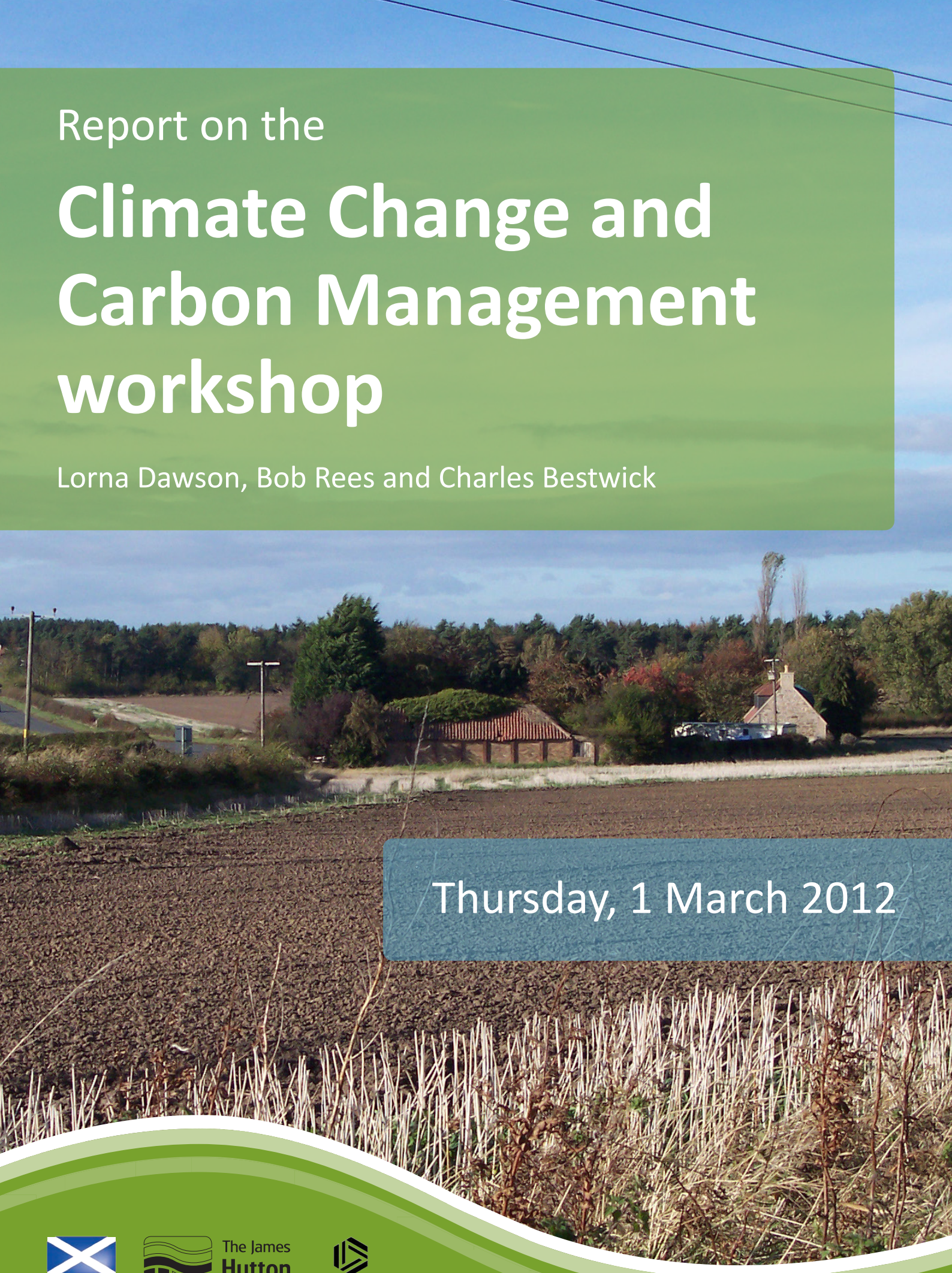
Report on the

Climate Change and Carbon Management workshop

Lorna Dawson, Bob Rees and Charles Bestwick



Thursday, 1 March 2012

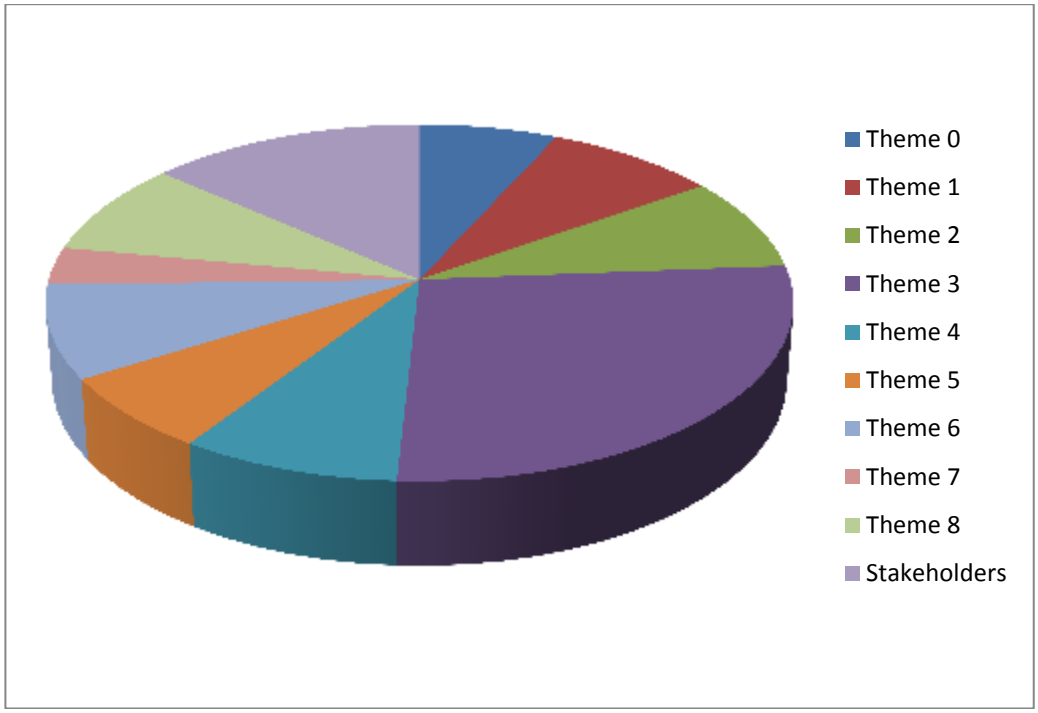
The Scottish Government
The James Hutton Institute
SAC

Background

The Scottish Government's Rural and Environment Science and Analytical Services (RESAS) division supports a large programme of strategic research that aims to provide knowledge that can support the delivery of national policy outcomes. Two multidisciplinary programmes cover Environmental Change and Food Land & People areas of research, with the aim of informing policy on the major issues of climate change, land use and food security. SAC's Carbon Management Centre organised this workshop in conjunction with the Programme Advisors and Theme Leaders from the RESAS Strategic Research Programme to explore the linkages between research on climate change and carbon management.

The audience was made up primarily of research staff from across the programme, along with key stakeholders and policy colleagues (Figure 1). Delegates came from all of the main research providers, Government agencies (UK and Scotland), the Scottish Government, Strategic Partnerships, universities, and representatives from industry.

Figure 1. Chart of delegate affiliation, where numbers refer to the programme theme



Meeting summary

A series of stimulating presentations was provided to give an overview of the initial findings within the strategic research, planned research and likely outcomes.

Chief Executive of the James Hutton Institute, Professor Iain Gordon opening the event

Dr Phil Balls, Scottish Government, setting the context within Scottish Government

Dr Bob Rees, SAC (Head of Carbon Management Centre) describing the role of the Carbon Management Centre

Discussion sessions identified areas where greater synergy would enhance the outcome of the programme and identify specific outcomes in relation to climate change and carbon management.





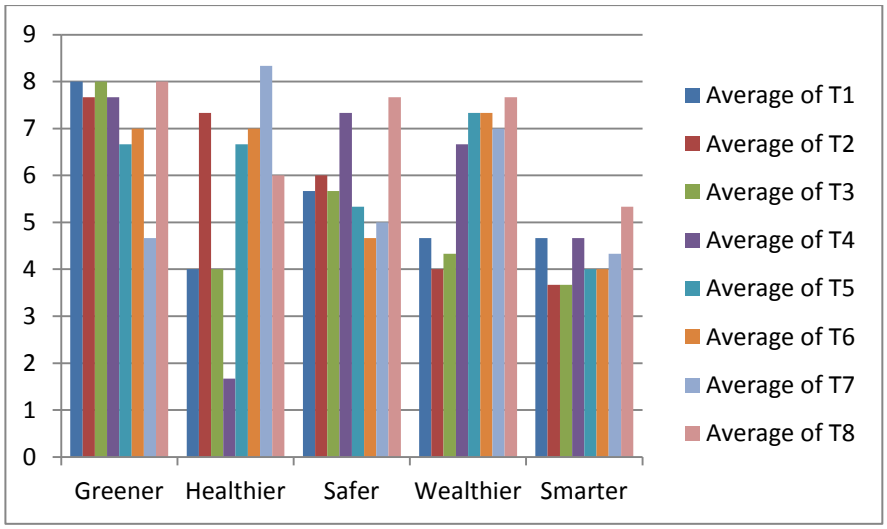
Interaction in the breakout groups

Meeting outcomes

One of the main outcomes of the workshop was to raise the awareness of the breadth of work being undertaken on climate change and carbon management, and new collaborations to enhance the delivery of the planned outputs of the research programme were set up.

Each theme could identify work that linked to delivery to all of the main objectives (Figure 2), with most of the current focus being on the greener outcome in programme 1, while more emphasis is on the wealthier outcome in programme 2.

Figure 2. Number of items in each research theme that link to the Governments' 5 strategic objectives*



Some examples of research outcomes that will make a major contribution to the strategic objectives that came out of the workshops are:

1. Integration of ecosystem mapping in Theme 1 – Greener
2. Theme 7 research into health – Healthier
3. Vaccine development in Theme 6 – Wealthier and Greener
4. Crop disease prevention in Theme 5 – Wealthier and Greener

There were examples of wider integration of outcomes. For example, improved control of animal disease leading to increased sustainable production will benefit a healthier, wealthier, smarter, greener, stronger Scotland. Also, an improved national flood management programme will provide safer and stronger, greener, healthier, wealthier Scotland. Strategies for Carbon management at a range of scales will deliver to all national outcomes.

Examples of linkages between existing research are identified in the following table (*please note these are examples and are not exclusive*).

Table1. Examples of research linkages

Theme	Theme	Linkage
3.3	2	Experimental manipulation – e.g. affects of Climate Change, and nitrogen on soil processes, and water Model development
3.2	1	Dynamic models
3	5,6	Soil tillage, integrated pest management. Germ plasm in T 5
8	4	Deliver a low Carbon economy
8	CoE CC	Energy and food poverty
4	1,3	Application of CAP reform

Network linkage models (developed by Matt Aitkenhead in Theme 1) were used to identify where links had been created, showing clearly where delivery of topics were focused and indeed where they could be developed in the future.

Issues that were identified as priorities for further research and analysis were:

- The need to develop a common understanding of language for example between natural and social scientists, agree on common definitions, e.g. what is the Low Carbon Economy?
- Resource use efficiency, where does Life Cycle Assessment start and finish, carbon footprints (what should be included?)
- The need to link across all trophic levels – what are the best units and indicators and conversion efficiencies?
- The need to have joined up, proportionate and practical knowledge exchange messages delivered across the programmes, strategic partnerships, centres of expertise and MRPs, as well as joined up requests from policy.
- Mechanisms to support the co-ordinated delivery of ongoing policy outcomes e.g. Soil Framework, arable systems, land use strategy and to adopt appropriate approaches such as translational research/interdisciplinarity to draw the work together.

Several aspects mentioned that would benefit from change were: joining up policy UK and EU, behaviour change – involving an awareness of scale, incentives for green measure uptake and the role of CAP reform. Areas where stronger links would help achieve outcomes are the use of scenario development and approaches that allow the use of shared data resources.

Other topics for future discussion within the programme were: e.g. Waste, Grounding the Land Use Strategy, consumption based assessments and consideration of the Global context. This linked to the topics that should be considered further within the topic of climate change and carbon management which are: positioning the local position in the global scene – contributions to global food and water and energy security, planning issues and land use for different end uses and addressing scaling issues across the UK (needs to account for changing aspects of production in England and Wales) and demographic issues and associated resource demands (including quality of life issues).

The workshop group felt that work should make contributions to national and international initiatives, should aim for Joint publications and joint KE activities and explore new funding opportunities.

***Wealthier and Fairer**: Enabling businesses and people to increase their wealth and more people to share fairly in that wealth

Healthier: Helping people to sustain and improve their health, especially in disadvantaged communities, ensuring better, local and faster access to health care

Safer and stronger: Helping communities to flourish, becoming stronger, safer places to live, offering improved opportunities and a better quality of life

Smarter: Expanding opportunities to succeed from nurture through to lifelong learning ensuring higher and more widely shared achievements

Greener: Improving Scotland's natural and built environment and the sustainable use and enjoyment of it.

Abstracts for oral presentations

Introduction to the RESAS programme, Dr Phil Balls, Scottish Government
A brief reminder of the structure of the work for the Scottish Government commissioned through RESAS will be presented. The presentation will highlight the relationships and interconnectedness of the different funding streams. A particular emphasis will be placed on the underlying principles associated with the commissioning of the work, notably its multidisciplinary nature and the need to integrate evidence from a diverse range of sources and expertise.

Some of the challenges associated with the delivery of outcomes from multi-institute programmes and specialisms will be discussed. Evidence of progress will be highlighted as will the ongoing challenge of embedding positive behaviours and good practice more broadly and deeply. The benefits and exciting opportunities available through collaborative working will be highlighted through the use of some non-scientific analogies. Participants will be encouraged to view administrative boundaries between funding streams as porous and as presenting opportunities for collaboration. The challenge will therefore be thrown down to use the opportunity presented by the workshop to initiate new actions that can help develop and move forward collaborative work on 'Climate Change and Carbon Management'.

Climate change and carbon management, Bob Rees and Rebecca Audsley, Carbon Management Centre, SAC
The setting of ambitious targets for reductions in greenhouse gas emissions has focussed policy makers on the need to deliver change across a range of sectors of the Scottish economy. This is reflected in the Scottish Government's Rural and Environment Science and Analytical Services (RESAS) current Research Programme in which climate change and carbon management are dominant themes. The RESAS programme supports research in a diverse range of sectors of the rural environment and will contribute to our ability to both mitigate greenhouse gas emissions and adapt to the affects of climate change. The purpose of this workshop is to explore the synergies and areas of potential collaboration that arise across the programme's main themes and to improve alignment with the delivery of the Scottish Government's Strategic Objectives. SAC's Carbon Management Centre is currently working with the agricultural sector to provide a similar level of integration across research consultancy and learning divisions, and some examples of this approach will be described.

The Environmental Change Programme of Research: Local Responses to Global Change, Professor Lorna Dawson, The James Hutton Institute

The Scottish Government Rural and Environmental Science and Analytical Services Division's Environmental Change Programme of strategic research deals with research into how we can respond to anticipated issues of global change, such as climate fluctuations and also shifts in demands on our precious land. It is vital that we are able to deal with such future eventualities, in an evidence based manner, while also considering the uncertainty associated with such change.

This Environmental Change Programme will work with Policy makers in relation to the main environmental pressures and the need to respond to the pressures for change and prospective environmental, economic and social impacts. Two of the most important and pressing issues that we need to deal with are those of Climate change and Carbon Management. This environmental change programme of research aims to contribute to building a safe, vibrant and sustainable future in Scotland.

Ecosystems services (Theme 1), Dr Helaina Black, the James Hutton Institute

This talk will give a short overview of the RESAS Ecosystem Services Theme (EST) which is tackling the identification and valuation of Scotland's environmental assets, biodiversity and ecosystem services to inform decision-making. Our challenge is to develop an integrated approach that will support the evaluation of synergies and trade-offs between different human needs from and demands on the Scottish environment at a range of spatial and temporal scales. Carbon is clearly an important ecosystem property with relevance to several goods and services, from biomass production, meeting GAEC guidelines to achieving good water quality. In parallel climate change is a key scenario of change in EST and one to explore and improve the understanding of the adaptive capacity of environmental assets.

The talk will outline some of the knowledge gaps that the EST is facing in order to integrate ecosystem carbon and climate change into the approaches being developed. The EST is looking to develop collaborations with other Themes and research activities to address these gaps where appropriate.

Water and Renewable Energy (Theme 2), Dr Marc Stutter, the James Hutton Institute

We are less involved with direct research into managing carbon, instead about the impacts of carbon related activities on the water environment. Water is central to the delivery of a range of ecosystem services from nutrient processing, attenuation of flooding, support of biodiversity, water for transport, industry, drinking and irrigation. The land use decisions being made in water catchments about location of agriculture, urbanisation and forestry all impact on water quantity and quality. Increasingly these decisions are being taken to support the provision of policy for renewable energy and resource use efficiency with indirect consequences for energy use. In this way managing water quality and securing appropriate water flows has become central to provision of 'low carbon' solutions and ways of tackling climate change. Direct examples of this are in potential conflicts between hydro-power, or wind developments and habitats for protected species, or drinking water supplies. More subtle examples include where to site 'C capture' woodland expansion, or where to grow biofuels. These examples need to be guided by coherent policies and modelling to understand cross-sectoral benefits vs issues and implications of future climate, for example in catchment runoff. Our work looks at some of the scientific issues behind these problems but also the societal and industrial options. Considerable energy savings may be made by efficiencies in water supply and use. Examples include recycling of household waste streams, recovery of energy and nutrients and reuse of water. We also give some minor specific examples of carbon accumulation in buffer strip soils and how carbon controls processing of N and P in rivers.

Land Use (Theme 3), Dr Allan Lilly, The James Hutton Institute

The overall aims are to understand how changing land use and climate affects greenhouse gas emissions, carbon sequestration and biodiversity as well as improving the evidence on the cost-effectiveness of different technical solutions for mitigation or adaptation to climate change in the rural environment. In striving to secure multiple benefits from the land and understand the biophysical environment, it is also important to understand how the roles of land managers and policy makers shape the land use patterns we see today and how these will affect future land uses. The Land Use theme has six broad research areas that cross scales from the plot and field experiments on soil water and gases fluxes to national scale assessments of future land use and includes work on intensively managed cultivated soil as well as upland uncultivated semi-natural soils. As well as examining processes in the soil, the research will also examine the role of changing land use and climate on animal production systems and on animal health. The findings from this work will inform the promotion of farming practices compatible with the sustainability of Scotland's rural communities.

Climate Change Research within the Rural Economy Resilient to Global and Local Change Theme (Theme 4 Economic Adaptation), Dr Alan Renwick, SAC

This talk briefly highlights the research being undertaken within Theme 4 (Economic Adaptation). Within the Theme, two distinct areas of research are being followed. The first aims to spatially combine estimates of the biophysical impacts of climate change with profitability data, in order to better understand the vulnerability, exposure and threats to rural land based industries. This will be followed by the identification and evaluation of robust adaptation actions to climate change in a range of rural industries. The second area focuses on the issues surrounding a move to 'a low carbon rural economy'. Over the five years, this research aims to develop our understanding of the key components of a 'low carbon rural economy'. This includes the sectors which might contribute (for example forestry, transport, housing, agriculture, energy, tourism) and the actors potentially involved (individuals, communities, the third/public/private sectors). In addition potential pathways toward a 'low carbon rural economy' will be highlighted and the associated costs, benefits and acceptability of these pathways will be examined. Part of the process will involve identifying the key barriers and facilitators of a 'low carbon rural economy' at multiple scales, from individual through to national. The talk will focus on work to date which has involved developing an improved understanding of what is meant by a low carbon rural economy, work on attitudes and behaviours, development of models of community energy usage and the completion of proof of concept social metabolism analyses. Future work will be briefly discussed.

An introduction to the Food, Land and People Programme
Research across the food chain, through to economic output and environmental outcomes
Professor Charles S. Bestwick, Advisor to the Food, Land and People Programme
Rowett Institute, University of Aberdeen, Greenburn Road, Bucksburn, Aberdeen AB21 9SB

The Food, Land and People Programme and the Environmental Change Programme form the two five-year Strategic Research Programmes commissioned by Scottish Government to help address and answer major policy agenda issues within climate change, land use and food security. The Food, Land and People Programme is aligned with the UK Global Food Security programme led by the Biotechnology and Biological Sciences Research Council (BBSRC) and responds to the Coordinated Agenda for Marine, Environment and Rural Affairs Science (CAMERAS) priority of Optimising the Use of Natural Assets. The individual research themes of Food, Land and People, each of which comprise targeted research packages, focus on: efficient, resilient supply chains for food; animal, plant health and disease and animal welfare; healthy safe diets and vibrant rural communities. Food, Land and People draws not only on the advantages of the multidisciplinary expertise from The James Hutton Institute, Moredun Research Institute, Rowett Institute of Nutrition and Health, Scottish Agricultural College and Biomathematics and Statistics Scotland within its own research themes but also on the allied structure of the Environmental Change Programme. The ability to utilise this collaborative expertise of leading teams of scientists, coupled with regular updates of research activity and output to identify new research synergies, provides a uniquely integrated scientific evidence base to address complex problems to the widest benefit of Scotland's economy and society. Within this, the Food Land and People Programme aims to achieve impact through the development of effective Government policy and through cohesive and targeted interaction with a wide range of stakeholders.

Food (Theme 5), Dr Steve Hoad/ Dr Andrew Barnes, SAC

Within the arena of carbon management the Food Theme has a strong focus on resource use efficiency as it delivers crops and livestock systems with improved performance. Resource use and crop or livestock performance are considered important from both a measurement perspective, in terms of deriving indicators for efficiency and reconciling these with other indictors such as carbon generated, and an applied scientific perspective for delivery of more sustainable farming systems and supply chains. Crop and livestock technology and efficiency are considered as work packages within the Food Theme. These are nested within an economic and supply chain framework for understanding the drivers behind resource use, which also aims to forecast the impact of new crop and livestock technologies and improvements on future productivity scenarios. The aim of this presentation is to highlight resource use efficiency, which in turn helps to minimise the carbon load which currently typifies input use within Scottish agriculture.

Health and welfare (Theme 6), Professor Willie Donachie, Moredun Research Institute

Health and Welfare (Theme 6) aims to improve farm productivity and sustainability, through improvements to plant and animal disease control and enhancement of farm animal welfare. A focus for this Theme is that the local impact of climate change and legislative changes in animal and plant disease control measures necessitates the development of novel approaches based on internationally recognised scientific research.

Given the dominance of ruminant livestock in the carbon footprint of Scottish agriculture and the potential impact of decisions related to animal health WP 6.1 is investigating the variables (psychological, location and other) that influence farmer decision making relating to areas such as climate change adaptation, mitigation and biodiversity. One objective of the research is to look at how trade-offs are made between different areas of farm management decision-making.

Recent changes in climate and global trade have also raised the risks of introduction of new diseases and changes in the epidemiology and incidence of endemic viral, bacterial and parasitic disease, with potentially severe consequences to UK farming. For example anthelmintic resistance is rife in ruminant roundworms and is a situation that will be exacerbated by climate change. New, sustainable strategies for control are being sought within the research of the WP6.2 which is focussing on diagnostic, vaccine and other management control measures.

In WP6.3 scientists are seeking to identify 'iceberg' indicators of animal welfare- simple to measure indicators which are predictive of many aspects of positive and negative welfare. This will result in practical information to provide guidance to dairy farmers about the welfare effects of likely system or management changes. In addition to welfare and system measures, information for carbon footprinting (i.e. land types and area, animal numbers, inputs such as fuel and feed and outputs such as milk) and information which will enable a proxy assessment of biodiversity (i.e. grassland management, hedgerows, presence of or proximity to 'wild' areas such as woodland) will also be collected on farm. This data will feed into modelling efforts elsewhere in the Theme.

WP6.4 scientists have previously investigated the major threats to potato posed by new and existing pests/pathogens in future climate change scenarios for Scotland and key targets, including both new and indigenous pests/pathogens, were identified as posing particular threats. Methodology for predicting disease risk for both potato and barley under the latest climate change and reduced pesticide senarios is being developed developed, and specific pathogens, namely PCN, potyviruses (indigenous threat) and Dickeya spp. (new threat) are being studied in further detail.

Diet and Health (Theme 7), Professor Paul Haggarty, Rowett Institute of Nutrition and Health, University of Aberdeen
Scotland has a strategic interest in developing a sustainable diet for the population which is affordable, safe and healthy, and is supported by a thriving agri-food business sector. The Scottish National Food and Drink Policy (Recipe for Success) highlights the need to make healthy and sustainable food choices, to ensure that our food supplies are secure and resilient to change, that healthy food is available and affordable to all, and that the population understands more about the food they eat. Theme 7 (Healthy Safe Diets) seeks to produce the knowledge, tools and understanding necessary to work towards these goals. This Theme also links directly to our work on Food Security within the Climate Change Centre of Expertise (climateXchange).

The Scottish and UK food supply chain is under increasing pressure from climate change, global commodity instability, land use conflicts (leisure, biofuels, biodiversity, organics), environmental degradation, sustainability of fish stocks, etc. It is comparatively easy to articulate individual challenges and research drivers but more difficult to reconcile tensions and trade-offs in order to develop coherent policies. For example in relation to fish, aquaculture has the potential to take the pressure off wild fish stocks whilst meeting the dietary needs of the population for omega 3 fatty acids. Reductions in fish stocks and catch quotas mean that farmed fish may have to be raised on vegetable oils. This would have consequences for agriculture but it would also reduce the omega 3 content and the health giving properties of fish. Such examples highlight the complex links between food production, diet, health and sustainability and the need for research to inform policy. Theme 7 is designed to contribute directly to the development of coherent policies in the area of sustainability by addressing complex issues such as these in concert with other Themes in the strategic research programme and the Centres of Expertise.

Theme 7 is investigating the scope for improving the Scottish diet – in terms of both health benefits and sustainability – through, production, reprocessing and reformulation. We aim to identify the changes needed to achieve a healthy diet and a sustainable food supply chain and the barriers to change in consumers, retailers, processors and producers. The development of a food supply chain which is sustainable and which meets the health needs of the population will also have

economic benefits and innovation in the area of sustainability may provide new opportunities for the food industry. Innovation and wealth creation within the food industry is considered within Theme 7.

One of the main effects of climate change experienced by the Scottish population will be in the area of food security; defined as access to affordable, safe, healthy food. Food insecurity is not experienced equally by all sectors of society. The impact is greatest in the most disadvantaged in society; those on low incomes, young unemployed adults, the elderly. An additional complicating factor which will interact with temporal change in climate and food insecurity is the increasing age of the population. Changes in future food supply, and the challenge of climate change, must take into account the changing demographic structure of the Scottish population. These issues are also considered within Theme 7.

Vibrant Communities (Theme 8), Professor Bill Slee, the James Hutton Institute
Rural communities generate amongst the highest per household carbon emissions in the UK. There are several reasons for this: the commuting behaviour of many rural residents; the affluence, lifestyles and larger houses of commuters; the higher dependency on oil and electricity for space heating; the proportionately larger private rented housing sector with poor insulation; the large proportion of single walled stone buildings; and the climate. Rural areas also experience very high levels of fuel poverty, which reflects high energy consumption and low incomes. Equally, rural areas are the places where renewables production takes place and where some types of carbon sequestration can take place (peatland restoration, afforestation). So carbon management is both a requirement of and an opportunity for rural communities. The external ownership of renewables militates against community vibrancy, albeit providing some employment in construction, but local private ownership or community ownership of renewables offers significant potential and certainly more financial gain than the trickle of 'tithes' that private external developers offer rural communities. However, renewables development can also be socially divisive and highly contentious. Creating an effective market in carbon would incentivise land-based offsetting and generate income streams for rural areas. Theme 8 addresses rural communities in the round; our objects of attention are businesses, households and recreational and tourist users of rural areas. All face the challenge to reduce their emissions. In all cases, the choice of business or household strategy and the effectiveness of policies generate multiple research questions. Many of these issues are being explored in RESAS Theme 8 and ClimateXchange work.

Knowledge Exchange Activities, Mr Willie Towers, The James Hutton Institute

Increasingly, research has to be relevant as well as excellent and nowhere is this more manifest than in the highly topical area of climate change. Climate change is a topic that runs through both RESAS research Programmes, particularly the Environmental change programme, but also the Food programme. Much of the research has an indirect relevance to Climate Change. Both Centres of Expertise, ClimateXChange and CREW, are also highly relevant and it is clear that increased co-ordination is required to ensure that a consistent and coherent message is given to our different audiences. A suite of different mechanisms have been or are continuing to be developed for our different audiences; these include Policy/Government, Farm/Land Based Industries, Public or Schools, Commercial/Business. Examples will be described and suggestions for others, using existing networks are welcome. Co-ordinating activities across both Programmes will also be described.

Abstracts for poster presentations

Nitrous Oxide Emission Measurements from Arable Soils, Dr Joanna Cloy, SAC

Joanna Cloy[1], Andy Whitmore[2], Nicola Winning[1], Amelia Bowden[3], Helen Balshaw[3], Colin Webster[2], Rhys Ashton[2], Tony Scott[2], Keith Goulding[2], John Williams[3], Bob Rees[1] and David Chadwick[2]
[1]SAC, [2]Rothamsted Research and [3]ADAS UK Ltd

Background

The InveN_2Ory project aims to improve the nitrous oxide (N_2O) inventory through a combination of measurements, modelling and verification. In order to generate country specific N_2O emission factors (EFs), additional field experiments are required to complement other studies delivering IPCC compliant EFs. N_2O emissions from soils are being measured taking account of influencing factors such as the amount and timing of manufactured and organic nitrogen applications, and the use of nitrification inhibitors such as DCD. The aim is to understand the major factors controlling the amount of N_2O released from soil and produce EFs that better reflect the range of soils, climate, crop and soil management within the UK.

Methods

Four arable sites have been selected in Scotland (Gilchriston) and England (Woburn, Rosemaund and Wensum) reflecting contrasting soil types and climatic conditions. In spring 2011, fertiliser nitrogen (ammonium nitrate (AN) and urea) experiments were started at Gilchriston, Woburn and Rosemaund, and in autumn 2011, a manure experiment commenced in Wensum. Over the 12 month period of each field experiment, direct N_2O emissions are measured using static chambers and auto-chambers. Soil samples are collected for determination of ammonium, nitrate and soil moisture contents. For the manure experiment in Wensum, measurements of ammonia emissions and nitrate leaching are also being measured using wind tunnels and porous cups, respectively.

Preliminary results

Preliminary results indicate that N_2O emissions from urea have generally been found to be lower than those from AN. N_2O emissions are noticeably reduced when DCD is used with AN (observed for Woburn and Gilchriston) and urea (observed for Gilchriston but not Woburn). Emission measurements are still continuing at all sites to generate 12-month N_2O EFs.

Nitrous Oxide Emission Measurements from Grasslands, Dr Joanna Cloy, SAC

Laura Cardenas[1], Neil Donovan[1], Joanna Cloy[2], Karen McGeough[3] and Amelia Bowden[4]
[1]Rothamsted Research, [2]SAC, [3]AFBI and [4]ADAS UK Ltd

Background

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Methods

Five grassland sites have been selected in Scotland (Crichton), Northern Ireland (Hillsborough), Wales (Pwllpeiran) and England (North Wyke, Drayton) reflecting contrasting soil types and climatic conditions. In spring 2011, fertiliser nitrogen (ammonium nitrate (AN) and urea) experiments were started at Crichton and Hillsborough, and in autumn 2011, manure experiments commenced in Pwellpeiran and North Wyke. Over the 12 month period of each field experiment, direct N_2O emissions are measured using static chambers and auto-chambers. Soil samples are collected for determination of ammonium, nitrate and soil moisture contents. For the manure experiments, measurements of ammonia emissions and nitrate leaching are also being measured using wind tunnels and porous cups, respectively.

Preliminary results

Preliminary results indicate that nitrogen applications increase N_2O emissions and emissions from urea have generally been lower than those from AN. At the Hillsborough site, N_2O emissions are noticeably reduced when DCD is used with urea. N_2O emissions for all treatments at the North Wyke site are lower than those found at the other sites. Emission measurements are still continuing at all sites to generate 12-month N_2O EFs.

The North East Scotland Energy Monitoring Project (NESEMP), Dr Tony Craig, The James Hutton Institute

The need for significant reductions in greenhouse gas emissions associated with households is well established and given due recognition by both UK and Scottish policies. Reducing the amount of Energy consumed by individual households is acknowledged to be an effective mechanism for reducing associated emissions, particularly if energy savings can be maintained over time. The UK wide roll-out of smart meters will include an in-home display as part of the minimum specification, and there is likely to be a growth in interest in product-development of consumer appliances and solutions associated with this infrastructure. This project will contribute to the evidence base which may inform such developments. This project is set to run for three years, and will produce robust evidence detailing the effectiveness of energy feedback for different household types.

The North East Scotland Energy Monitoring Project was established in partnership with Aberdeenshire Council and Aberdeen City Council with two main aims:

1) To provide households of employees of the local authority with the opportunity to learn about domestic energy consumption, and investigate the social and psychological issues associated with motivating reductions in energy consumption.

2) To improve understanding about the effectiveness of different types of feedback – including both disaggregated (appliance) feedback and social-comparison feedback.

Phase 1 of the project has now been completed, which has established a one-year baseline of data from which to compare the electricity consumption in Phase 2, after an experimental condition has been introduced. Phase 2 will run from 2012 to 2013.

Estimating greenhouse gas abatement potential of biomass crops in Scotland under various management options, M. E. Shibu[a] , R. B. Matthews[a], I. Bakam[a], A. J. Moffat[b] and N. Baggaley[a]

[a]The James Hutton Institute, Craigiebuckler, Aberdeen AB15 8QH, UK

[b]Forest Research, Centre for Forestry and Climate Change, Alice Holt Lodge, Farnham, Surrey, GU10 4LH,UK

Bioenergy crops are one of the renewable energy options available to decarbonise the energy sector in Scotland and help to achieve the overall planned target of 80% reduction in greenhouse gas (GHG) emissions by 2050. A process-based model for poplar and willow developed for simulating the effect of different environmental and management options on growth and biomass yield was used to estimate the GHG abatement potential (GHG-AP) under different crop management options in Scotland. Data from different field studies conducted across Scotland were used for model calibration and testing. The model was further applied at fifteen sites in Scotland, to estimate the GHG-AP for willow and poplar in Scotland under different crop management options, including variations in plant density and harvest cycle, and rates of nitrogen fertilizer application. The model results of annual wood yield showed a strong relation with initial soil organic carbon. Increasing plant density and decreasing harvest frequency increased GHG-AP. Application of N-fertilizers at a rate of 50-100 kg N ha^{-1} resulted in the buildup of carbon in low organic soils (<180 Mg C ha^{-1}). However, in high organic soils, annual emissions resulting from N fertilizer application was higher than the carbon saving through marginal increases on wood yield and carbon input to the soil. The best management scenario in terms of economic and environmental objectives depends on identifying an optimum plant density based on the site specific conditions with a fertilizer application of 20-100 kg ha^{-1} y^{-1} and a five year harvest interval. Even under the best economic scenarios, SRC willow and poplar have a GHG-AP ranging from 9.9-11.6 and 8.8-10.0 Mg CO_2 eq. ha^{-1} y^{-1}, respectively. Under the best environmental scenarios this range increases to 10.5- 13.2 and 9-11.1 Mg CO_2 eq. ha^{-1} y^{-1} for willow and poplar, respectively.

Heterogeneity of expert perceptions regarding opportunities and challenges of climate change mitigation by tackling deforestation in the tropics, Maria Nijnik and Robin Matthews (JHI), Albert Nijnik (Environmental Network Ltd)

The EC funded FP7 REDD-ALERT project coordinated from the James Hutton Institute focuses on ways to reduce the rate of tropical deforestation and consequently to cut global GHG emissions. It also analyses REDD+ initiatives seeking to offer new incentives for developing countries to reduce emissions from forested land by going beyond deforestation and forest degradation alone, towards the combining of avoided deforestation with conservation and sustainable management of forests.

Various dimensions of tackling deforestation to mitigate climate change, including the effectiveness and feasibility of policy measures, as they are perceived by experts are analysed in this paper. The Q-method is used (i) to identify and explain existing attitudes towards REDD/REDD+, with the primary focus on Peru, Cameroon and Indonesia, and (ii) to provide some insights into the success and failures of policy interventions to alleviate deforestation, with further consideration of opportunities and challenges to implement sustainable policy measures on the ground.
The overall conclusion is that there is an interplay of the proximate and underlying causes of deforestation, and that its drivers operate at different scales and are not easy to handle. The results indicate that the potential of REDD/REDD+ projects is shaped not only by international climate change and forestry policies and instruments but to a large extend by national and regional policies and various local cultural values that affect susceptibility to develop forest-based activities on the level of indigenous communities, large and small businesses and on the acceptability of these projects by people on the ground. It has been the case that land use decisions are shaped less by market signals and more by international arrangements on the national, regional and local levels of governance and by public policy initiatives towards sustainable forestry in combination with climate change mitigation. The potential to tackle climate change through combating of deforestation not only positively shape climate mitigation policy with respect to forestry but, if successful, could provide additional opportunities to developing countries of economic, social and environmental nature (e.g. biodiversity conservation, or poverty alleviation). The results have provided (i) some useful information about the opportunities and challenges of tackling deforestation which might have important implications for the implementation and acceptability of REDD-type intervention measures and (ii) some new insights into social choices to support decision-making.

The Scottish Government Strategic Research Programme, 2011-2016. Evidence Based Research to Improve our Prosperity and Well Being, Professor Lorna Dawson, RESAS Programme 1 Advisor, Professor Charles Bestwick, RESAS Programme 2 Advisor
The Scottish Government Rural and Environmental Science and Analytical Services Division (RESAS) have initiated an exciting new portfolio of strategic research which is designed to address major policy and societal issues. This is being carried out by leading teams of scientists across the range of the Main Research Providers: Biomathematics and Statistics Scotland, the James Hutton Institute, Moredun Research Institute, Rowett Institute of Nutrition and Health, Scottish Agricultural College and Royal Botanic Garden Edinburgh.

The core of the Scottish Government's Strategic Research portfolio consists of two main programmes: Environmental Change (Local Responses to Global Change) and Food, Land and People (Optimising the Potential of Scotland's Natural Assets). The work brings multidisciplinary research expertise directly to policy issues, in a cohesive blend of biophysical, economic and social science, to help protect and nurture Scotland's valuable assets under the uncertainties of climate and environmental change. The provision of evidence-based information on these topics is vitally important to our nation's future prosperity and wellbeing.

Fuel Poverty or Energy Poverty: What is the real issue? Bill Slee, Alana Gilbert, Yan Xu, and Adekunle Ibiyemi , The James Hutton Institute
Fuel poverty is a significant issue in rural Scotland. It can be seen as an outcome of low incomes and high proportion of the housing stock comprising old detached and thermally inefficient homes. Rising energy costs also impact on households in other ways. In particular they are embodied in transport and mobility costs. They raise prices of products in outlying and remote areas and they increase the costs of mobility. Because of the weak public transport infrastructure and irregularity of service most rural households are car-dependent for access to work and access to basic services. Rural areas are thus hit by a ‘double whammy’ of escalating transport costs and rising heating costs. We consider it sensible to address this through the idea of ENERGY POVERTY.
We intend to combine data on fuel poverty with data on expenditures on personal mobility to provide an “energy poverty map”. We will then explore the socio-economic reasons behind the evidence in the map, and identify the associated policy implications. This poster gives initial findings and further work considerations.

Climate Change and the SRDP: The challenge of monitoring and evaluation, Bill Slee, The James Hutton Institute

The Scottish Rural Development Programme is monitored using the Common Monitoring and Evaluation Framework. One of the areas that must be evaluated is climate change. The only impact indicator required by the European Commission relates to on farm renewable energy production. There are many ways in which a range of measures in the SRDP can impact on climate change. Some measures are likely to reduce greenhouse gas emissions but other measures almost certainly will increase emissions. Furthermore, on farm renewable energy production is driven more by other energy policies than by the SRDP and could easily be misattributed to the wrong support measures. The poster explores some of the challenges of evaluating the impact of the SRDP on rural land based emissions.

Carbon and nitrogen isotopes of Scottish soils, Barry Thornton, Andrew J Midwood, Malcolm Coull, Gordon Hudson, The James Hutton Institute

From 2007 to 2009 soil was collected from 20 km intersects of a grid covering the whole of Scotland. At each site composite 0 – 15 cm auger samples from a 20 m x 20 m square were bulked to provide a representative sample. Roots were removed by hand picking, the samples were dried (30 ^{o}C), sieved (< 2 mm) then ball milled. The %N, δ^{15}N, %C and δ^{13}C of the samples were determined using an elemental analyser connected to an isotope ratio mass spectrometer.

The %C values of the soils ranged from 1 % to 50 %, whilst %N values ranged from 0.1 % to 2.4 %. The δ^{13}C values of all but one sample fell within the range -31.8 ‰ to -24.5 ‰, the exception of -5.2 ‰ being located on machair (containing sea shells) on the island of Coll. The δ^{15}N values ranged from -2.3 ‰ to 8.0 ‰. Both %C and %N values showed a bimodal distribution whilst the isotope data δ^{13}C and δ^{15}N were modal. Spatially the %C, δ^{13}C and %N values showed broad separation along a north west / south east divide. Greater %C , more enriched δ^{13}C and greater %N values being found in the soils of the north west corresponding to areas dominated by upland soils, moorland and bogs. The distribution of δ^{15}N appeared more complex but was generally more enriched in areas of arable and improved grassland.

Modelling Nitrous Oxide Emissions, Kairsty Topp[1], Steven Anthony[2], John Williams[3], Sarah Buckingham[1]
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To better understand sensitivities of calculated nitrous oxide (N_2O) emissions to soil and climate, the DeNitrification-DeCompposition model (DNDC94; Li *et al.*, 1992), was used to estimate emissions for representative soil and climate combinations across the UK. The model was run for a continuous period of 60 years, using measured weather at 4 UK locations: North Wyke, Hillsborough, Bush and Boxworth. Emissions were simulated for 6 soil types that were broadly representative of each of the RB209 mineral soil texture classifications, for both a winter wheat and cut/grazed pasture. For each land use, 4 separate fertilisation strategies were defined, combining mineral and manure nitrogen (N). The model was run for each possible combination of weather time series, soil type, land use and fertiliser strategy to generate a database of model outputs from which we could select results that were representative of different regions of the UK.

Simulated N_2O emissions were averaged over the 30 year period, differenced against a control simulation (receiving no additional N), and expressed as a percentage of the total quantity of N applied in mineral fertiliser and managed manures. Model results were normalised by expressing all emissions relative to an arbitrary reference (Deep Clayey Soil Texture and 700 to 750 mm Rainfall). Normalisation was carried out separately for wheat and grass simulations. Hence it is not appropriate to make comparisons between them. For both wheat and grass, the N fertiliser regime accounted for less than 1% of the total variance, although there was evidence that the model derived emission factors increased by *c*. 20% as the total quantity of N applied (mineral fertiliser and manure) increased from *c*. 100 to 200 kg ha^{-1} N. Soil type was dominant, accounting for 55 to 60% of the total variance, and the remainder was explained by rainfall. The long-term annual rainfall at a site accounted for less than 2% of the total variance, with emissions being driven by the inter-annual variation in rainfall. Further factorial analysis established that interactions between soil type, annual rainfall and N regime account for only 5% of the total variance. This justified a simple extrapolation of the fitted relationships to estimate N_2O emissions across the UK by integration with tabulated areas of arable and grassland under each soil texture class and average annual rainfall.

It is clear that for arable soils, the greatest contribution to total UK emissions is likely to be from the areas of low (<750 mm) annual rainfall and Deep Clay or Medium soil texture. For the improved grassland, it is the Medium texture soils that are the greatest source of potential emissions, and a substantial proportion occurs in areas of high (>900 mm) annual rainfall. The model predictions suggest that the potential for arable N_2O emissions is low because most arable production occurs in low rainfall areas. On grassland the potential for N_2O emissions is greater that from arable as most production occurs on medium soils in high rainfall areas.

Li, C.S., Frolking, S and Frolking, T.A (1992) A model of Nitrous-Oxide evolution from soil driven by rainfall events 1. Model structure and sensitivity. Journal of Geophysical Research-Atmospheres 97: 9759-9776

International Nitrous Oxide Emissions

Systematic Literature Review

Sarah Buckingham[1], Kairsty Topp[1], Steven Anthony[2] Laura Cardenas[3], Suzanne Higgins[4], Karen McGeough[4], Rodrigo Olave[4], Ronnie McLaughlin[4]

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An International systematic literature review gathered data from published reports to assess nitrous oxide (N_2O) fluxes and emission factors (EFs) derived from comparable experimental programmes for non-UK sites. The collation of non-UK, but UK-relevant data (due to similar climate) will be used to improve the characterisation of probability distribution functions and validate ranges to check against UK data being gathered within the Greenhouse Gas Platform Project, Defra. This review will put UK N_2O fluxes and EFs into a wider context and provide insight as to where the UK N_2O emissions fit on a global-scale distribution.

The principles of a systematic literature review (CEBC, Bangor) were utilized to search for and gather publications for review, which involved the formulation and utilization of a search strategy throughout the data gathering process. Key parameters assessed included flux data, environmental conditions, soil characteristics, agricultural management and fertilization treatments. All publications extracted from searches were screened rigorously for suitability and compliancy with defined conditions outlined in the review strategy. Quality assurance checks were engaged throughout the data gathering process involving pilot studies, assessment of consistency between individuals extracting, recording of progress in a central database with all those excluded from publication listed with notes to justify all exclusions based on the criteria outlined for this particular review. An additional quality control check was conducted following extraction completion with all entries being thoroughly checked against each original publication.

Following an initial screening of 941 publications, data from a total of 63 publications were extracted. As N_2O measurements made over varying time periods are not comparable due to fertilization effects, N_2O data measured over a period of < 6 months were excluded and data covering 6 months or more were retained. A coding system was incorporated to differentiate between sampling periods covered and soil parameters included in the dataset. Initial results indicated many publications (20%) lacked data for both temperature and rainfall, which are key parameters. Additionally, 30% of publications did not provide measurements for control fertiliser treatments. Slurry, manure and NH_4NH_3 were the most common fertiliser to be utilised (applied individually and/or in combination with other fertiliser types) in the publications reviewed. Future assessment of the captured data will involve applying multivariate statistical techniques to determine key correlations and probability density functions. In addition the compilation of data available can be assessed in terms of formulating a pro-forma for minimum data reporting for N_2O experiments.

References

Guidelines for Systematic Review. Centre for Evidence-Based Conservation. Bangor University
http://www.cebc.bangor.ac.uk/introSR.php