

ENVIRONMENT



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Nottingham's new tram system should reduce the city's carbon emissions by encouraging the use of public transport

Policy pressures are intensifying as national governments adopt increasingly ambitious carbon reduction targets

Economics of low carbon cities

Professor Andy Gouldson says that incentives, motivational initiatives and investment are required to decarbonise a city

WHAT IS THE best way to decarbonise a city? There are plenty of reasons why we might want to do so. As cities could be particularly exposed to the impacts of climate change, we might hope that they would play a leading role in helping to avoid it. But climate change is a collective action problem on a global scale, and the case for local action on environmental grounds alone is not always strong enough. Fortunately, there are other drivers that might motivate cities to address issues of climate change – some of which appeal more to self interest than to collective concern. Incentives to invest in energy efficiency and energy security are going up as energy prices increase. In some settings at least, policy pressures are intensifying as national governments adopt increasingly ambitious carbon reduction targets. And economic development opportunities are becoming more prominent as the low-carbon and environmental goods and services sector – which has been estimated to be worth £3.2 trillion a year and to employ 28 million people worldwide – continues to grow.

These trends could have major social and economic implications for all – through their impacts on growth, competitiveness, employment, social welfare, fuel poverty and so on – but arguably their effects are likely to be felt more acutely in cities than in other contexts. In urbanised countries, around 80 per cent of all economic output is generated in cities, and around 80 per cent of people live in cities. Further, it has been estimated that between 40 and 70 per cent of all anthropogenic greenhouse gas (GHG) emissions are produced in cities, and that at least 70 per cent of emissions can be attributed to the consumption that takes place within cities. Cities seem to be as exposed to attempts to reduce energy use and carbon footprints as they are vulnerable to the effects of climate change itself.

THE RESEARCH

So what do we do about this? There are thousands of low-carbon options available and although they present a significant opportunity to reduce energy bills and carbon footprints there is often a lack of reliable >

› information on their performance. The higher levels of risk and uncertainty that emerge as a result of this can be a major barrier to action, making it hard to develop a political, a business or a social case for investment in low-carbon options.

Research by the ESRC Centre for Climate Change Economics and Policy, and the Centre for Low Carbon Futures has sought to address this problem. The research has reviewed the cost and carbon effectiveness of a wide range of the low-carbon options that could be applied at the local level in households, industry, commerce and transport. Scaling down national level data from the UK Committee on Climate Change, it has explored the scope for the deployment of the different low-carbon measures at the local level, and the associated investment needs, financial returns and carbon savings. It has also explored the wider implications of these investments for employment and the wider economy.

As an initial case study, the research has focused on the Leeds City Region. This is the second largest city region in Britain, with a population of three million and an economy worth £52 billion. The research finds that if nothing else changes, projected levels of economic growth, combined with a continuation of gradual improvements in the energy and carbon intensity of GDP, will lead to a small increase in carbon emissions in the city region between 1990 and 2022.

However, this prospect is mitigated – in almost equal proportion – by the effects of three other trends. The first is that the substantial increases in energy prices that are predicted through to 2022 will have major impacts on levels of energy demand. The second is that the investments in new energy infrastructure at the national level will lead to significant drops in carbon emissions. And the third is that exploiting all of the realistic potential for energy-savings measures and low-carbon options at the local level would lead to a further significant drop in carbon emissions. It is this third aspect that Andy Gouldson focuses on in the research.

THE FINDINGS

The research ranks all of the options available to households, industry, commerce and transport at the local level in terms of both their cost and carbon effectiveness. This analysis is done at the interest rates and energy prices available to households and



Regenerating canals, such as the Liverpool to Leeds development, encourages low-carbon behaviour

businesses to provide a realistic business case for investment. If nothing else, this offers a useful guide for decision-makers who are able to prioritise and focus their resources on the most cost- or carbon-effective options. But it also enables us to predict the impact of different carbon

Incentives to invest in energy efficiency and energy security are going up as energy prices increase

reduction strategies. The research finds that, when combined with the impacts of price increases and the decarbonisation of the grid, the exploitation of the cost-effective low-carbon measures would lead to around a 35 per cent carbon cut in the city region between 1990 and 2022. This would require several billion pounds of investment, but these

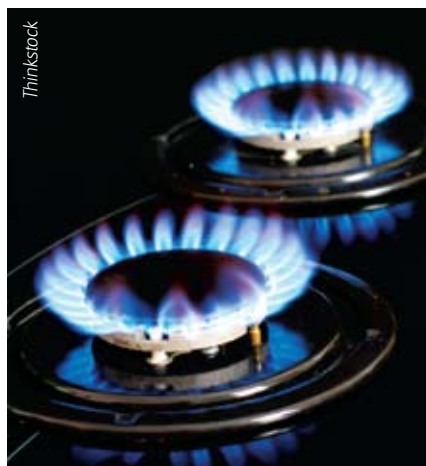
investments would pay for themselves on commercial terms in around four years. The energy bill would be cut by over £1 billion and several thousand jobs would be created in the low-carbon sector within the city

region. If the savings from these cost-effective measures were captured and re-invested in further low-carbon measures, then these figures increase substantially.

Of course, the fact that these opportunities exist on this scale is obviously not enough to ensure that they are actually exploited. Incentives – no matter how strong they are – have to be matched with appropriate capacities if progress is to be made. These relate both to the capacity to supply appropriate levels of investment, and to the capacity to stimulate and sustain demand for such investments. To stimulate the supply of the very significant levels of investment that are needed, we need to think about innovative financing mechanisms, based on new forms of cost recovery and benefit sharing and new ways of managing risk. And we need to develop new delivery vehicles that can stimulate and sustain demand for investment in low-carbon options by overcoming the many potential barriers to change.

THE IMPACTS

The researchers hope that by presenting a realistic but compelling case for investments in numerous low-carbon options their research will have a major impact on transitions to a low-carbon economy and society at the local level, not only in the Leeds City Region but also in other contexts. But they recognise that economics is not the only discipline that has something useful to say on the transition to a low-carbon economy or society. Wider analysis is also considering the social and political acceptability of the different options, as well as issues relating to the social equity and broader sustainability of the different pathways towards a low-carbon economy and society. ■



Natural gas produces lower-level carbon emissions

www.ccep.ac.uk

Becoming energy-efficient citizens

How we use buildings is as important as their design

DOMESTIC ENERGY USE is one of the biggest sources of fossil-fuel emissions worldwide. Britain is committed to reducing its carbon emissions by 80 per cent by 2050, and part of this target will be met by making all new homes 'zero-carbon' by 2016. Renewable energy and green-fuel technologies are developing rapidly. But our whole energy system (the amount we use, the type of fuel and the sorts of things that consume power in our homes) is driven by demand. So how we use buildings is at least as important as their design when it comes to energy use.

My research looks at how we live and work, and how our practices change – or don't – when we have to try to be more energy efficient. Old habits die hard, even in a state-of-the-art eco-home. Our social expectations – keeping up with the Jones' new 50-inch 3DTV – and energy-consumption patterns can defeat the most careful design. It's an area that has been largely ignored by existing efforts to improve energy efficiency, which instead focus on architectural and technological developments. In the face of climate change these solutions are important, but they can't do everything.

PROVIDING INFORMATION

Understanding how socioeconomic and technical change affects energy demand in Britain is crucial if we're to find an approach to climate change and energy security that works. Does more mean better? Take solar power. Grid-connected solar is the world's fastest growing power-generation technology. Meanwhile, reducing energy demand in homes is a critical part of meeting carbon reduction targets. But if people install a new Photovoltaic (PV) panel without making their house more efficient first, we might just end up consuming more solar panels rather than becoming wiser energy users.

Many who live in PV-powered houses designed to be 'zero energy' in reality don't change their energy use. This doesn't mean that PV arrays and energy efficiency measures aren't effective – they are. Case studies show there is an across-the-board decrease in energy bills in zero energy home (ZEH) developments compared to neighbouring conventional ones. But people in ZEH developments often don't produce enough solar power to meet their needs. Moreover, energy-use patterns in ZEH developments exactly mimic those of their neighbours, rather than reflecting the near 'zero energy' intention of their designers. This means that while people are paying less for their energy, they aren't using less. One problem with relying exclusively on renewables to solve carbon emissions problems



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Many who live in PV-powered houses don't change their energy use

is that although the fuel is free, the devices to capture and transform renewable energy are expensive. Renewables currently provide a tiny fraction of the energy used in the world, which means we have neither the production capacity nor the cash to rapidly replace our fossilised system for a renewable one, so the smaller our energy needs are, the quicker our renewable capacity will match our needs.

Widespread adoption of 'green' technologies, such as hybrid cars or PVs, may have unintended consequences: The car may be driven more often because it's more efficient, or someone may add an air conditioner to their home because the electricity is 'free'. In this way increased consumption of PVs or hybrid cars may actually increase our energy consumption. What is

the answer? We could start by addressing the fact that when asked to reduce their consumption households and bill-payers often don't have the information they need to change their energy-use habits. Giving people direct feedback on how they use energy is one way to help. Research shows that feedback devices, like smart meters

and energy monitors, can help people reduce their consumption by 10-20 per cent, by showing them how changing their behaviour directly affects their energy use. In the case of PV, a real-time feedback meter invites people to see themselves as producers as well as consumers of energy.

This approach paves the way for a change from blind consumer to educated citizen, but it's not the end of the story. Surveys in the US reveal that most people appear not to understand energy issues; many of us are uninterested or simply ill-equipped to handle the challenges presented by the need to reduce energy consumption. So

relying on energy feedback to change people's behaviour is unlikely to be enough.

INTEGRATED SOLUTION

Education of a different kind is needed to address habits and 'social norms' that are the strongest influence on people's behaviour. This could come through schools, where integrating the built environment into the curriculum could benefit physics, maths and art students, and tackle sustainability more thoroughly for architecture students. Architects could also take on more responsibility for teaching building users to see their homes as dynamic systems, rather than static objects. It could even be an issue for public health education, or perhaps a new profession; one at the intersection of the built environment, public health and climate change.

Whatever the approach, people's behaviour in their homes needs to be considered more. Designers must work with home owners to encourage more sustainable behaviour in buildings, rather than designing around people's existing habits. And new technologies need to be part of an integrated solution to our energy needs, including educating people. ■

www.ukerc.ac.uk



DR KATHRYN JANDA

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Born sceptics?

Climate scepticism is linked to people's values and politics but new findings also suggest it may be a defence mechanism

RESEARCH CONDUCTED AT Cardiff University's ESRC Centre for Business Relationships, Accountability, Sustainability and Society (BRASS) has explored why some people – but not others – are sceptical about climate change. Public awareness about climate change has grown over recent decades, but over the last few years opinion polls from around the world show a drop in concern and a rise in doubt about the issue.

A survey of the British public by Professor Nick Pidgeon from BRASS and colleagues found that the number of people believing the world's climate is changing dropped from 91 per cent in 2005 to 78 per cent in 2010. Similarly, an English survey by Dr Lorraine Whitmarsh from BRASS found that agreement that 'Claims that human activities are changing the climate are exaggerated' doubled between 2003 and 2008 from 15 per cent to 29 per cent. Yet the last few years have also seen the publication of the latest assessment of climate science, highlighting the human causes and risks of climate change, and the launch of British laws to tackle climate change. So why does public uncertainty about climate change appear to be rising when most experts are now more certain than ever about its reality and the need to tackle it?

This question has led BRASS researchers to explore the reasons for climate change 'scepticism', which encompasses doubt about the reality, human causes and risks of climate change. While some people have claimed that

Opinion polls show a drop in concern and a rise in doubt about climate change

scepticism is due to a lack of understanding of the science of climate change, others suggest political or psychological factors are behind it.

To test these competing explanations, Dr Whitmarsh surveyed English residents to look at the characteristics of climate sceptics – including gender, age, income, education, knowledge about climate change, environmental values, lifestyle and voting intention. Her analysis showed that education and knowledge had little to do with scepticism, while the most important factors were values and politics. Those who voted Conservative and tended not to value the environment were the most sceptical. The implications of this research are that providing sceptics with more scientific evidence of climate change will probably not convince them about the issue. Instead, we need

to focus on environmental education that promotes ecological values.

The latest research by Dr Whitmarsh goes further to explore the psychological mechanisms behind scepticism. We know that denial can be a coping response to threatening information – for example, when told about health risks from eating high-fat foods or smoking. Could it be that climate change denial is an identity-protective response to information that threatens individuals' lifestyles (by requiring us to reduce our carbon footprint)? Dr Whitmarsh and colleagues set out to answer this question by looking at how individuals decided whether or



not they believed in the reality and severity of a newly discovered risk.

In an experiment in which students were provided with information about a new (hypothetical) risk (water pollution from livestock farming), Dr Whitmarsh and colleagues varied whether the information included behavioural implications (rationing of meat) or not. They expected that the students would be more likely to deny the reality and severity of the risk if they were told they would have to change their behaviour. As expected, those who reported enjoying eating meat were significantly more sceptical and less willing to take action

Less burp in your burger

The adoption of breeding technologies means beef and sheep farmers could reduce livestock emissions of methane

METHANE IS A potent greenhouse gas produced as a by-product of digesting grass. Agriculture accounts for about nine per cent of British greenhouse gas emissions, of which around 36 per cent is due to methane. Government commitments to the radical reduction of greenhouse gases are increasing the focus on the contribution of agricultural emissions. Modelling work suggests that adopting breeding technologies, such as selective breeding (not genetic modification) can reduce methane production per kilogram of meat produced, and make more profit for farmers. But, historically, adoption of such technologies has been slower by sheep and beef cattle farmers than for other farm species. Dr Ann Bruce, a researcher at the ESRC Innogen Centre at the University of Edinburgh, is undertaking research to find out why.

Many livestock farmers use current breeding technologies, but a number of barriers to adoption are raised by others. Sheep and beef farming in Britain is embedded in a variety of 'systems of production' that have evolved with geographical location and the opportunities afforded by those locations. There are a number of barriers to adoption of breeding for methane reduction in these contexts, such as lack of trust in scientifically-derived evaluations of the breeding merit of animals, and the cultural role of breeding.

Market signals are complex: many farmers rely on payments for ecosystem services and provision of high-quality 'natural' meat – a product they perceive to be adversely affected by adoption of some technologies. Dairy farmers, who produce around 50 per cent of beef calves, only perceive these calves as the 'icing on the cake' of



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Melting ice caps are evidence of 'climate change', but why do people doubt it's happening?

to reduce the risk – but only when the risk information stated that meat eating must be dramatically reduced to avoid the risk.

This experiment suggests climate change scepticism may work the same way – to cope with the uncomfortable implications of climate change for our way of life. Further research by the BRASS team aims to find new ways of engaging the public with climate change that avoids provoking this defensive reaction when talking about climate change. ■

www.brass.cf.ac.uk

their core business of producing milk. Perhaps most tellingly, methane emissions are viewed by farmers as a natural and inevitable product of sheep and beef farming – it has always existed and cannot be influenced by farmers' practices. Also, beef and (particularly) sheep production systems rely heavily on feeding grass rather than cereals, so there is little artificial input. And as grass captures carbon, farmers are led to wonder how emissions can really be an issue.

Britain's green landscape, with its grazing animals, is seen as something desirable, rather than a site of pollution. But, despite the increasing focus on agricultural emissions as a source of greenhouse gases, there are few clear motivations for many farmers to change practices. ■

www.genomicsnetwork.ac.uk/innogen

Low-carbon leisure

It's time to consider the impact of leisure pursuits on the environment

FEW PEOPLE THINK about the environmental impacts of leisure, but 27 per cent of the greenhouse gas emissions from our lifestyles come from it. Britain is committed to making substantial reductions in these emissions to mitigate climate change. Dr Tracey Bedford, Dr Kate Burningham, Dr Nicola Green, Dr Geoff Cooper and Professor Tim Jackson, from the ESRC Research Group for Lifestyles, Values and the Environment (RESOLVE), explored the leisure activities of a small sample of middle earners and their implications for sustainable living.

There is growing interest in how work and leisure time can be balanced to achieve sustainability, and in what types of leisure are most sustainable. Leisure-time activities related to broader aspects of sustainable lifestyles and communities – such as protecting the natural environment, increasing wellbeing, and cultural participation – are receiving growing political interest. In particular, there is a policy focus on encouraging more access to green space, outdoor activities and playing sports and musical instruments. But campaigns to encourage low-carbon or less resource-intensive patterns of leisure time use have not been as high profile.

Perhaps because of this lack of leisure-specific campaigning, few of those in the study were aware of or thought about environmental concerns in relation to recreation, leisure or tourism. Even those who were concerned about climate change and undertook other environmentally-friendly actions, such as recycling, struggled to think about ways in which they could reduce their impact. Some were aware of concerns around flying, but giving up flying for holidays was seen as a large sacrifice. But a small number of people did intentionally reduce or change their leisure travel and purchases for environmental reasons.

The research paid particular attention to personally fulfilling, time-consuming hobbies, which are viewed as a potential way to encourage low-carbon leisure. There are large differences in the travel and equipment involved in different pastimes. Some, such as playing bridge, require few resources, while others can

involve large amounts of travel and goods. A good example of this was given by a bird-watcher who explained how what started out as a fairly cheap, nature-based hobby now involved expensive telescopes, cameras and waterproofs. Specialist equipment that provides the committed hobbyist with more competency at their chosen hobby, or makes them more comfortable when performing it, is very appealing. Moreover, what could be low-carbon leisure becomes less sustainable as people travel to attend events or engage in their leisure activities in new, interesting and beautiful places at home and abroad.

FEELING THE SQUEEZE

The middle earners in the sample were followed across a year of recession and rising fuel prices. Many people began to feel a squeeze on their budgets and cut back spending on leisure: holidaying in Britain; going out less; travelling less distance; and watching more television. In terms of reducing carbon emissions from lifestyles, this could be seen as positive, but some

valued hobbies were affected or lost as people had less time and money for leisure.

Importantly, these reductions in leisure often took place when the individual was under stress due to financial pressures.

The research suggests there are many hobbies that allow people to spend time in ways that are both good for wellbeing and sustainable. As fuel prices increase there is a need to ensure these positive activities continue to be part of people's lives. Those involved in promoting and enjoying high-carbon leisure activities should be encouraged to look at methods to reduce their impacts and the 27 per cent of greenhouse gases arising from leisure in British lifestyles. ■

resolve.sustainablelifestyles.ac.uk



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Policy focuses on more access to green spaces

Valuing the environment

Can we put a monetary value on the many benefits that we derive from using our green spaces?

FOR THE FIRST time, a wide-ranging, multi-disciplinary report into Britain's ecosystems puts a monetary figure on the relaxation benefits, health and happiness our outdoor spaces give us. The UK National Ecosystem Assessment (NEA) measures the benefits the natural environment provides to society and continuing economic prosperity, and finds that the health benefits of living near a green space are worth up to £300 per person per year. Looking at the many other 'services' our natural environment provides, the actual value to the British economy as a whole runs to billions of pounds a year.

The UK NEA brought together more than 500 experts in ecology, economics and social sciences under the chairmanship of Professor Bob Watson and Professor Steve Albon, and was funded by Defra, the Scottish Government, the Welsh Assembly

Government, the Northern Ireland Executive, the Natural Environment Research Council and the ESRC. The funding was co-ordinated through the Living with Environmental Change Partnership (LWEC), formed of 22 government departments, devolved

The benefits that inland wetlands bring to water quality are worth up to £1.5 billion per year to Britain

administrations, research councils and other bodies.

Where the UK NEA differs from previous studies of the environment is the new approaches it uses to estimate the value of the natural world by taking account of the economic, health and social benefits we get from nature. Traditionally, the common view has been that caring for the environment means extra financial burdens. But the UK NEA shows that there are real economic reasons for looking after nature by providing values for a range of ecosystem services the natural environment provides.

For example, the UK NEA finds that the benefits that inland wetlands bring to water quality are worth up to £1.5 billion per year to Britain. The threat to British agriculture caused by declining bee populations is well-documented, but through its research the UK NEA can put the value of pollinators to British agriculture at £430 million per year.

Looking at leisure and recreation, according to the UK NEA the amenity benefits of living close to rivers, coasts and other wetlands are worth up to £1.3 billion per year to Britain, making a strong economic rather than emotional case for fighting for their protection and preservation.

"The concept of ecosystem goods and services was introduced to make clear that we derive a range of benefits from the natural environment, many of which are taken for granted," explains Professor Andrew Watkinson, Director of LWEC. "While we recognise the value of some ecosystem services such as food, water and energy as they pass through the market, the value of others such as climate regulation, the delivery of clean water and green spaces for recreation are much more difficult to capture.

"This is where the social and economic scientists have made such an important contribution to the UK National Ecosystem Assessment in allowing us to assign a tangible economic value to ecosystem services that could not otherwise be measured."

ECOSYSTEMS UNDER PRESSURE

The study shows that while some ecosystems are getting better at delivering services, such as crop production from farmland and climate regulation by woodlands, the tendency to focus only on the market value of resources we can use has led to the decline of some ecosystems and habitats through pollution, over-exploitation, and land conversion. Over 30 per cent of services assessed were found to be in decline, and others degraded, such as marine fisheries, wild species diversity and soil quality.

Continued population growth and climate change are likely to put additional pressure on ecosystems, the study warns, and actions taken now will have consequences far into the future. It stresses the need for a more collaborative approach to enhancing our environment, with everyone – government, the private sector, voluntary groups and the public – playing their part to capture more of nature's benefits in a sustainable way. ■

www.lwec.org.uk

The UK National Ecosystem Assessment Secretariat is based at UNEP World Conservation Monitoring Centre in Cambridge: uknea.unep-wcmc.org

The 'services' provided by green spaces add billions to the British economy



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Cycling cultures

Government policy aims to encourage cycling, but the cyclist remains stigmatised

THE CYCLING CULTURES project, carried out by Rachel Aldred and Katrina Jungnickel from the University of East London's Sustainable Mobilities Research Group, examines cycling experiences in four relatively high-cycling English urban areas: Bristol, Cambridge, Hackney and Hull. The project finds that even in these areas, many people who cycle are ambivalent about the 'cyclist' identity, making comments like 'I'm not a bike nut', or 'I'm not a proper cyclist'.

Being a 'cyclist' carried a dual threat. On one hand, interviewees feared being seen as incompetent, as enduring national stereotypes cast cyclists as unable or unwilling to follow traffic rules. On the other, being 'too competent' as a cyclist was also a threat, associated with particular styles of dress (such as Lycra, helmets and high-visibility clothing) marking a person out as belonging to an unpopular subculture. This implies the need for local and national policymakers to avoid reinforcing stigmatising images of cyclists through policy statements.

Other findings highlight different cultures surrounding cycling. Bristol and Hackney are



London's mayor, Boris Johnson, supporting the Barclays Cycle Hire initiative in the capital

places with historically low cycling levels alongside recent increases in cycling. In both, cycling has diverse subcultural connotations on top of more traditional sporting associations, with community organisations promoting cycling as linked to artistic activity, to environmentalist lifestyles, and/or social inclusion agendas. Cambridge and Hull have historically higher cycling levels and cycling is seen as a more 'everyday' activity rather than a conscious choice, although there are differences between the two: Cambridge is perceived as a 'cycling city' where all cycle regardless of class and gender; in Hull cycling is perceived to be linked to poverty and lack of choice.

COMMON GROUND

The research does find common factors in the four areas supporting cycling. As cycling is seen in relation to other transport choices,

where other modes appear relatively inaccessible or unattractive, this can play a role in encouraging cycling. People in Cambridge often owned cars but said they found driving stressful, while those in Hackney (less likely to own cars) cited no local Underground connection as an inducement. The research identified policy interventions in the four areas likely to have helped to support cycling: for example, in Hull during the 1990s policy innovations included wide cycle lanes on main roads, and 20mph zones.

Pressure from campaigners is another factor – Bristol has a strong tradition of environmental transport activism as the birthplace of the charity Sustrans. ■

www.cyclingcultures.org.uk

Science by non-scientists

Non-scientists with local expertise can produce science to tackle environmental issues

WHAT IS SCIENCE and can it only be done by scientists? A UK Research Councils' Rural Economy and Land Use (RELU) Programme project has shown that good science can be about finding ways to improve your environment, and that non-scientists with local expertise can work effectively with scientists to bring this about.

Loweswater in Cumbria was the test-bed for this new approach. For over a decade the lake has suffered from 'blooms' of potentially toxic blue-green algae. These are off-putting for tourists and meant that the lake was unlikely to meet the demands of European legislation on water quality. Local people were worried that fertilisers used in farming might be the cause. The National Trust (the land-owner) was also concerned. So local farmers got together to try and address the problem with the help of scientists at the Centre for Ecology and Hydrology and Lancaster University. The farmers



Community collaboration came up with answers to the blue-green algae problem at Loweswater

and other residents, interested organisations including the National Trust, and scientists, pooled their knowledge in an initiative known as 'The Loweswater Care Project'. They aimed to investigate Loweswater, to seek local solutions to the problems and to give equal value to everyone's contribution, whether a scientist or

non-scientist. The group met regularly and involved everyone in defining their research objectives and collecting data. The initiative also funded some small research projects suggested by participants from the group.

The investigations produced interesting findings about potential causes of the algae. Land use and fertiliser do play a role, but so do domestic septic tanks, so collective action may be taken on septic tank problems. But the group also worked to examine wider challenges in an area admired by tourists but with little housing or employment to offer young people, and which has to balance the demands of a predominantly farming economy with environmental concerns. The project has provided an example of how community environmental management can work at a local scale. ■

www.lancs.ac.uk/fass/projects/loweswater

Belief in biodiversity

Why do agri environment schemes intended to improve conservation on farms fail to bring home the bacon?

ACROSS EUROPE, MONEY has been poured into schemes for farmers to manage the countryside, both directly by governments, and via the Common Agricultural Policy. The first schemes of this kind were introduced in Britain in 1987 and now cost over £160 million a year in England alone, but results are disappointing. Should we accept that this is just another form of income support to help farmers? Can we realistically expect to stem the seemingly inevitable decline of our native species? The population of skylarks, for example, halved during the 1990s and is still going down.

Researchers from the UK Research Councils' Rural Economy and Land Use (RELU) Programme argue that we could make schemes more effective and better value for money. The Management Options for Biodiverse Farming project examined what influences farmers' decisions about what crops they grow and how they manage the land. Making a profit is top of the agenda, but other factors, such as maximising free time, managing risk and ensuring easy crop management, are also important. Personal interests (for example in shooting and/or conservation) play a significant role.

The team found that different crops benefit or disadvantage different native species markedly. For example, within arable landscapes yellow wagtails thrive better

if potatoes are grown. Which species of weeds are present is also important for bird populations, and this varies according to the types of weed management being carried out.

The farmers the team surveyed were by no means unwilling to promote biodiversity, at least in principle. The majority of the 63 farmers interviewed would like to see key

There should be better incentives for farmers to prioritise biodiversity

farmland bird species on their land: all wanted to have skylarks and all but one welcomed finches, yellowhammers and partridges. However, this did not seem necessarily to translate into action. For example, it did not reduce herbicide use. So how can agri environment schemes

bridge this gap and capitalise on this apparent willingness to do better?

Professor Bill Sutherland who led the project thinks we would be better off focusing more on the interested farmers, and providing better incentives for them to prioritise biodiversity, rather than making payments available to larger numbers of landowners.

He explained: "Placing more emphasis on areas where schemes can provide tangible and rapid benefit to the environment and wildlife, combined with other areas where food production is the predominant priority, would result in a more segregated approach to landscape management and conservation, but could bring the results we seek."

Professor James Bullock from RELU's Improving the Success of Agri Environment Schemes project looks at a different angle. He concludes that improving farmers' understanding of the strategy and science behind the schemes is vital.

FACE-TO-FACE TRAINING

Most participants get information from leaflets, the internet and similar channels, but is that enough? The project has investigated two groups of farmers with similar types of farms: one group has had information from the traditional channels; the other has received face-to-face training. The latter approach seems to be bearing fruit and policymakers are interested in early results from the project. "We have found that less direct communication, using written materials and the internet, may be useful for supporting and maintaining involvement," said Professor Bullock, "but may not be sufficient to build the necessary enthusiasm and support among farmers. Face-to-face training is much more effective – as long as the trainer is appropriate and has credibility. We have shown that this can improve the outcomes from schemes."

The results suggest that a shift in understanding and perspective among farmers is as important as financial incentives in changing the outlook for conservation. ■

www.relu.ac.uk/research



Farmers are keen to see farmland bird species such as the skylark



While increasing biofuel production is important, using food crops to do so is affecting global food supplies

the 'reverse Murphy's Law' of biofuel life cycle analysis, where at every point in the analysis the most positive assumption is always assumed. Our inability to understand the dynamic interactions that drive food price rises is mirrored in our inability and unwillingness to understand the relative environmental impacts and benefits of global biofuel production.

There is unease that energy policy and interests might be driving solutions that may simply generate new problems, especially in less developed parts of the world. We would be wise to avoid rushing policy and embracing targets that might lock-in profound economic, environmental and political implications. Britain's Department for Transport, for example, has recently closed a consultation on the European Union's Renewable Energy Directive that required Britain to ensure that by 2020 ten per cent of the energy used in transport is from renewable sources, which essentially means biofuels. The government's response to the consultation has not yet been made public, but it is clear that there are serious implications to the implementation of the directive, and, perhaps more importantly, that we simply are not in a position to understand precisely what they are, who they will affect, and how irreversible they may be.

DEEP CONNECTIONS

The paradox of biofuels can be found in their ability to generate deep connections across multiple systems – environmental, agricultural, economic, social and political. Demand for greener fuel in Europe may lead to the destruction of 20,000-year-old forests and peatlands in southeast Asia, or a desire for national energy security may reinvigorate unsustainable agricultural production systems. Perhaps more seriously, focusing on biofuels may mean we do not seriously consider the other, more fundamental, politically costly options that may be necessary if we are to tackle pressing global problems such as climate change, underdevelopment and access to sustainable sources of energy.

This global interplay of cause and effect is of course nothing new – grappling with the vagaries of globalisation has preoccupied us for centuries – but the ability of biofuels to generate so much interconnectedness and with it new alliances for and against is quite unprecedented. The paradox of policy is to capture this interconnectedness, consider it and deal with the inevitable trade-offs, impacts and implications of a technology that promises so much, yet the implications of which we currently understand so poorly. ■

www.genomicsnetwork.ac.uk/innogen

Biofuels, hope & hubris

Once seen as a sustainable energy solution, biofuels are now sparking debate, even cited as one of the causes of world food shortages

THERE IS FIERCE debate about biofuels. In the space of a few years they have swung from being the great green hope for more sustainable development to being a 'crime against humanity', according to the UN Special Rapporteur on the Right to Food in 2007. By 2009 the Food and Agriculture Organization of the United Nations claimed that for the first time in human history over one billion people suffer from inadequate food.

Researchers from the ESRC Centre for Social and Economic Research on Innovation in Genomics (Innogen) find that decline in

food availability is not easy to define, much less understand and intervene in. Food prices are spiking, but attributing the relative impact of the growing of plants for fuel and not for food is a tricky (and brave) business. In 2008, the US Secretary of Agriculture claimed that only 2-3 per cent of food price rises could be attributable to biofuel production. At the same time the leaked Mitchell Report (originally written for the World Bank) quoted 75 per cent. Other organisations suggest a figure somewhere between the two.

On the face of it, biofuels are ideal. In theory, they are greenhouse gas neutral. As crops grow, they fix carbon from the atmosphere and when they are burned (as biofuel) this trapped carbon is simply released back into the atmosphere. The reality, of course, is different. Emissions are associated throughout the life cycle of biofuels, from clearing land to intensive agricultural practices, processing, and transportation.

Crucially, greenhouse gas neutrality is defined as by how broadly one chooses to frame the implications of the life cycle of biofuels. For example, indirect land use change – new land cleared for food crops that have been displaced by fuel crops – is generally not included in analyses. Tim Searchinger has talked of

We would be wise to avoid rushing policy and embracing targets that might lock-in profound implications

The effects on health of asbestos-based building materials has long been a concern



diseases, discourages asbestos mobilisation, while perpetuating people's use of unregulated asbestos products. South Africans' widespread knowledge of asbestos illness and systems of compensation facilitate ordinary people's involvement in political forums and interactions with government and other stakeholders over environmental and health issues.

DEFINING THE DISEASE

Linda Waldman's research shows that these dominant official legal positions seldom match the experiences of those South Africans, Britons or Indians affected by asbestos. Medical definitions of asbestos disease and scientific understandings of how it manifests itself seldom correlate with the bodily sensations felt by asbestos sufferers – not least because these bodily sensations are not experienced in isolation from socio-political, economic and environmental factors. In expressing their disagreement with these dominant positions, individuals are also asserting their identities. For British insulation workers, masculinity is all about their ability to work, and their core identity is highly threatened by science that defines some asbestos diseases as 'okay'. In contrast, South African asbestos sufferers experience unemployment and poverty, so asbestos compensation helps bolster their identities, albeit temporarily. Indian campaigners, struggling to develop a collective identity in a context where asbestos disease is not recorded, use science and mobilisation to challenge the government's pro-asbestos stance.

The science of asbestos diseases is different in each of these countries. Yet, in all three countries, anti-asbestos movements seek not to hinder or challenge scientific knowledge but to make science more accountable to their concerns and experiences. Their aspiration is to use science to construct a better future; better for them as men and women, better for the environment and better for the nameless asbestos victims of the future. As Linda Waldman argues, asbestos mobilisation thus challenges the way in which science, knowledge and political power are interconnected to benefit the powerful, while simultaneously seeking to influence science with poor people's experiences, identities and concerns. ■

www.steps-centre.org

For more information see *The Politics of Asbestos: Understandings of Risk, Disease and Protest* by Linda Waldman, www.earthscan.co.uk

The politics of asbestos

Scientific knowledge and legal definitions of different kinds of asbestos and diseases do not necessarily mean better treatment and regulation, or enhanced compensation

IN MAY 2011, after hearing the most recent scientific evidence, the Chief Scientific Advisor to Her Majesty's Government, Sir John Beddington, concluded that there was no reason to downgrade the British classification and legislation of white asbestos as a 'class 1 carcinogen'. Questions about asbestos and its potential to cause cancer have plagued politicians, scientists, government officials and ordinary people for the past century. They are not, however, purely scientific questions about evidence, risk and exposure. In the new book *The Politics of Asbestos* – part of the Social, Technological and Environmental Pathways to Sustainability (STEPS) series – Linda Waldman of the Institute of Development Studies argues that debates about the safety of asbestos are tied up with issues of governance, politics, economics, citizenship and identity. The question put to Sir John Beddington – how dangerous is asbestos? – is explored by contrasting people's experiences and governance processes in South Africa, Britain and India. The answer, however, is neither straightforward, nor to be found in the most recent scientific evidence.

The Politics of Asbestos explores the role of science and regulation, the use of law and the medical criteria for asbestos disease from the perspectives of the powerless: those who are diagnosed with asbestos-related diseases; those who live in asbestos-polluted environments; or those who mobilise around asbestos issues of recognition, compensation, retribution and rehabilitation. Using cases from South Africa, India and Britain, the book shows that scientific knowledge and

Questions about asbestos have plagued politicians and ordinary people for the past century

legal definitions of different kinds of asbestos and diseases do not necessarily facilitate improved treatment, better regulation or more easily accessed compensation. Instead, these dominant understandings inform patients about how they should behave and what kinds of bodily sensations they should feel. For example, British pleural plaque patients are told to continue living their lives as normal, experiencing only slight breathlessness. This knowledge also informs legal processes and standards for compensation. In India, government reluctance to acknowledge asbestos as a carcinogen, and to diagnose asbestos

The rise of recycling

Regional variations still exist within recycling rates

A STUDY BY Professor Andrew Abbott from the University of Hull, and Professor Shasikanta Nandeibam and Dr Lucy O'Shea from the University of Bath that examined variation in recycling rates across Britain finds that the lower the frequency of residual waste collection, the higher the recycling rate. This result is particularly pertinent when considering the government's decision not to force local authorities to re-introduce weekly bin collections and the controversy this caused when it was announced in the Waste Review released on 14 June 2011.

The motivation for the study was to answer why, with much improvement in the national recycling rate (rising from 0.8 per cent in 1983/4 to about 40 per cent currently) there is still variation countrywide. The data (wastedataflow.org) showed that England and Wales both performed better than Scotland and Northern Ireland in terms of their mean dry recycling rates over the study period, 2006–2008. The mean composting rate is on average 60 per cent of the mean dry recycling rate. In the regions, the South East, South West, East of England and East Midlands performed better in dry recycling than the rest of Britain. Variability in composting rates is higher than dry recycling. The region with the highest recycling (dry and composting combined) rate is the East Midlands. But even within regions there is variation, with significant differences in recycling rates between the best and worst performers.

SIZE MATTERS

In addition to finding an inverse relationship between bin collection frequency and recycling rates, apparently because households have a greater incentive to sort their waste, the study also found that the method of collection for dry recycling is important. Different sizes and types of container give rise to different rates of recycling. According to the findings, the smallest wheeled bin has the largest impact on dry recycling. The frequency of recycling collection appears to be important for composting but not for dry recycling; the lower the frequency of green waste collection, the higher the composting rate. Although counter-intuitive, this result may reflect the nature of composting that takes place on a much more intermittent basis than dry recycling. The method of residual waste collection appears to be unimportant for dry recycling and composting. ■

www.bath.ac.uk/economics
www2.hull.ac.uk

More fuel-efficient aircraft models like Boeing's 787 Dreamliner can help make aviation greener



Green skies ahead?

How new technology could make aircraft more efficient

CONCERN ABOUT THE impact of aviation on climate change has prompted consideration of a number of technological solutions but, as research at the University of Edinburgh shows, it is naive to see this as a simple technological fix. This is not because relevant technology does not exist, but because it has not been taken up.

Three main technological options can make aviation greener: substituting 'biofuels' for aviation kerosene; improving air traffic management to minimise inefficient routing of aircraft; and building more fuel-efficient airliners. Biofuels offer the most potential for making aviation almost carbon neutral, but finding sources of biofuels that do not cause damage, or unintended economic consequences, is difficult, especially given the scale of production required to meet the demand for aviation fuel.

Improvements in air traffic management could save fuel by enabling more direct routes, and by avoiding the need for aircraft to circle while awaiting a landing 'slot'. Some improvements are being achieved through the use of computer programs that can project aircraft trajectories and thus enable air traffic controllers to predict and avoid conflicts as aircraft arrive at an airport. But while hardware requirements for implementing such technology are modest, the complexity of the socio-technical system is such that implementation is difficult to co-ordinate. The benefits of such improvements will only be fully available once most airlines have invested in new avionics systems, so there is little incentive to be a 'first mover'.

Finally, more fuel-efficient airliner technologies include turboprop engines, flying wing airframes, and the use of lighter structural materials such as carbon fibre. These are not new technologies but have either been introduced slowly (carbon fibre), only used for some short-haul aircraft

(turboprop engines), or have not been used at all (flying wings). Given that these technologies can be seen as offering both fuel savings and environmental benefits, this seems surprising. The reason for this is that airliner development is conservative in nature, with manufacturers reluctant to adopt radical technologies because of the potential difficulty that they might pose for safety certification, along with concerns about public acceptability. Instead, manufacturers such as Boeing and Airbus have focused on incremental improvements to the 'dominant design' – a design comprising a tube-shaped fuselage with swept aluminium wings and powered by turbofan 'jet' engines.

For example, a consequence of the 1973 'oil shock' was the establishment at NASA of an Advanced Turboprop Project. By 1987 this fuel-efficient engine design was so established the *Washington Post* stated that: 'The aircraft engine of the future has propellers on it'. However, the easing of oil prices, concerns about engine noise, and the perception within the aviation industry that the public thought such engines looked old-fashioned and possibly unsafe, meant that manufacturers stuck with the proven turbofan approach.

Technologies already exist to make air travel greener, but this alone will not stimulate a shift towards greener aviation. There are huge stakes involved in the design of a new airliner and radical technological change is risky. The latest Boeing airliner (the 787 Dreamliner) is the first to use high levels of carbon fibre in its structure, achieving major gains in fuel-efficiency, but it was also delayed. Governments need to do more than support research and development of new technologies; they must improve the commercial risk involved in producing greener aircraft, or establish environmental standards that compel their development. ■

www.issti.ed.ac.uk



Houses and farm plots cover the ground underneath the Yangtze River Bridge No 1 in the northwestern outskirts of Nanjing, China. This growth has raised living standards, but how has it affected the environment?

Living off the land

How Britain is helping sustain the world's natural resources to benefit the poor

FORESTS FOR FIREWOOD, streams for irrigation, wetlands for flood defence – many of the world's poorest people depend on natural systems for their wellbeing. How can these be protected in ways that leave everyone better off? This question is driving a series of research projects under the Ecosystem Services for Poverty Alleviation programme (ESPA), which runs until 2017 and is funded by the Department for International Development, the ESRC and the Natural Environment Research Council.

The idea of marrying green and pro-poor initiatives is gaining credence in policy circles, but it requires an understanding of the many environmental and social factors involved. Often the challenge lies in making a win-win idea work on the ground. That's the case for one ESPA project working to conserve mangrove forests on Kenya's southern coast.

For coastal communities, mangroves drip with value – from storm protection to fish nurseries. And even more than terrestrial forests, they fight climate change by sucking carbon out of the air and storing it safely underground. But globally, mangroves are fast

being cut down. The ESPA-backed 'Swahili Seas' project seeks to market the carbon-storage capacity of mangroves to international 'carbon-credit' schemes. A research team led by Mark Huxham of Edinburgh Napier University, and James Kairo of the Kenya Marine and Fisheries Research Institute, is working with villagers in Gazi, Kenya, on a demonstration project. They will use payments from the international carbon market to conserve and restore mangroves, and fund improvements, such as a new school building, as chosen by the community.

Many of the world's poorest people depend on natural systems for their wellbeing

Swahili Seas is the first carbon-credit project for conserving mangroves – ironing out how to satisfy international standards while ensuring the poor benefit. The project is also helping Kenya's government to visualise the value of mangroves.

Using satellite photos and carbon-storage estimates, researchers are mapping forests' potential values and superimposing a map of the mangroves most at risk of clearance, such as those near hotel developments. Presented on a user-friendly website, the maps will highlight conservation priorities at a glance.

Thinkstock

Another ESPA project is also helping policymakers focus on severe ecological risks – in this case tracking changes over time. In the lower Yangtze river basin of eastern China, the rise of intensive agriculture and industry in the past century has greatly raised the region's GDP and living standards. But how have resources like clean water and biodiversity fared? John Dearing at the University of Southampton, with his scientific colleagues in Britain and China, is tracing this history through chemical and biological clues found, for example, in layers of lake sediment.

FINDING THE BEST DIRECTION

Linking the natural trends with social and economic records clarifies how the whole system responds to change. The group combined data from six environmental 'stocks' in an Ecosystem Services Index, akin to the financial world's Dow Jones index. The regional index as a whole has halved over the past 40 years, but some stocks did better than others. The sharpest drop was in water quality – so steep it suggests that this part of the system may be crossing a threshold beyond which damage is irreversible. These results show another side of the connection between natural systems and economics. China's determined efforts to lift people out of poverty were in many cases a greater immediate priority than the long-term sustainability of natural systems on which livelihoods depend. The economic success of China is well known, but to avoid the collapse of resources that would gravely affect the poor, planners must now adopt a more integrated approach.

There is no simple path to ensure we use the earth's natural resources in a sustainable way that benefits the world's poor. ESPA's projects are helping to point us in the best direction. ■

www.espa.ac.uk



The Swahili Seas project is helping to preserve Kenyan mangroves

Unlocking green innovation

Can manufacturers developing low-emission transport technologies make green vehicles more appealing?



How can more drivers be encouraged to switch to electric cars?

RESEARCH AT THE ESRC centre for Business Relationships, Accountability, Sustainability and Society (BRASS) is examining whether 'Business Model Innovation' offers the potential to bring new ultra-low emission vehicle technologies to market. Doctoral researcher Gavin Harper has been conducting research with vehicle manufacturers to discover how automotive industry business models are evolving to meet the challenge of realising the potential of Ultra Low Emission Vehicles (ULEVs).

Around a quarter of Britain's carbon emissions come from transport and there are questions about where to get our transport energy in the future. ULEVs use a range of innovative new technologies – electric, hydrogen and advanced plug-in hybrid technology – that decrease reliance on oil as a fuel. Many manufacturers see opportunities here and governments worldwide are offering incentives to encourage uptake of them. ULEVs also have the potential to bring good news for British industry – as a high-value, knowledge-intensive export product for British manufacturers.

The transition to low-carbon automobility isn't just an opportunity for manufacturers but also for their key partners who furnish the industry with components and technology. We need to make these vehicles appealing, but technical innovation is slow and expensive. ULEV technologies offer different performance to conventional vehicles (which will satisfy many users) but the market share occupied by ULEVs is still small and needs to grow. Does the answer lie in Business Model Innovation and redefining customer relationships with

vehicle manufacturers? The BRASS research contrasts the views of volume manufacturers to niche manufacturers who produce fewer vehicles. The niche manufacturers often have a different cost structure to manufacturing, requiring, for example, technologies to create bodywork that is economical at much smaller volumes. Their scale necessitates carrying out the key activities in a different way from volume manufacturers. This can often unlock sustainable synergies allowing lightweight bodywork that requires less energy to move around.

By contrast, volume vehicle producers are wedded to the technologies of large-scale production, so many of their ULEV offerings are based on heavy, pressed-steel bodywork.

One of the upshots is that niche manufacturers must offer an attractive value proposition to entice customers to purchase their vehicles, so often target specific customer segments. Some differentiate their niche offerings on performance and exclusivity; some cater for businessmen.

We need to re-evaluate the way that we pay for our automobility. We are used to a world of cheap vehicles and fuel, but now the price of road fuel continues to rise with the realisation that oil is a finite resource. By contrast, the 'fuel' for electric vehicles (electricity) is comparatively cheap, although the vehicles are expensive. There is also the matter of servicing and maintenance: with fewer moving parts electric vehicles require less consumable, disposable service items over a life cycle. Perhaps the answer lies in new business models that create value for the consumer, while offering new revenue streams for the industry. ■

www.brass.cf.ac.uk

Communication in a time of uncertainty

How to explain the complexities of climate change to the public and policymakers

CLIMATE CHANGE IS the most urgent and one of the most complex of the world's global environmental problems, involving fundamental questions about the natural world, our global energy supply, and changes to human behaviour. It might be considered straightforward to communicate the risks and uncertainties surrounding future climate changes in ways that are useful for both policymakers and the general public, but the reality is very different. Given its critical importance, public and policy understanding of climate uncertainties deserves the strongest possible communications science.

Unfortunately, the trustworthiness of climate science and scientists has come under intense scrutiny, following the publication of emails from the University of East Anglia Climatic Research Unit in late 2009. Although independent inquiries all upheld the integrity of the scientists involved, this episode was portrayed in the world's media as casting doubt on the validity of climate science as a whole. Doubts about the reality of climate change have also been gradually rising in sections of the British public. A major national survey found that only 78 per cent believed that the world's climate was changing in 2010, down from 92 per cent who believed this in 2005.

On the face of it these developments run counter to the core messages from climate science over the past ten years. We have confidence that the world is warming, that human activities are a cause, and that prompt action is needed to reduce the risk of catastrophic impacts. But many other aspects of the climate system are less well understood, such as the role of clouds in influencing global temperatures. Such uncertainties are often seized on by climate sceptics, using them to argue for a delay in action.

The fact that climate science involves uncertainty should not be a barrier to communication or action. Individuals and institutions debate and make decisions under uncertainty all the time (with respect to investments, health, new technologies and so forth) and climate change is no different. The Stern report on the Economics of Climate Change broke new ground in 2005 when it argued for approaching climate decisions in terms of the costs, risks and uncertainties of different options. Adopting such a perspective shifts the focus away from a sterile debate over whether there is anthropogenic warming or not, onto what gambles we should take with our world, and what we are prepared to pay to avoid or reduce



The Thames flood barrier could require modifying

risks to things that we value. It also requires analysing the expected costs and benefits of different options, as a precursor to taking actions.

The need to deal with risk and uncertainty is already being felt in relation to climate adaptation – we cannot say when the next major flood or heatwave might occur in Britain, just that the likelihood and severity of such events are set to increase with a warming world. Risk assessments have been conducted to assess the integrity of the existing Thames Flood Barrier, taking account of the uncertain evidence that, over the next 80-100 years, the South East is likely to experience sea level rise, more frequent summer hot spells, and wetter, stormier winter weather. Social and decision science research identifies key lessons that are especially relevant to communicating such complex uncertainties. One is that 'risk' can be defined in different ways, by analysts and lay people, depending on how they value the outcomes

at stake. Some people care primarily about threats to the environment while others care about the economy, so each may need different risk estimates and evidence. Proponents of environmental justice need to know which groups bear the risks and which get the benefits of proposed policies, while others need to know the extent to which risks are voluntary, controllable, uncertain, irreversible and catastrophic.

As a consequence, understanding the special needs of an audience or decision-maker is the first step in designing effective risk communications – a process best described as 'strategic listening'. Its methods (surveys, interviews, moderated deliberations) are used to establish which outcomes matter to different people, which options they have for realising their goals, and what additional

knowledge they need. This decision science approach takes an inside view, letting decision-makers' own needs determine the content of communications, rather than just relaying the messages scientists think are crucial. With some decisions, people might already know enough about the relevant climate science, but need to learn more about risks to prized ecosystems or the viability of cap-and-trade schemes. For others people will know enough about the facts of the matter, but are uncertain about how to make the hard trade-offs – for example between risks to the present generation and to future ones – that climate change poses. There is no way to know what information or decision support people need without careful research that begins by listening to them.

TRANSLATING THE SCIENCE

Communication worthy of climate change also requires strategic organisation – a sustained contribution from cross-disciplinary teams, working within an institutional framework that provides support for their efforts. Such teams would include climate and other environmental domain experts, decision scientists, social and communications specialists and program designers. To preserve neutrality it must maintain a stance of non-persuasive communication, trusting the evidence to speak for itself. Although there is an important place for persuasive communication, for example in encouraging more sustainable behaviours and public policies, it must be distinct, so that climate communicators and scientists are not seen as inept politicians.

Creating such teams will require what sociologists term a 'boundary organisation', with unique capabilities so far absent in the climate change arena. Such an organisation will be chartered both to conduct basic science and translate its results into decision-relevant terms. A model for such interdisciplinary 'big science' would be the RAND Corporation in the US, which performs publication-quality research on applied problems while also contributing critical expertise to address policy problems. The science of communicating science has become so important that it requires and demands an equivalent institution dedicated to this task. ■

www.understanding-risk.org



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