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for climate change
garden**

○ **Barriers to
adaptation**

○ **Forest carbon
trading**

○ **Metropolitan
emissions**

○ **Coastal
Simulator**

○ **Finding out why
people fly more**

Directors



Director: Professor Andrew Watkinson, University of East Anglia



Strategic Development: Professor Robert Watson, University of East Anglia



External Science Co-ordination: Professor John Shepherd, University of Southampton



Engineering: Professor Jim Hall, University of Newcastle-upon-Tyne



Social Science: Professor Katrina Brown, University of East Anglia



Distinguished Science Adviser: Professor John Schellnhuber, University of Potsdam

Tyndall Research Programmes



Programme 1 International Climate Policy

Leader Professor Diana Liverman, University of Oxford
Deputy Dr Alex Haxeltine, University of East Anglia
Deputy Dr Mark New, University of Oxford
www.tyndall.ac.uk/research/programme1



Programme 2 Constructing Energy Futures

Leader Professor Kevin Anderson, University of Manchester
Deputy Dr Jim Watson, University of Sussex
Deputy Dr Sarah Mander, University of Manchester
www.tyndall.ac.uk/research/programme2



Programme 3 Adaptation

Leader Professor Neil Adger, University of East Anglia
Deputy Dr Irene Lorenzoni, University of East Anglia
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Programme 4 International Development

Leader Professor Katrina Brown, University of East Anglia
Deputy Professor David Thomas, University of Oxford
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Programme 5 Sustainable Coasts

Leader Professor Robert J Nicholls, University of Southampton
Deputy Dr Mike Walkden, University of Newcastle
www.tyndall.ac.uk/research/programme5



Programme 6 Cities

Leader Professor Jim Hall, University of Newcastle
Deputy Dr Miles Tight, University of Leeds
www.tyndall.ac.uk/research/programme6



Programme 7 Community Integrated Assessment System (CIAS)

Leader Dr Terry Barker, University of Cambridge
Deputy Dr Rachel Warren, University of East Anglia
www.tyndall.ac.uk/research/programme7



Professor Diana Liverman



Professor Kevin Anderson



Dr Irene Lorenzoni



Professor Robert Nicholls



Dr Sarah Mander



Dr Rachel Warren

Measuring impact

Tyndall Centre staff gathered last summer in London for a party to celebrate the seven-year leadership of Professor Mike Hulme, Tyndall's Founding Director at the University of East Anglia. It was at this time that I took over as Director, while Robert Watson joined Tyndall as its Director of Strategy, in addition to being the Chief Scientific Advisor to the UK Department of the Environment and Rural Affairs (Defra).

In the year-and-a-half that I have been Director, my Tyndall Centre colleagues have participated in the UN process for collating climate change knowledge from around the world (the Intergovernmental Panel on Climate Change 4th Assessment Report), produced the background briefings to the UN Human Development Report, published research for the OECD on the world's vulnerable port cities, convened an international adaptation conference in London, and in their spare time, won a Silver Medal at the Chelsea Flower Show. They also published 83 peer-reviewed manuscripts in the scientific literature, 28 book chapters, 51 Working Papers and other reports. And since 2006 they have raised £8.5m of funding.

I know that nearly everyone in climate change research says that they contributed to the IPCC – but what differentiates the Tyndall Centre from other organisations is the extent to which it contributed to the report. We had 3 co-ordinating lead authors and 9 lead authors, contributing

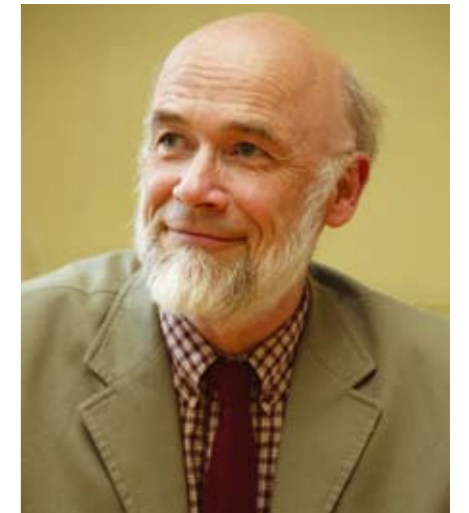
authors and review editors. An impressive contribution.

My Tyndall Centre colleagues are remarkably productive. In fact, the UK Research Councils' point this out in their own assessment of the economic impact of Tyndall; "Tyndall received 5% of NERC's budget for Research and Collaborative Centres but was responsible for 17% of its total mentions in Parliament, while scientific publications are on a par with other research for its level of funding"

So, that is where Tyndall has been but where does it go next? The external agenda of climate change policy and science is fast-moving and so we have been taking stock of the past two years of research. We of course are hoping for new funding under forthcoming Research Council initiatives and are realigning some of our priorities in the light of what the new funding opportunities might be.

I personally have learned much from my colleagues and my science has been greatly influenced during my tenure first as Deputy Director and then Director of Tyndall. In the autumn, I too am standing-down as Tyndall Director to take-up Directorship of the UK programme of research called

“researchers that assess their professionalism by their impact on the world as well as their learned publications”



Professor Andrew Watkinson

Living with Environmental Change, a joint venture between the Research Councils, Government and Agencies. I would not have been able to take on this role without my experiences in the Tyndall Centre. I wish the Tyndall Centre an even brighter future and that it continues to be a flagship academic organisation that is staffed by researchers that assess their professionalism both by their impact on the world, as well as their learned publications. I hope that you enjoy reading this year's magazine.

Professor Andrew Watkinson
Director



Assessing the effectiveness of global climate policy



Few policy decisions are made in the isolation of a single scientific discipline and climate policy makers need information about the consequences of different policy options based on sound multi-disciplinary evidence. Working closely with the UK Government's lead department for tackling climate change - the UK Department for Environment and Rural Affairs - the Tyndall Centre has now completed development of its Community Integrated Assessment System (CIAS) to evaluate climate policy problems at the global scale. CIAS is unlike other models in that it is not seeking a single ideal path for global climate policy but is instead a tool for evaluating the effectiveness over time of different options to mitigate climate change.

CIAS calculates the benefits of each climate policy and its subsequent avoided damages on people and resources, for example in terms of reductions in the population exposed to water stress or coastal flooding, or in numbers of plants and animals at risk of extinction.

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The Community Integrated Assessment System calculates the benefits of climate policies and subsequent avoided damages to people and resources



At its core, CIAS is complex computer software that combines a series of independent models that represent the economy, the climate, and climate impacts.

Terry Barker at Cambridge University provided the model, called E3MG, which describes the world energy-economy to the end of this century and produces cost estimates for emission reductions and changes in greenhouse gas emissions. The resulting changes in global climate are represented by a simple global climate model called MAGICC that comes from the Climate Research Unit at the University of East Anglia. The impacts of these different global climates on people and natural systems under different population scenarios are provided by a portfolio of models, including, freshwater availability (Walker Institute at Reading University); coastal flooding and sea level rise (Southampton University and Potsdam Institute for Climatology); and impacts on biodiversity (Oxford and Canterbury Universities). A further model downsizes these widespread impacts to the 50x50km scale so that other impact models around the world can plug-in the outputs of CIAS.

In addition, the different models though combining together within CIAS can operate separately on computers at their host institutions.

CIAS project leader Rachel Warren at the University of East Anglia has recently won a prestigious 5 year NERC Advanced Fellowship to further develop her work. Through the Fellowship Rachel will use CIAS to further inform policy makers about the outcomes of different global policies for human and natural systems, including changes in extreme weather as well as average climate. Rachel will also detail the range of future climates and impacts that need to be considered for adaptation policy; evaluate the interaction of climate and landuse policy, with particular reference to policies for biofuel cropping and deforestation; and assess how climate change impacts feed back to the world economy.

Further information

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The Tyndall Centre Coastal Simulator



The threat of sea-level rise and climate change means that coastal managers are being increasingly asked to make long-term assessments of potential coastal impacts and responses. Shoreline management planning in the UK for flood, erosion and spatial planning now takes a 100 year perspective and such long-term management decisions need a rigorous evidence-base. In response to this challenge, the Tyndall Centre's Coast programme of research is developing the world's first Coastal Simulator that enables an integrated and interdisciplinary assessment across a wide range of physical, ecological and social factors.

The Coastal Simulator is an ensemble of different models connected together to allow integrated assessment of the coast under a range of scenarios, including climate change projections. The development of the Coastal Simulator has involved interdisciplinary partners from across all of the Tyndall institutions led initially by the current Director Andrew Watkinson and now by Robert Nicholls at Southampton University.

The Coastal Simulator uses a set of models that span processes from global to local scales including: sea-level rise, tides, surges, waves, sediment transport, coastal morphology, coastal flooding, risk, ecosystem change and socio-economic change. Simulations are made under a series of scenarios to deal with the uncertainties inherent in future coastal management and socio-economic change. Future climatic conditions are represented probabilistically. A range of different modelling methods are being used to provide a comprehensive suite of different types of information on possible futures for the coast.

The Simulator focuses on the North Norfolk coast as an example case of an economically important coastline that is vulnerable to erosion, sea-level and climate change. Around 1,400 properties are within 100 metres of the cliff top and 20,000 properties are within the coastal flood plain, illustrating many current coastal management issues. It has been developed alongside public and private sector stakeholders since its beginning. It includes software that allows stakeholders and researchers to interrogate the Simulators library of models and their outputs.

Early successes have allowed the effects of different coastal management options to be predicted for both erosion and flood risks. The results indicated the economic benefits of allowing coastal erosion in some locations because of the knock-on reduction of flood risk for people and habitats further along the coast. Such early results clearly illustrate the benefits of the large-scale Simulator-approach for informing long-term management decisions by viewing the bigger picture.

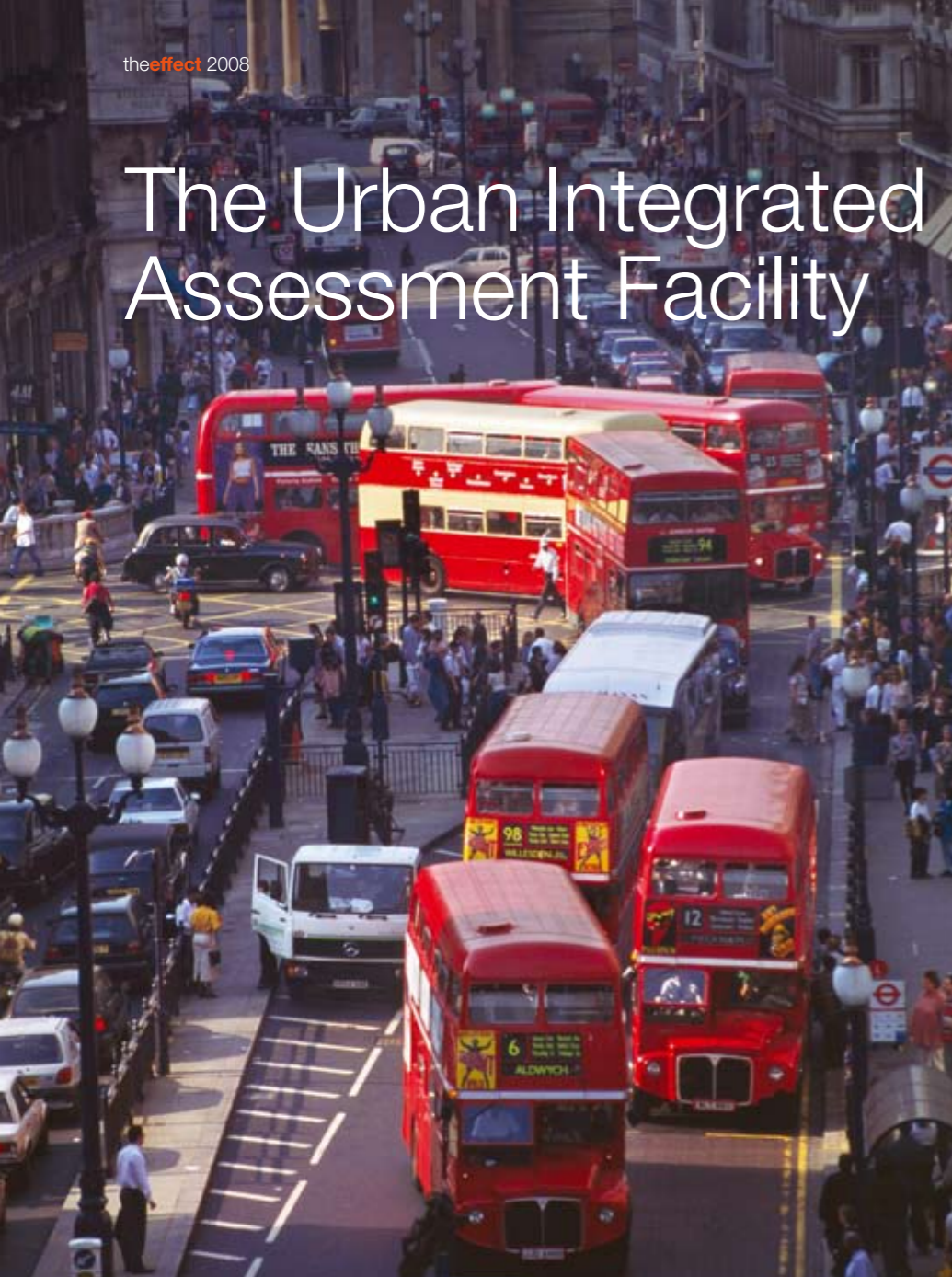
Further information

Tyndall Centre Working Paper 110 or contact mike.walkden@newcastle.ac.uk or robert.nicholls@soton.ac.uk

the world's first Coastal Simulator allows integrated assessments of the coast under a range of scenarios including climate change

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The Urban Integrated Assessment Facility



Users can generate and explore a vast range of results that integrate London's land use, climate impacts and energy policies

produces maps of London's possible population and employment change. The next step is selecting options for adapting to the impacts of climate change on this pattern of population and employment, which produces maps to show areas at risk of flooding, heat risk and drought. Users then assess London's policies for reducing its greenhouse gas emissions by using Tyndall Manchester's Greenhouse Gas Inventory Protocol (GRIP). They are able to define existing as well as future mitigation strategies. Transport emissions are a challenge for every city, and the relationship between employment locations, population and access to transport are important determinants of land use policy. The transport emissions analysis has been undertaken by Leeds and Loughborough Universities.

A final level of interaction means that users can generate and explore this vast range of results that integrate London's land use, climate impacts and energy policies, driven by national and global economic and climate change. Much of the land use, transport and employment-population information is visualised down to the scale of 100m, using a combination of plug-in models developed at University College London and Newcastle University.

The Urban Integrated Assessment Facility has been developed alongside stakeholders at the Greater London Authority, Transport for London, Thames Water and other policy bodies.

Further information

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A prototype of the world's first tool for assessing the future of a city under a

changing climate has been demonstrated by the Tyndall Centre's Cities Programme, led by Professor Jim Hall at the University of Newcastle. Tyndall's Urban Integrated Assessment Facility enables stakeholders and researchers to do their own integrated assessment of how London might change its economy, population, planning policies, energy policies and adaptation policies under a changing climate.

Assessments of cities are commonly story-based and linear narratives of change, often dealing with only one sector. "The Tyndall Urban Assessment Facility enables users sitting at a laptop to interrelate the factors that they think important to London under a changing climate, and also enables

Tyndall's Urban Integrated Assessment Facility enables assessments of how London might change its economy, population, planning policies, mitigation and adaptation policies

many more permutations" says Jim Hall. The Urban Assessment Facility covers the Greater London Authority area and the Thames Gateway.

Each assessment is begun by first selecting current, low or high scenarios for London's economic growth, based on Cambridge Econometrics' well known MDM-E3 regional economic model. Second, scenarios of climate change are selected, including new climate change simulations from the Climatic Research Unit at UEA. It is then possible to analyse how these influence land planning that determines population and employment patterns. At this stage, the Urban Assessment Facility



Researchers across 26 institutions worldwide have been analysing where Europe's current climate change policies are heading

Supporting European climate policy

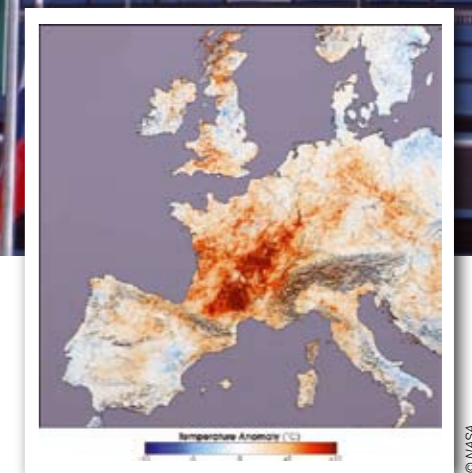


The ADAM project (Adaptation and Mitigation Strategies) has been assessing Europe's strategies to adapt to climate impacts and reduce its global share of greenhouse gas emissions. Researchers across 26 institutions worldwide have been analysing where Europe's current climate change policies are heading. The consortium is led by Professor Mike Hulme at the University of East Anglia, Founding Director of the Tyndall Centre.

The big question for international climate policy is whether the world can really limit its global warming to 2°C above pre-industrial levels. First model results suggest that known technologies can limit the amount of greenhouse gas pollution in the atmosphere to this level. There is a one-in-two chance of exceeding the 2 degrees target at a carbon dioxide equivalent concentration in the atmosphere of 450 parts-per-million. The known technologies for achieving 450 parts-per-million include energy saving, nuclear energy, renewable energy and

biofuels, and burning fossil fuels using carbon capture and storage techniques. To limit to this level of greenhouse gases in the atmosphere, annual per person emissions must not exceed 2 tonnes of carbon dioxide equivalent by 2050. Current EU levels are ten-and-a-half tonnes per person.

The likelihood of limiting the atmosphere at 450 parts-per-million carbon dioxide equivalent is clearly challenging. ADAM reveals though that the costs of achieving an atmosphere with a greenhouse gas concentration of 550 parts-per-million of carbon dioxide equivalent are moderate and lie between 0.6 percent of GDP to minus 2.6 percent GDP by the end of this century. Such costs of mitigation must be weighed against the costs of inaction and many European countries are already vulnerable to climate related extreme events. Flood damage, for example, is already higher than 1% of GDP in most of the newest EU Member States and is expected to rise considerably by the end of the century for a business-as-usual situation of relatively



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unchecked emissions, leading to costs for the wider economy.

But how can policymakers know which policies work best to bring about this shift to a low-emission EU? An ADAM examination of 262 policies reveals that it is the policies that deliver co-benefits which become legislation. For example in addition to lowering emissions, co-benefit policies help secure future energy supply or stimulate new technologies. But a prerequisite for knowing if a policy is working is its monitoring. The researchers are struck by how few policies are evaluated for their emissions reductions, which is essential if the EU wants to assess its progress to achieving its ambitious climate targets.

Further information

www.adamproject.eu or email [Dr Henry Neufeldt](mailto:Dr.Henry.Neufeldt@uea.ac.uk), the project manager, h.neufeldt@uea.ac.uk

Climate Bill overshoots emissions targets



The scientific logic of the UK's groundbreaking Climate Change Bill is that it is more likely to contribute to a world average temperature 4°C warmer than to constrain warming to the EU target of 2°C. This is the conclusion of Professor Kevin Anderson and Dr Alice Bows at Tyndall Centre Manchester in their Briefing Note rapidly published in response to the world's first climate change bill.

This means in terms of atmospheric pollution that the UK's national contribution to cutting global warming amounts to an atmosphere containing at least 600 parts-per-million of carbon dioxide instead of the

target of 450 parts-per-million. Parts-per-million are the measure of the amount of greenhouse gases in the atmosphere. Or put another way, the Bill correlates with an 80% chance of exceeding the target of 2 degrees centigrade and a 60% chance of exceeding 3 degrees centigrade.

the Bill correlates with an 80% chance of exceeding a target of 2 degrees Celsius and a 60% chance of exceeding 3 degrees Celsius

The Briefing Note stimulated much ongoing policy debate. Scotland is drafting its own Climate Change Bill and is aiming for a higher cut in its relatively small proportion of global emissions. The UK's newly established Climate Change Committee is keeping the targets of the UK Bill under review.

The analysis addresses the exclusion from the Bill of emissions from shipping and aviation. Previous Tyndall Centre work has highlighted the policy conflict between growing the aviation industry and cutting climate change. Current work is investigating the emissions of international shipping and its importance to climate change because of the rapidly increasing imports and exports necessary for global trade.

Further information

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Finding out why people fly



New funding secured from the Joule Centre will enable the Tyndall Centre at the University of Manchester to make a comprehensive assessment of aviation's contribution to the economy of the North West Region of England. The project is combining a range of insights for the first interdisciplinary study of aviation's role in regional strategies for economic development and protecting the environment. A spin-off from the project is the first robust methodology for including aviation emissions into regional greenhouse gas inventories.

The project adds a regional dimension to Tyndall Manchester's successful projects that focused on aviation at the national and EU scale. By 2010, aviation emissions in the UK are projected to be similar to those from car travel; by 2020 it is likely to be the sector with the second highest emissions; and by 2030 it is likely to dominate emissions. "The knock-on effect to UK climate change policy is that to allow for the growth in aviation emissions, other sectors of the economy will have to reduce their emissions even further" says Alice Bows of Manchester University.

Alice has interviewed frequent leisure flyers to better understand what is driving the growth of aviation. Flying is itself not a practice – people do not fly for the sake of flying – rather it enables people to engage in other practices, and has raised the standard of these associated practices. For example, it is not uncommon for a future bride-and-groom to celebrate their engagement abroad with two separate parties. Such changing practices of celebrations abroad, holidays and short-breaks, and visiting family and friends, ratchets-up the number of flights each year. Changing people's social practices is exceptionally difficult for policy, particularly through voluntary means.

Easy online booking and check-in enable quick purchasing and delivery of tickets and the relatively low prices of flights enable people to take more flights. Some leisure users – for example enthusiastic skiers and climbers – book several trips for the year in one session of online booking. As one interviewee put it, "ticket costs are absurdly low." The regionalisation of airports is also key – people can fly with ease and speed from their nearest airport.

There are also contradictions as to what constitutes a good global citizen – a well-travelled and culturally educated flyer or an environmentally compassionate stay-at-home? There is some willingness to make marginal adjustments to address the environmental impacts of flying such as compensation by tree planting, but some frequent flyers felt that environmentalists were harbingers of doom.

In addition to frequent-flyers, in-depth interviews and a workshop with aviation industry representatives have covered a series of topics on aviation emissions, from economic drivers to constraints and opportunities in airplane manufacture. Five scenarios for future aviation emissions have also been developed, one specifically by the stakeholders that sets out a vision for a growing industry with zero growth in emissions.

Further information

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What constitutes a good global citizen – a well-travelled and culturally educated flyer or an environmentally compassionate stay-at-home?

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International development in Africa

© Natasha Grist



Climate change could exert some of its biggest impacts on the world's poorest

people, particularly in Africa, where people are heavily dependent on natural resources such as rainfall at the right time of year for growing crops and recharging rivers and lakes. A series of Tyndall Centre workshops on climate change in Africa is bridging the gap between policy and research, helping scientists to focus on the needs of those who plan, fund and carry out international development.

The first workshop was held at Oxford University Centre for the Environment in March 2007. Three main themes were discussed: how to implement development in the face of climate change; how to get development practitioners and academics working together; and how to ensure climate change is properly incorporated into development programmes. Aid organisations like Oxfam and the Red Cross were represented, as well as organisations working on development policy, like the International Institute for Environment and Development. There were officials from the World Bank, the United Nations Development Programme, and the South African and British Governments.

The workshop held in Burkina Faso marked the first Tyndall Centre workshop in West Africa

Most people felt that climate change should be a fundamental consideration in development but it is included in only a very small proportion of international aid budgets. Too weak a case is being made for the proofing of development policies against climate change, and one priority is to make the information about climate impacts and adaptation directly tied to particular development issues. Although the science is far from certain about what will happen in Africa's different regions, it is vital that current development activities don't put people more at risk. For example, it would be wrong to encourage water dependent farming methods in an area where farming may be entirely unviable fifty years from now.

"Climate change is just one of many variables that affects welfare in the developing world. The challenge is to situate it as a key consideration" says Dave Thomas of Oxford University, and Deputy Leader of the International Development programme.

The second workshop, held in Burkina Faso in April 2008, marked the first time the Tyndall Centre has had a workshop in West Africa. The workshop brought together

national policy-makers, development practitioners, funders, scientists and NGO representatives to discuss the current situation and development futures of climate change in Burkina Faso. Burkina Faso is expected to be hard hit by climate change, and currently is facing difficulties in planning adaptation to climate change. Global climate change models are particularly inconclusive about levels of change in the region. Christian Aid co-hosted the workshop.

The third workshop in this programme is due to be held in Cape Town, South Africa, in February 2009, and will focus on development futures for Africa in a number of key areas including food, water and energy security. It is being organised by Andy Newsham at Oxford University's Environmental Change Institute.

i Further information

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Twenty three percent of China's carbon emissions are from the manufacture of goods exported to consumers - the equivalent of more than double the UK's emissions or the whole of Japan's. The conclusion is that counting carbon emissions only within national borders, as is currently the case under the UN's Kyoto Protocol, hides who is actually responsible for the emissions made from exports.

"Passing-on your emissions to someone else is not cutting your emissions" says Jim Watson of the Tyndall Centre at Sussex University. "Not only are industrialised countries historically responsible for the majority of carbon emissions to date, but they have significant responsibility for driving the rapid growth in emissions from other countries"

Jim Watson and colleague Tao Wang calculated the carbon emissions of China's net exports in 2004, the most recent year of full data. They consider their results conservative because in the two years between 2004 and 2006, China's trade surplus (the value of exports minus imports) increased five-fold from \$32bn to \$177bn. China is now believed to be the world's largest emitter of carbon dioxide having overtaken the United States.

working with Chinese decision-makers on how China can industrialise without becoming locked long-term into fossil fuels

"The Chinese government's efforts to reduce the expansion of exports are so far not effective because of high international demand for Chinese goods" said Tao Wang. The majority of China's trade surplus comes from goods such as textiles and consumer electronics that are less carbon intensive to manufacture. But recent exports of carbon intensive materials such as rolled steel and aluminium are increasing at more than 50% annually.



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The research is part of a Tyndall Centre project that is working with Chinese decision-makers on how China can industrialise without becoming locked long-term into an energy system and economy that is heavily dependent upon fossil fuels. Energy systems in the already industrialised countries have significant and long-term lock-in to fossil fuels.

The analysis provides further evidence for the international negotiations around climate change. The United States in particular argues against industrialised countries like the US reducing their emissions unless new economies like China, India and Brazil also do so. The US is the top destination for exports of Chinese made goods.

The Energy Programme is additionally assessing the carbon emissions of shipping and who takes responsibility for these emissions. Shipping, like aviation, is not yet accounted for in national greenhouse gas assessments and worldwide is a massive growth sector for carbon dioxide pollution

Jim Watson said: "Our results strengthen the argument that industrialised countries should move first to make real progress in cutting their carbon emissions – and also help nations like China and India shift to a more low carbon path of development."

i Further information

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in adapting to the impacts of flood and drought. There is also local knowledge, for example on which wild plants can become food supplements during droughts. Barriers to better adaptation are poverty and lack of information, skills and support networks. Some of these barriers can be overcome by supporting people's attempts to diversify into new income earning activities. This is where short-term policy and help can focus, but overarching poverty and lack of skills and knowledge are likely to be with us for decades.

Suraje Dessai of the Tyndall Centre and the University of East Anglia is assessing how organisations in the UK use scientific information to influence their adaptation decisions and what barriers need to be overcome. His recommendation for organisations and businesses is not to delay adaptation while waiting for more precise information about climate change but to focus on climate-proofing to a wide range of climate projections.

Professor Neil Adger at the University of East Anglia leads Tyndall's adaptation research. "Adapting to the impacts of climate change will be a painful process for people around the world. The international community should with great urgency be adapting to the climate change that is happening now and in the foreseeable future. We are learning the lessons for this relatively new area of policy." The EU last July released its first policy paper on adaptation to climate change.

i Further information

Tyndall Centre Briefing Note 20. The conference *Adaptation 2008: Living with Climate Change* is audio podcast at www.tyndall.ac.uk/research/programme3/adaptation2008/index_outputs.html

The many extra deaths during the 2003 summer heat wave showed that old people are vulnerable to heat waves, and that adaptation is needed. Johanna Wolf of the Tyndall Centre and the University of East Anglia presented research which shows that elderly people in the UK whose health can be affected by both cold snaps and heat waves do not see themselves as vulnerable. Information campaigns and social networks currently do little to counter the self-perceptions of old people and so do not help them cope. The conclusion for health policy is that awareness raising needs to be targeted to both elderly and their support networks.

Marisa Goulden of the Tyndall Centre and the University of East Anglia with colleagues Lars Otto Naess and Katharine Vincent (now at the University of the Witwatersrand, South Africa) found that in a study spanning fisherman from Ugandan Lakes and farmers in Tanzania and South Africa – people are through necessity already experienced

Overcoming barriers for adapting to climate change



The Adaptation Programme hosted a major conference at the Royal Geographic Society in London to identify barriers to coping with the impacts of climate change. Adaptation 2008 drew together a worldwide community of over 200 adaptation researchers and decision-makers to assess the state of new knowledge about how to adapt.

Ugandan fisherman and Tanzanian farmers are through necessity already experienced in adapting to flood and drought

What if the climate changes quickly?



There has been a lot of talk about sudden changes in climate, like the thermohaline circulation shutting down, or a new El Niño regime becoming the norm. But few have researched the potential impacts on human society. Professor Nigel Arnell from Tyndall Southampton, and now at the Walker Institute in Reading, made a first assessment of how abrupt climate change could affect people. His research highlights global consequences of rapid change, including impacts on world food markets.

Nigel's report looks at three scenarios of abrupt climate change: shutdown of the thermohaline circulation; rapid temperature increase due to positive feedbacks and a complete change of climate regime, such as a shift to a permanent state of El Niño Southern Oscillation (ENSO) or a permanent change to the south Asian monsoon. It considers what might happen to water supplies, energy, health, agriculture, biodiversity, settlements and infrastructure.

Without the thermohaline circulation in the North Atlantic, temperatures across Europe could fall by around 3°C in little more than a decade. The impacts of this depend largely on when it happens. Cold-weather disruption of infrastructure and increased winter mortality, for example, may not be so serious if the change is superimposed on a substantially warmer world. If the thermohaline circulation collapses in the next 10 years, though, its effects will be more severe. The hydrological models used in this study suggest that thermohaline collapse could reduce the availability of water in south and east Asia as well as in Europe. This is unexpected, and needs to be researched in more detail.

The impacts of rapid temperature change, more than half a degree per decade, are the same as the impacts of gradual climate change, only worse. Significant changes in river flows, greatly increased water scarcity in some areas, substantial increases in heat-related mortality and falls in crop yield could be expected, and many natural ecosystems would be threatened.

The development of a new stable state in the climate system with different rainfall patterns tends to have regional, rather than global effects. But one impact consistently emerges: World food prices are likely to go up. It may be because the fisheries of the eastern Pacific are less productive, less flooding has reduced soil fertility in the south Asian lowlands or more flooding has reduced harvests in the same area. Rapid change is difficult to adjust to and when prices go up, more people go hungry.

The aim of this research was to put the possible impacts of abrupt climate change on the research agenda so that some thought has been given to what it means for people.

i Further information

Tyndall Working Paper 99 or n.w.arnell@reading.ac.uk (now Director of the Walker Institute at Reading University).

A first study of adaptation to abrupt climate change shows across all scenarios that world food prices increase, possibly because of failing fisheries or flooding reducing soil fertility and harvests



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Coastal planning for people and biodiversity



The BRANCH project has brought together planners, policy makers and researchers from England, France and the Netherlands to investigate the impact of climate change on species and habitats and how spatial planning could help biodiversity adapt to such change. Spatial planning is a broad term encompassing all types and scales of land-use planning that influences the distribution of people and their activities. BRANCH is the project name for 'Biodiversity Requires Adaptation in Northwest Europe under a CHanging climate'.

As Tyndall Centre partners in this bigger EU funded project, Professor Robert Nicholls and colleagues at Southampton University and Simon Jude at the University of East Anglia selected six coastline case studies on the south coast of England to investigate the potential impact of sea-level rise on coastal habitats. The sites represent a range of habitats, their morphology and geology, together with associated management issues. These included constraints imposed by current and historic land use, land ownership, protected habitats and erosion. The coastal habitats studied were shingle beach, sand dunes, saltmarshes, mudflats, grazing marshes, saline lagoons, reed beds, and coastal cliffs.

Modelling results indicate that areas for cliff habitats are likely to remain unchanged unless current planning priorities change. For inter-tidal areas in the south of England, intense development and coastal protection means that space is limited and, by the 2080s, the majority of the saltmarsh areas, under most of the sea-level rise scenarios, will have disappeared.

Planners and conservationists are faced with a choice about the relative importance of habitats, all of which are designated as specially protected under EU and UK legislation. For example, coastal grazing marsh and saline lagoons often only exist behind man-made coastal defences. In some areas of coastline the maintenance of defences has been abandoned to increase saltmarsh areas but this means that the habitats behind the defences will be lost. If the defences are maintained, then saltmarsh will decline more rapidly as sea-level rise encroaches.

At the regional scale, suitable land exists for habitat (re)creation that could compensate for local habitat loss. To be effective, suitable areas will need to be saved now and managed to allow for habitat creation later in this century. Planning decisions must therefore consider much longer timescales

than currently practiced and be integrated into other land use decisions, for example agricultural policies. Planning also needs to recognise that while land banking these areas can help maintain the diversity of habitats, local conditions may not support existing networks of habitats at the species level. Accepting these adaptations to climate change will require a more flexible interpretation of biodiversity legislation and guidelines.

Further information

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The development of new 3D visualisation techniques were effective for knowledge exchange with a diverse range of coastal stakeholders



The BRANCH project has brought together planners, policy makers and researchers from England, France and the Netherlands to investigate how spatial planning could help biodiversity to adapt to the impacts of climate change

Change managing coastal communities



The national strategy for coastal defence, called Making Space for Water, signals a shift toward allowing the coastline to function more naturally and away from a preference for engineered coastal defences. This means that in some places there will now be a policy of no active intervention, otherwise known as coastal retreat. But, the local implications of retreat have not been matched by any policies or mechanisms for enabling its application at the local level to be managed socially, economically or environmentally. Consequentially, many coastal communities, for example Happisburgh in North Norfolk, are facing the prospect of losing homes and local infrastructure to various extents over the next 25 to 100 years in the absence of any compensation arrangements or other community support.

Sophie Nicholson-Cole's research at the Tyndall Centre at the University of East Anglia is working closely with coastal stakeholders, particularly on the North Norfolk coast, where coastal change is high on the political agenda. She has revealed a number of underpinning factors that

Research with coastal communities is identifying barriers for adaption to coastal erosion and sea-level rise

are challenging progress on adaptation to this changing coast. She categorises these challenges as: changing risk and uncertainty; the sensitive economies and cultures of coastal towns; a shifting policy context; mismatched expectations and understandings; many stakeholders with different interests; complex and new management arrangements; and a lack of cross-sectoral co-ordination and questions of what is socially just and fair.

"My research demonstrates a real tension between national strategic frameworks and local flexibility for its delivery. Despite pioneering efforts on the ground, the broader institutional context is constraining the local potential to adapt to coastal

change", says Sophie. "For the moment, this leaves coastal communities in a state of limbo, desperately trying to ensure a sustainable future". Planned adaptation initiatives which are properly financed, managed and inclusively developed are critical, she says. For this to happen, coastal governance needs to become more adaptive in its thinking before local efforts can really take flight.

The situation is not altogether bleak, however. The North Norfolk District Council have been making unprecedented efforts to design, enable and implement adaptation measures that are starting to offer some hope for coastal communities in the area. Moves are also being made regionally to co-ordinate efforts, and nationally to develop a range of adaptation options for flooding and coastal management.

Further information

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Who is more effective, efficient and faster at combating climate change?



The Tyndall Centre is investigating the role of organisations that are key to reducing greenhouse gas emissions but are outside of the formal United Nations (UN) climate change negotiations, the traditional realm of climate policy research. What can these businesses, cities, regions, offset companies and others achieve for climate change policy? Heather Lovell of Edinburgh University went to the 2007 annual UN climate change negotiations in Bali to ask why thousands of people organise and attend side-events and what they hope to achieve.

Side-events by outsiders were originally intended to feed the latest scientific evidence into the official negotiations but they have grown considerably and are now on a par with the official UN meeting: At Bali there were 200 side-events and at least 6000 people who work on climate science, policy and business.

Heather and colleagues surveyed the events and interviewed key players. "The outsiders are vocal about their ability to take quick and effective action in combating climate change in comparison to the slowness of agreements in the UN process" says Heather. "But they also

recognize that their opportunities are heavily influenced by what is decided by the formal negotiations". All countries have to agree any decision which means a 180-piece puzzle is in progress during the annual two-week UN meetings.

"The negotiations are seen by the outsiders as less about climate science and responses and more about diplomacy skills, vested interests and political power. Side-events, in contrast, tend to be solutions-focused with vigorous debate about new ideas for mitigating climate change and the latest science" said Heather.

Further information

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What can businesses, cities, regions, and others outside of the UN process achieve for climate change policy?

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Learning lessons from London's leadership



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By positioning itself as a global innovator, London has made political capital of its climate change endeavours



Global cities like London are central to the functioning of the world economic system with influence far beyond national boundaries. What role do such global cities – as entities that are not included in country-by-country UN negotiations - have in influencing and achieving policy on climate change? Heike Schroeder at Oxford University and Harriet Bulkeley at Durham University have examined London's role in both galvanising its own climate change action and if it influences international policy.

They conclude that the drivers behind London's step-change for climate change over the past eight years include leadership and commitment; the courage born from interim policy success such as the congestion charge; a background of positive public opinion; lack of opposition from key interest groups; and the new economic opportunities in carbon trading for city finance firms.

First of these drivers was leadership for committed partnerships. Under the eight

year reign of Mayor Ken Livingston and Deputy Nicky Gavron, London positioned itself to provide climate leadership at city, national and international levels. "Climate change was core in the policy agenda of the Greater London Authority which meant that people working day-to-day on climate change strategy had the critical ingredient of high-level support" says Heike. This support in turn led to ambitious targets for reductions in emissions and widespread acceptance of climate change as an overarching policy issue.

London's political leaders also galvanised its business leaders who were already alert to climate change and carbon trading. This is one example of where global cities can interact with international climate policy: With London as a centre of the new carbon finance industry it has the potential to shape international carbon trading while the UN carbon trading framework will also shape the City.

International leadership was a further element of success. By positioning itself as a global innovator, London has made

political capital of its climate change endeavours. It established the C20 network of climate change cities in 2005. C20 is now C40 and is a conduit of climate advice, knowledge and finance.

But only six London Authorities have climate change action plans. One explanation for this lack of political interest is party politics - London's mainly Conservative Party suburban Councils are less willing to engage than inner-city Labour Party authorities. With the Labour leadership of Mayor Ken Livingstone voted out in May 2008, it is still unclear if similar emphasis on climate change will be led by Conservative Mayor Boris Johnson.

The International Policy programme has also assessed the contribution of Los Angeles to climate leadership. Melbourne and Mexico City are also being investigated.

Further information

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The constraints to forest carbon trading

The International Development programme has shown the challenges facing developing country governments if they are to effectively participate in global markets for forest carbon

emissions each year. It also estimates that 5% of the world's forest is lost each decade.

Their paper published in the leading development studies journal *World Development* exposes the difficulties in designing systems and institutions to market forest carbon, and the constraints and challenges facing developing country governments if they are to effectively participate in global carbon markets. These constraints include the unwillingness of some people or communities to engage in markets, the lack of skills and capacity to secure funding for implementing projects, and the misfit between community practice and sophisticated national and international rules.

In order for market-based mechanisms to be effective in protecting forest ecosystems, these constraints must be overcome. But this is immensely expensive for developing countries in terms of time, expertise and effort. Sophisticated rules and the large scale of investments may mean that poorer countries are excluded. The impact of these combined and significant constraints likely explains why there is only one CDM forestry project registered so far and a handful of voluntary certified forest projects worldwide.

Overcoming these constraints has clear implications for further development of Kyoto mechanisms that are relying upon market trading of carbon, forest sequestration and other ecosystem services. In forthcoming international climate change negotiations there will likely be a greater emphasis around promoting forest carbon markets.

i Further information

e.corbera@uea.ac.uk or the technical journal *Corbera, E. and Brown, K. (2008), Building institutions to trade ecosystem services: Marketing forest carbon in Mexico. World Development*

For research by Manuel Estrada that compares regulated and voluntary offset schemes, please see Tyndall Centre Working Paper 116

Using market mechanisms to prevent deforestation in developing countries allows industrialised nations or industry to offset their emissions by funding projects that reduce deforestation. Compensation for avoiding deforestation could also

Sophisticated rules and the large scale of investments may mean that poorer countries are excluded

help to improve forest management, its governance, and boost the incomes of rural communities. The role played by tropical forests in storing carbon and regulating the global carbon cycle is well researched. When forests are felled or burned, they release their carbon into the atmosphere. Conversely, when forests are planted or conserved, carbon is locked-away. The World Bank reports that deforestation accounts for 20% of carbon dioxide



Locking-away carbon by storing it in tropical forests is a potentially important part of managing levels of carbon dioxide in the atmosphere. Moreover, using market-mechanisms to pay for the management of forests to store carbon is enthusiastically promoted by the UN Framework Convention on Climate Change, the World Bank, large conservation organisations and by private-company carbon traders. Research by Dr Esteve Corbera and Professor Kate Brown of the Tyndall Centre and the University of East Anglia compares government-led initiatives for forest-carbon projects, such as those proposed under the Kyoto Protocol; to voluntary, retail-based, carbon markets operated by private businesses. They examine the case-study of Mexico's markets for forest carbon and find that there are severe constraints to the creation of environmentally-sound, effective, markets.

Why the FTSE fights climate change



Profit is of course the main incentive behind big company's carbon reduction programmes but there is a combination of other motivations for action writes Chukwumerije Okereke in his review of the FTSE 100's climate change activities. FTSE100 companies are global players with businesses that operate in many countries across the world and few nation-States have such influence. Chukwumerije is based at Tyndall Centre Headquarters at the University of East Anglia.

All FTSE 100 companies that report on climate change made a link between profit and carbon management and report amounts of money saved. In 2005 Shell reported \$60 million of savings, Alliance Boots between £1 million and £2 million and Aviva 'massive financial savings'. Other motivators include recognition that climate change will bring fundamental shifts in the way that companies operate and that it is better to be proactive than oppose international and national climate agreements. Chief Executives also have an obligation to confer market advantage and steer away from possible losses through climate change.

All FTSE 100 companies that report on climate change made a link between profit and carbon management and report amounts of money saved

The typical perception that business strategy is incompatible with ethics and morality appears out of date. The majority of companies argue that the trust gained from customers in 'doing the right thing' is outweighed by the cost. Yet whether big businesses see climate change as an

issue of business strategy or an obligation is unclear. Over 86% of all companies who report their climate action do so under corporate social responsibility.

FTSE 100 companies identify the most significant barrier to action as the absence of a clear and long-term policy framework. If a framework existed the companies would have a strategy upon which to base their decisions, they say. British Airways is one of the many businesses calling for a strong and long-term framework to stimulate deep emissions cuts from the aviation industry in a globally competitive business.

Related to the absence of a framework are the uncertainties in how governments might respond, uncertainties about the market place, and geo-political uncertainties such as the future role of India and China and the oil rich countries in climate change agreements. With this uncertainty and without a long-term economic value for low carbon technologies, it is difficult for Chief Executives to justify to their investors the high upfront costs of engaging with climate change.

"In the past few years we have seen a curious move in corporate environmentalism from opposing a global climate agreement to a more proactive stance including advocacy in some cases. However, a lot of work is still needed to investigate the link between aspiration and actual emissions reduction," concludes Chukwumerije.

FTSE 100 is important to UK and global emissions - one report shows that the group of leading companies was responsible for 73% (480 million tonnes) of the UK's greenhouse gas emissions between 2003 and 2004.

i Further information

Tyndall Centre Working Paper 109 or c.okereke@uea.ac.uk

Getting a GRIP on Europe's metropolitan emissions



Cities across Europe are employing a new service that quantifies and projects greenhouse gas emissions across a region's industries and economic sectors. Four regions: Stockholm County, Veneto, Bologna Province, and Glasgow and the Clyde Valley have already used the system and a further 21 are next in line, including ten capital cities: Madrid, Paris, Stockholm, OHelsinki, Brussels, Athens, London, Oslo, Moscow, and Ljubljana. The system is designed to make it straightforward for decision makers to assess their region's emissions and use their expertise to produce tailor-made scenarios for reducing emissions.

Called GRIP (Greenhouse Gas Inventory Protocol), the service was developed by Sebastian Carney for his PhD at Manchester University. It was first built for the North West of England and was part-funded by the Environment Agency and the Tyndall Centre – with supplementary funds provided by the researcher. GRIP exemplifies the Tyndall Centre's approach of working alongside stakeholders to produce agenda-setting research that is truly useful.

Many commercial organisations produce many different greenhouse gas inventories. "GRIP embraces all these varied approaches and has an open methodology that its users trust" says Sebastian. "GRIP

is quick to deploy, adaptable to different data, transparent, replicable, and is clearly communicated". GRIP results are also consistent and comparable to national inventories, between different regions and between different years. The methodology is in line with international standards laid-down by the UN's Intergovernmental Panel on Climate Change.

The European Union's Energy Policy acknowledges the need for greenhouse gas reductions of 60-80% by 2050. Cities have the central role in achieving Europe's target. Its 100-plus metropolitan areas house over 60% of Europe's population of 490 million people and are

GRIP is designed to make it straightforward for decision makers to assess their region's emissions and produce tailor-made scenarios for reducing emissions



© stockphoto

the main source of Europe's greenhouse gas emissions. "Climate change requires trans-national cooperation and therefore a common language. My hope is that GRIP will become the standard tool for European Cities and Regions wanting to work together to assess, compare and reduce their greenhouse gas emissions" said Sebastian. "The use of GRIP is the way to inform choices that have to be made" wrote Roger Read, Secretary General of the network of European Metropolitan Regions and Areas.

To keep-up with the user demand for GRIP, Sebastian Carney has founded a private company Carbon Captured Ltd.

Further information

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Glasgow and Clyde Valley is a metropolitan region that has already used GRIP and 21 other regions across Europe are next in line

Used cooking oil is the most sustainable biodiesel



Paul Upham and Patricia Thornley at the Tyndall Centre and Manchester University,

are assessing the sustainability of the source materials that supply the UK with biodiesel. Using methods defined by the UK government's Renewable Fuels Agency, they conclude that only used cooking oil has guaranteed sustainability benefits. Other raw materials for making biodiesel, called feedstocks, have a CO₂ payback period of 25-5,000 years, depending on whether the crop is grown on existing cropland, converted forest or converted grassland. Payback is the length of time that a crop would need to be grown on an area of land to recoup the greenhouse gas emissions caused by clearing that area of land to grow the crop.

If collection of used cooking oil was 100% efficient then it could provide the UK's biodiesel needs under the existing renewable fuels obligation. Such efficiency is unlikely ever to be achieved but it does demonstrate what can be achieved with waste feedstock before resorting to virgin crops. "Incentives for oil recycling could be provided by an extensive collection network for collecting used oil from homes and businesses, though the emissions arising from such a system would themselves need to be assessed," says Paul.

There is currently an obligation on transport fuel suppliers to ensure that 5% of UK fuel by 2010 is from renewable sources, and it is likely that a significant proportion will be imported. The work by Tyndall Centre

Manchester and Kings College London runs from 2007 to 2011 and will shed further light on the impacts of particular feedstocks and on the details of alternative scenarios for supplying the UK with biofuels.

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If collection of used cooking oil was 100% efficient then it could provide the UK's biodiesel needs

Small is not always beautiful for biomass power



Small-scale, community-based biopower plants produce higher levels of emissions per unit of electrical output than large facilities, says research from the Tyndall Centre at Manchester University. Patricia Thornley and Paul Upham show while small facilities do have their plus points – for example, transport impacts are lower and local communities tend to support them – their environmental performance is usually inferior to that of larger plants.

"There is a need to look not only at emissions, but at carbon savings, costs and jobs all side by side – and that is what we have done in this study," said Patricia. They also found that, while all biopower generating systems show substantial reductions in greenhouse gas emissions compared to conventional electricity,

using the most efficient technology in bioelectricity plants does not necessarily result in the lowest carbon emissions. Moreover, Patricia points out that the bioelectricity technologies have differing implications for local air quality: "Carbon savings are pretty constant across all sizes and types of plants but the overall emissions vary a lot."

Four key airborne pollutants – carbon monoxide, nitrogen oxides, particulates and volatile organic compounds (VOCs) – were tracked across every step in the bioenergy system, from field to power plant.

The market for bioenergy systems is currently without guidelines on preferred types or size, meaning that deployment is on a case-by-case basis. Local circumstances, including rural social initiatives, have in many cases driven the

development of small-scale facilities in the UK, or local protest has stalled or halted development.

The research – as part of the SUPERGEN Biomass and Bioenergy Consortium funded by the Engineering and Physical Science Research Council – assesses the impact of 25 complete bioelectricity systems from crop to light switch. The work was in conjunction with The University of Ulster and Aston University.

Further information

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the technical journal *Thornley, P. (2008). Environmental emissions from biomass based power generation systems, Environmental Research Letters 3*

Climate and society at the Chelsea Flower Show



© Saffron O'Neill

Over 140,000 people attended this year's Royal Chelsea Flower Show where Saffron O'Neill and Johanna Forster were delighted to win a silver medal for their climate change garden

Johanna Forster and Saffron O'Neill from the Climatic Research Unit and the Tyndall Centre at the University of East Anglia were delighted to win a silver medal at this year's Royal Chelsea Flower Show for their 2050 Garden. The 2050 climate change garden was a popular hit with thousands of Chelsea visitors and designed with science communication in mind; it was the only interactive exhibit in the show.

The 2050 Garden reflected upon the traditional English garden of the 1950s before looking to gardens of 2050 under a changed climate. The 2050 borders illustrated two possible future climates that UK gardeners may be working: one under a 'low emissions future' and the other a 'high emissions future'. In addition to the plantings, the back walls were clothed with a stylised landscape behind each border to give a visual impression of the 1950s past, a low emissions future and a high emissions future. Populating the borders were information boards explaining the climate scenarios, the likely environmental

conditions, and the associated garden plants that were on display. Other information explained changes of particular interest to the gardener about longer growing seasons; extremes in rainfall; increases in pests and fewer frosts.

At the front of the garden was a hedge planted with Box species where visitors posted their own observations, hand-written on plant labels, of how the climate is changing their gardening. By the end of the week the 'ideas-box-hedge' was decorated with comments on climate change and gardening from Australia, the US, Canada and the UK.

We are grateful to SureStep for donating a hard-wearing but porous path made from recycled china-clay waste. The decorative path was a huge talking point with visitors. People seem aware of changing rainfall patterns and the need for soak-away surfaces, instead of concrete and asphalt drives.

Johanna said: "People cherish their gardens as much as their homes and we were showing what climate change might mean for gardeners by 2050, and why." The Principal Funders were the Natural Environment Research Council, the Economic and Social Research Council and the Tyndall Centre.

Visitors, including Environment Minister Phil Woolas, newscaster Sir Trevor McDonald and NERC Chief Executive Prof Alan Thorpe, had the opportunity to discuss the issue of climate change with Tyndall and CRU researchers who staffed the garden for the whole week. Sky News broadcast a day-long series of interviews from the garden.

The garden was developed in response to an invitation from the Royal Horticultural Society to participate alongside several other UK research and teaching establishments in this year's education theme of climate change. "The 2050 Garden was a tremendously fun experience, but with a very serious message: climate change is real and we must all dig deep to mitigate its dangerous effects" said Saffron.

Further information

For the garden design:
www.tyndall.ac.uk/2050garden

Motivating students to switch off

Neil Jennings is a recently completed Tyndall PhD researcher at the University of East Anglia who in his 'spare' time begun a hugely successful initiative to encourage students to save electricity. With other Universities wanting to join-in the fun, getting students to switch off has become his full-time job.

"At the start of my PhD, if you had told me that I would ever visit the Arctic I would have handed you a straight jacket. And yet in April 2007 I was privileged enough to embark on the trip of a lifetime to the Arctic Circle as an Ambassador for the Ben & Jerry's Climate Change College. Here's how it all came about.

As a Tyndall PhD student, climate change was rarely off my mind – which was probably just as well! I recalled my undergraduate days when students in halls of residence paid a set fee for their accommodation and electricity bills and remembered just how much energy got wasted. It seemed to me that to address this problem we needed to find a way of tapping into existing motivational prompts. The two characteristics I picked out as being most important for students were the pride associated with their Hall of Residence and freebies! And so the Student Switch Off was born, an energy saving competition between Halls of Residence to see which Hall could reduce their energy

usage by the greatest amount from a baseline level. Over the next few months I approached sponsors to provide prizes for the initiative and Ben & Jerry's, Powergen, Odeon, The Independent and First came on board. Key to the success of the initiative were individuals called Eco-Power Rangers – students living in halls who pledge to use their energy carefully and encourage their friends to do so as well. The scheme proved a huge success as electricity usage decreased by 10% over the academic year 2006/07 and saved around 90 tonnes of carbon dioxide from going into the atmosphere.

With the backing and help of the Ben and Jerry's College I took the Student Switch Off to seven Universities in 2007/08, reducing energy usage by an average of 8.7% and saving the Universities a cumulative total of over 500 tonnes of carbon dioxide and over £100,000 in the process. I've now finished my PhD and am running the Student Switch Off as my full-time job.

Sixteen Universities have signed up to host the initiative for the forthcoming academic year and a further nine are already on the waiting list for the following year. I'm looking forward to donning my lycra 'Eco-Power Ranger' outfit again to spread messages about climate change and the importance of personal action to a new batch of students this year. Together with the experience and inspiration gained from being at the Tyndall Centre, I'm looking forward to encouraging even more 'friendly' competition, all in the name of reducing carbon emissions."

Further information

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Neil Jennings and his Eco-Power Rangers are enthusing students and campuses across the UK to save energy and emissions

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