relu

Rural Economy and
Land Use Programme

Landmarks for Policy

The UK Research Councils' Rural Economy and Land Use Programme was launched in 2003 to carry out strategic interdisciplinary research into the multiple challenges facing rural areas. Involvement throughout the research process of a wide range of stakeholders, with competing demands and visions, is also key to the Relu philosophy. The challenges range from restoring trust in food chains and tackling animal and plant disease in socially acceptable ways, to mitigating and adapting to climate change. Running through most of the projects is the thread of rural land and how we use it. Land use often plays a part in creating problems, but may also be part of the solution. It has, therefore, loomed large within the Relu programme. In this document we draw on the research projects, on a range of stakeholder involvement and comment, and on the work of two land use policy analysts commissioned by Relu, in order to inform current thinking and policymaking on rural land in the UK.

Landmarks for Policy

Baroness Young of Old Scone:

"What do we, collectively, as The Great British Public, want of the land? We aren't making any more of it – how do we achieve multifunctional land use in a small island? The time may have come for a land use plan."

Hilary Benn, Secretary of State for Environment, Food and Rural Affairs:

"As a society we need to take a fundamental look at how we use and value our rural land and what sort of countryside we want future generations to inherit."

Nick Herbert, Shadow Secretary of State for Environment, Food and Rural Affairs:

"If we are to conserve the countryside, its wildlife and habitats for future generations, as well as meet the demands of a growing population and changing environment, we will need to shape a new approach to the management of our land and natural resources."

What do we need from our land?

Following World War 2 and "Dig for Victory" the UK made great strides in increasing production from every hectare of land. But the 1970s and 80s brought surpluses and "food mountains" so we started to cultivate biodiversity instead. Now we need to harvest increasingly diverse benefits from our land: food, clean water supplies, timber, biofuels, wildlife, flood management, carbon storage, leisure activities and more houses and infrastructure for a growing population. Demands shift and grow in an uncertain economic, as well as meteorological, climate. Technological advances continue but public acceptance often lags behind, as in the development of genetically modified crops, resulting in controversies that may be difficult to resolve.

Multiple demands upon such a finite resource can only be resolved by ensuring that each area of land fulfils multiple or strategically chosen functions. The ecosystem services approach, which recognises the integration of different functions, seems to lend itself to this but it does also require more holistic policymaking.

Ultimately the management of land depends on the individuals and institutions that own it, but land managers face multiple challenges. It is important for policymakers to understand what influences land managers in weighing risks and taking decisions. They are not a homogenous group and although, for most, making a living will be high on the agenda of priorities, it is seldom the sole driver. Nearly all the Relu projects work directly with people who manage the land, and all emphasise the diversity of this group of professionals. If policymakers fail to recognise this and adopt a blanket approach, their interventions may have unintended or even perverse consequences.

Land managers' decisions are influenced by personal circumstances such as whether the next generation wants to take over the farm, whether they want to shoot game, what sort of farming is happening next door, as well as by current commodity prices or the levels of subsidy on offer. These drivers will change over time. How do we understand this complex mix of motivations? The projects are using diverse approaches to try and achieve a better understanding, which is essential for effective policymaking.

Can we reasonably expect farmers to see themselves as "integrated land managers" managing "multifunctional landscapes" and providing "ecosystem services" that include not only food but also a range of other functions from biodiversity to carbon storage and flood management? And how should we be rewarding them for these different services?

Catharine Ward Thompson, Research Professor of Landscape Architecture and Director, OPENspace Research Centre, Edinburgh College of Art:

"There is a complex interrelationship between arable and grassland, woodland and moorland, etc, that affects the healthy functioning of a range of systems, from hydrological and energy flows to access to the land for recreation and human wellbeing. A holistic view of these is necessary."

Marcus Sangster, National Adviser on Land Use and Social Research, Forestry Commission:

"The UK still has a lot of land that is marginal for agriculture and is farmed largely to benefit from subsidies. So the question is what does society want to buy with its financial support? Less flooding must be high on the list."

Willow and miscanthus are biomass crops with potential for renewable energy production in the UK, and government policies are encouraging farmers to grow more of these crops to help reduce CO_2 emissions. The **Impacts of Increasing Land Use Under Energy Crops** project found that there is real interest in growing biomass crops but the relative level of profitability and clear policy support would be essential elements in their large-scale adoption in the UK. There is sufficient land available to meet production up to the UK Government Biomass Strategy objective of 350,000 hectares for electricity without significantly impacting on food production. To meet an additional hectarage for transport biofuels would place increased pressure on land. Despite anxieties about possible effects on biodiversity, the research found many positive benefits, particularly of short rotation coppice willow. Sympathetic plantation design and management protocols would help to ensure that such benefits are realised. GIS-suitability mapping and sustainability appraisal were found to be useful tools for integrating the evidence into decision-making.

Current policy changes will have major implications for farming and biodiversity in the hills. The **Sustainability of Hill Farming** project has been investigating the impacts of changes such as the reduction in support for production and the introduction of the Single Farm Payment. Their model shows that this encourages a reduction in stocking densities, with a shift away from beef cattle, a reduction in application of chemical fertilisers to inbye land and a reduction in the numbers of people employed on the farm. There is also a trend towards greater specialisation. Many farmers have come to depend on subsidies from agri-environment schemes, which encourage them to provide habitats for wildlife or access for recreation. At the moment these payments play a role in moderating the likely effects of the Single Farm Payment but are also likely to undergo major changes in the future.

The management of rural floodplains is a product of policy interventions that have promoted particular objectives at different times. "Reclaiming and improving" for agriculture was the dominant purpose for over 50 years until the 1990s, but now we expect a great range of ecosystem services from this land. The **Integrated Management of Floodplains** project has investigated the trade-offs that have to be made in order to prioritise different services and modelled the gains and losses under different management regimes. As climate change brings more frequent extreme weather events, allowing rural areas to flood may have benefits for towns, but the costs to agriculture must be taken into account. There are measures that can help. For example, livestock farmers could reduce their vulnerability by creating buffers of feed for livestock. This could include reserves of grazing land, or buying in feed. Arable farmers could replace crops which are susceptible to flooding with crops that are more resilient. Resilience could be increased by maintaining or restoring land drainage in farmed areas as a means of evacuating flood water and controlling ground water levels after flooding.

Who decides?

There is also the wider issue of who should have a say in land management. Apart from a small number of institutions and large property owners, most of the land in the UK is in the hands of small and medium-sized commercial businesses.

However, we all have a stake in the goods and services that land provides. Food and clean water are essential to support life, and we subsidise them through our taxes. Ecosystem services such as carbon storage, aesthetic landscapes, biodiversity, energy production, storage of flood water are also important to all of us, whether we live in rural or in urban areas.

Organisations in charge of decision making often exclude or discourage others from taking responsibility. More flexibility and "letting go" by such bodies might encourage individuals and communities to cooperate in designing and implementing their own solutions.

One of the tenets of Relu research is the involvement of the total range of stakeholders, which has enriched the programme and added value to research outputs and knowledge exchange. The Relu projects suggest that involving local communities in land use controversies, tapping their "non-professional" knowledge and insights and developing models and potential solutions collaboratively, will help speed up and improve policy decisions and delivery.

There is an increasing sense that we need to integrate scientific knowledge with local experience when considering potential futures for our land. But there also needs to be more public debate about the problems and choices when policy is being made. How do we value all of these aspects of ecosystem services? How do we avoid the "unintended consequences" of policymaking? And what trade-offs might we be prepared to make?

Flooding has become an issue of great concern over recent years and understanding its causes and how we can reduce risk is the focus of increasing efforts among scientists. Researchers working on the **Understanding Environmental Knowledge Controversies** project have taken the phenomenon of flooding and used it to investigate a new way of doing science. They want to improve the way in which the public are involved in decisions about environmental controversies and use local expertise that is not currently being exploited. In their first study area, Ryedale in North Yorkshire, which has experienced serious flooding in recent years, they formed the Ryedale Flood Research Group, made up of residents and scientists, to carry out the research collaboratively. This collaboration produced a customised computer model of local river systems, which enabled group members to try out their own ideas for managing local flood risk and resulted in a proposal to build bunds for upstream storage which has now been adopted by Defra as a pilot scheme.

In the Lake District catchment of Loweswater, the impetus to improve water quality has come from the local community, who are working with researchers in the **Testing a Community Approach to Catchment Management** project. Loweswater has high levels of phosphorus which, periodically, cause blue-green algal blooms. These blooms are potentially toxic, as well as unattractive to visitors, and mean the lake waters would probably fail to meet required European Water Framework Directive standards. Modelling work by the researchers suggests that the problem is caused by a combination of diffuse pollution from fertilisers and failing septic tanks in the catchment. By forming the Loweswater Care Project and working with scientists to monitor the problems, land owners and residents are taking action themselves. Several land owners have already taken steps to separate clean from dirty water, cover yards and middens and replace faulty septic tanks.

Deer are an important resource, attracting tourists to stalk or observe them, and providing jobs for stalkers and within the game meat industry, but they may cause problems, such as road traffic accidents, damage to crops and gardens and overgrazing in some priority habitats. The **Collaborative Deer Management** project has been investigating how they could be most effectively managed and what lessons could apply more widely. There seems to be little communication across sectors with differing objectives and a need for better quality data to help stakeholders pinpoint local conflicts and address these more collaboratively. The project has developed participatory GIS systems to support this. They recommend voluntary schemes, tailored to local needs as more likely to be successful, but these take time to achieve success and to integrate different types of knowledge.

Mark Tinsley, Chief Executive, PC Tinsley Ltd vegetable growers:

"We behave differently as a tenant or as a landowner: ownership has been good for diverse landscapes in this country."

John Varley, Director, Clinton Devon Estates:

"Most farmers and land managers think long-term and are passionate about their stewardship of the environment and the need to sustain viable rural economies and communities for the benefit of the next generation."

Ian Brown, North East England food and energy entrepreneur:

"Owning/having rights over land means that a part of this country's potential is with an individual or legal structure. If that asset is not used for the good of mankind it is a shame, in certain circumstances even a tragedy!"

Modelling the Impacts of the Water Framework Directive has found that putting this European legislation into practice could have serious financial implications. The Directive states that all European Community member countries should reach good chemical and ecological status in inland and coastal waters by 2015, unless the cost of improvements disproportionately outweighs the benefits. But how much are we prepared to pay for these kinds of improvements? The team developed a "water quality ladder" to show the ecological and recreational impacts on rivers of different levels of pollution and used virtual reality images to show how rivers and landscapes change with the level of pollution. They could then investigate the trade-offs that people are prepared to make between their water bills and water quality. This showed that the value of cleaning up rivers is as much to do with location as the extent of the clean up. Improving rivers in urban areas can be extremely valuable.

What needs to change?

In order to move to a more integrated ecosystem approach, it will be necessary to take the long view, while maintaining flexibility to deal with short term and unexpected changes. Climate change adds an additional uncertainty.

Policies must also be sensitive to spatial scale. The delivery of different services needs to be considered at different scales, from field-scale management of vulnerable invertebrate habitats, to UK-wide delivery of targets for carbon reduction.

Above all, policies need to be "joined up" more effectively. Current rural land use policy is often fragmented and inadequately targeted. Lack of coordination increases the risk of unintended consequences. Ecosystem services cannot be considered effectively in isolation and some policies may actually inhibit each other. For example, policies to tackle diffuse pollution and improve farmland habitats might have been pursued in tandem rather than separately. Only recently have manures stabilised by anaerobic digestion, in accordance with the Government's 'digestion protocol', been reclassified as a resource rather than waste, thereby avoiding regulatory costs in the application of these to land. An integrated approach would mean avoiding or remedying such conflicts.

It also seems clear that the market alone cannot be relied upon to promote all ecosystem benefits and government intervention is necessary to ensure services such as landscape beauty and clean water.

Relu projects are examining a range of mechanisms that can support more integrated policymaking and delivery. These include practical decision-making tools, economic instruments, the role of advice and training and creating new markets for services such as carbon storage.

Tom Tew, Chief Scientist, Natural England:

"In times of great change, business as usual is no longer good enough to conserve our environment; our policies and actions must be large-scale and integrated."

Mark Avery, Conservation Director, RSPB:

"We need to change our diet. Being vegetarian four days a week would make a big change."

Maggie Gill, Chief Scientific Adviser Rural Affairs and Environment, Scottish Government:

"Many parts of the world (for example the hills and uplands in the UK) are not suitable for crops, but do grow grass which is converted by livestock into human food."

Angus Collingwood-Cameron North East Director, Country Land and Business Association:

"The trick must be to formulate a policy designed to provide food security and environmental security, whilst also taking on board the other land use issues. This can only be achieved through funding to deliver the non-market public goods, whilst ensuring long term production."

Robin Matthews, Climate Change Theme Leader, Macaulay Land Use Research Institute:

"Land is a more-or-less limited resource, there is only so much to go around, and whatever we decide to use it for means that there will be less for something or someone else."

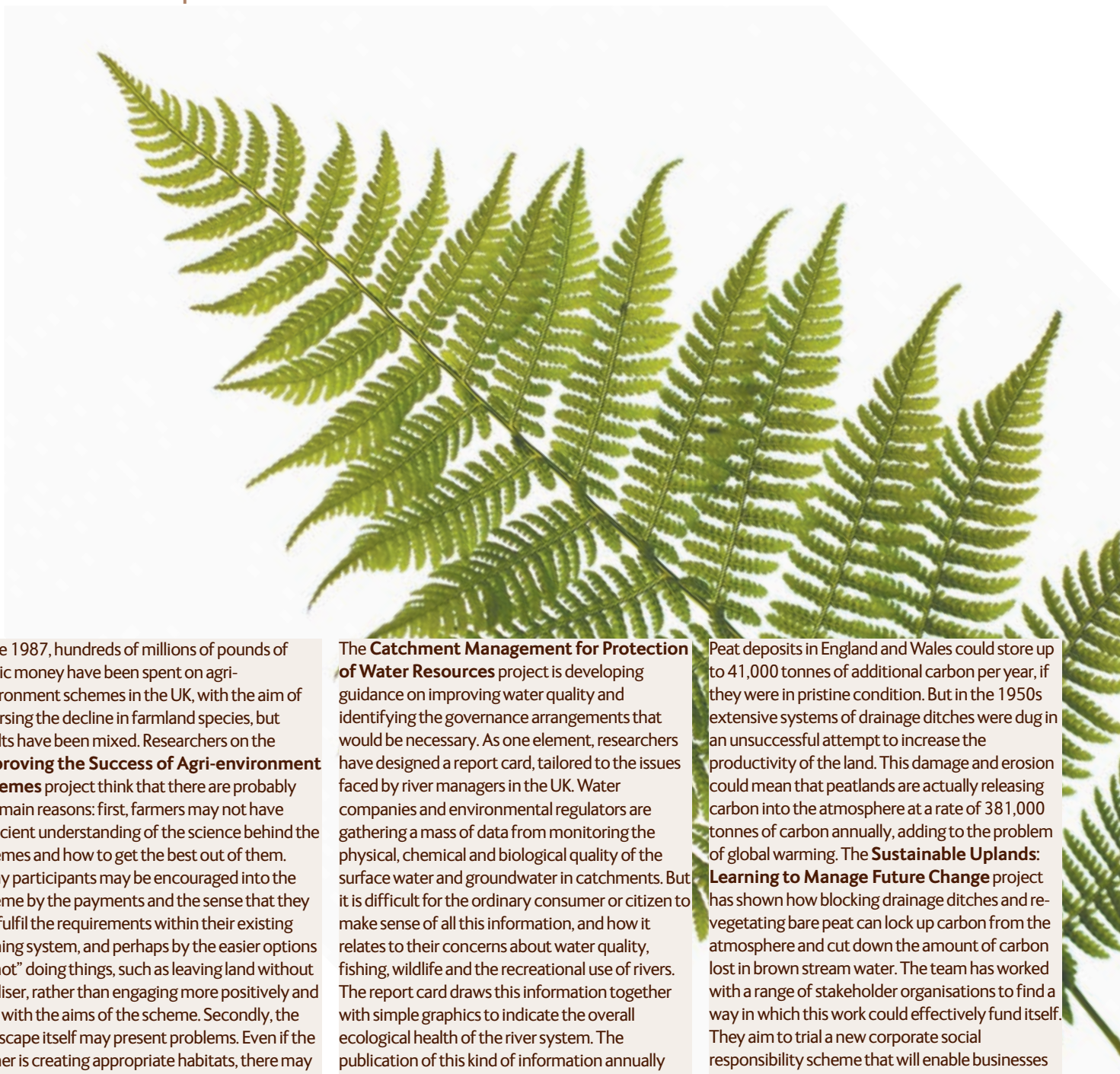
The **Implications of a Nutrition Driven Food Policy for the Countryside** project has found that if everyone adopted healthier eating habits this would have profound implications for the UK countryside and we need to take these unintended consequences into account. With loss of demand for red meat, remote regions more dependent on beef and sheep production and unsuited to arable production would see a decline in numbers of animals farmed. Loss of employment would have significant detrimental effects on the rural economy and migration to more prosperous regions would increase. The effects of these changes would also be felt in upstream industries, particularly feed suppliers. In the east and south-east of England intensive horticulture would expand, together with the use of poly-tunnels and irrigation. In such areas able to take advantage of the new arable and horticultural opportunities, farming income would increase, but significant increases in regular farm employment are unlikely as farmers would probably turn to casual labour and mechanise more tasks.

The **Sustainable Uplands: Learning to Manage Future Change** project has found evidence that reductions in the Single Farm Payment would lead to destocking on upland farms and an increase in burning off vegetation. This could in turn lead to more erosion of the peat, which causes discolouration of water supplies. This is already an expensive problem for water companies. They suggest that incentives are needed to change land management practices to avoid this situation.

The **Angling in the Rural Environment** project found that anglers are often good and appreciative observers of the natural world and their interactions with the aquatic and surrounding habitats can be beneficial. For example, while a key factor for the River Swale Preservation Society in replanting sections of riverbank was to enhance bankside refuge and feeding habitat for fishes such as chub, there are wider benefits for wildlife. However, angling also has some negative impacts, such as the use of lamphreys as bait. Researchers found that several tens of thousands of river lampreys, a threatened species listed on the EU Habitats Directive, are sold as bait each year. Many are captured as they migrate to spawn in the Swale and Ure, and this represents the largest lamprey fishery in Britain. Anglers are, perhaps unwittingly, supporting commercial fishing for a threatened species, highlighting the need for improved governance and communication.

What policy mechanisms are available?

Relu projects are throwing light on several of the mechanisms for delivering integrated land management. These include: providing information, decision tools, advice, and training; promoting voluntary agreements; imposing regulations; developing economic instruments (including taxes or levies, as well as incentives); and creating new markets. There is a particular focus on the extent to which these should be developed and implemented using 'top-down' and/or 'bottom-up' approaches, and on how the UK can usefully learn from experience from elsewhere in the European Union and further afield.



Since 1987, hundreds of millions of pounds of public money have been spent on agri-environment schemes in the UK, with the aim of reversing the decline in farmland species, but results have been mixed. Researchers on the **Improving the Success of Agri-environment Schemes** project think that there are probably two main reasons: first, farmers may not have sufficient understanding of the science behind the schemes and how to get the best out of them. Many participants may be encouraged into the scheme by the payments and the sense that they can fulfil the requirements within their existing farming system, and perhaps by the easier options of "not" doing things, such as leaving land without fertiliser, rather than engaging more positively and fully with the aims of the scheme. Secondly, the landscape itself may present problems. Even if the farmer is creating appropriate habitats, there may not be populations of animals and plants sufficiently nearby to colonise them, or physical barriers may get in the way. Early results seem to show that appropriately delivered training could overcome some of these difficulties and make a big difference to the success of agri-environment schemes.

The **Catchment Management for Protection of Water Resources** project is developing guidance on improving water quality and identifying the governance arrangements that would be necessary. As one element, researchers have designed a report card, tailored to the issues faced by river managers in the UK. Water companies and environmental regulators are gathering a mass of data from monitoring the physical, chemical and biological quality of the surface water and groundwater in catchments. But it is difficult for the ordinary consumer or citizen to make sense of all this information, and how it relates to their concerns about water quality, fishing, wildlife and the recreational use of rivers. The report card draws this information together with simple graphics to indicate the overall ecological health of the river system. The publication of this kind of information annually could enable consumers and other stakeholders to evaluate management decisions about the allocation of resources in their area.

Peat deposits in England and Wales could store up to 41,000 tonnes of additional carbon per year, if they were in pristine condition. But in the 1950s extensive systems of drainage ditches were dug in an unsuccessful attempt to increase the productivity of the land. This damage and erosion could mean that peatlands are actually releasing carbon into the atmosphere at a rate of 381,000 tonnes of carbon annually, adding to the problem of global warming. The **Sustainable Uplands: Learning to Manage Future Change** project has shown how blocking drainage ditches and re-vegetating bare peat can lock up carbon from the atmosphere and cut down the amount of carbon lost in brown stream water. The team has worked with a range of stakeholder organisations to find a way in which this work could effectively fund itself. They aim to trial a new corporate social responsibility scheme that will enable businesses to assist local projects to protect and enhance natural carbon stores, whilst providing many other environmental and social benefits.

Relu projects suggest an important role for local adaptation and innovation in land use policy, not 'blueprint' solutions. This logically reflects the sheer diversity, across the UK, of landform, landscape and habitat, of the ecosystem services sought, and of land managers and stakeholders. The devolved administrations in Scotland and Wales are well-placed to interpret the needs of their communities. Integrated Regional Strategies may offer a similar opportunity in England. A more radical approach would be further devolution of responsibility to local authorities, but high levels of collaboration would be required to ensure planning and delivery of ecosystem services takes place at an appropriate scale.

Some local authorities have already been making innovative use of rural development funds. For example, one unitary Council is proposing to set up a series of 'Rural Environment Forums', each covering about 20 parishes. The Forums will foster dialogue between local stakeholders (residents, farmers, countryside users) and officials from relevant public agencies (Environment Agency, Natural England, Forestry Commission, and the Council). These opportunities for consultation and participation in decision-making should help local communities to 'own' local environmental management.

The voluntary sector is well-placed to bridge the divide between national 'top-down' and local 'bottom-up' approaches. For example, bodies like the National Trust and Royal Society for the Protection of Birds deliver public policy objectives over their own land and through partnerships. Their land-holdings give them a stake in local communities, alongside the public sector and private land managers, and they provide expert advice to individuals as well as analyses and recommendations on national policy issues. They have provided a local perspective as stakeholders within many Relu projects.

Looking further afield, there are lessons to be learnt from international experience. Other countries have more experience of using land-management agreements to secure long term benefits, and of 'group agreements' which deliver coordinated action across several farms rather than taking a piecemeal approach focused on individual farms only. This is particularly important in tackling challenges at a catchment or landscape scale, such as improving water quality or recreating networks of wildlife habitats to facilitate adaptation to climate change. International experience also underlines the importance of long term, farm-level advisory support, from locally based and trusted advisors.

Alongside public policy mechanisms, there may also be a stronger role for the market itself. Organic food and products sold under certification and labelling schemes tend to cost more than conventional products because the market price reflects the costs of avoiding environmental damage. However, consumer support for such labelling is not always reflected in their purchasing decisions. Carbon-offsetting is a market-based mechanism for attracting a wider range of funds for land management, generally through planting trees and investing in renewable energy schemes. Relu research has added to this portfolio by investigating the potential for restoring peatlands as long-term stores for carbon.

'Habitat banking' – the restoration, creation or enhancement of habitats to compensate for development impacts elsewhere – may be a further means of using a market mechanism to secure long term environmental land management benefits, encourage collaboration between land managers, or secure beneficial change at a landscape scale. The concept involves developers purchasing credits from a 'bank' which uses these to fund the purchase and/or management of land to yield long term environmental gains.

The **Sustainable and Safe Recycling of Livestock Waste** project has developed a visual tool for farmers and farm advisors to use to assess the risk of pathogenic organisms entering the water supply. This kind of pollution has implications for public health and for local industries depending on clean water such as shell fisheries, irrigated crops and leisure. The tools they have designed helps farmers and their advisors to determine where mitigation might be best suited and at what cost.

Julian Dennis, Director of Quality, Environment and Sustainability, Wessex Water:

"Working closely with one farm we have managed to reduce diffuse pollution by up to 60% just by looking at local conditions."

Vicki Swales, Land Use Policy Analyst:

"We need to approach land use planning at an ecologically relevant and socially meaningful scale, for example, at catchment level, rather than be constrained by current administrative boundaries."

Les Firbank, Head, North Wyke Research:

"It should be possible to use science to design future landscapes in which land is used according to its potential to deliver food, fibre, housing, habitats, water and so on, according to the climate, soil type and topography."

Neil Sinden, Director of Policy and Campaigns, Campaign to Protect Rural England:

"If we are to deliver what society needs from land then in future we need to safeguard and enhance the role of spatial planning in public policy. And we need to understand better the complex job that it performs in seeking to secure the long term, public interest in the development and use of land."

Can models and indicators help?

Increasingly sophisticated techniques are being developed by Relu projects to model interactions between land use, land managers, other stakeholders, the economy and the environment. This kind of modelling can usefully inform policy, particularly where it is grounded in local experience, but it is important to recognise that modelling is more about understanding uncertainty than delivering definitive answers. It does, however, help to illuminate the trade-offs to be made between different ecosystem services.

Techniques for sustainability appraisal and life-cycle analysis are also being developed by Relu projects to help understand conflicts and trade-offs and there is wider potential for their application, not only in future policy making but in analysing current land use and in providing a more rounded global economic, social and environmental view of the impacts of local actions.

Indicators help track policy outcomes, but need to be reviewed regularly to ensure that they are not themselves 'driving' policy (so that the aim becomes 'to improve the indicator' rather than to secure the underlying outcome). There are government indicators for 'sustainable development' and 'biodiversity', and other environmental indicators are being developed. Several Relu projects touch on sustainability indicators. For example, one project suggests that it is easier, and just as valuable, to monitor arable weed species in fields as to monitor birds. This work will assist in developing new and more meaningful indicators to help assess the performance of policy interventions.

Robin Matthews, Climate Change Theme Leader, Macaulay Land Use Research Institute:

"Any debate on land use needs to consider not just how land is used in the UK, but also the impact that this will have on land use elsewhere in the world. The idea of a ecological footprint is a useful one, i.e. the amount of land that would be required to sustainably support our lifestyles. In Britain, the average ecological footprint has been calculated as 5.5 ha/person, but the biological capacity is only about 1.5 ha/person. Where is the difference coming from?"

Sue Everett, independent ecologist and countryside management consultant:

"Do we need to look at a countryside where there are considerably more farmers, and many more different crops grown? For example, should we be taking a cue from the agro-forestry movement? Should we also be considering a debate on land reform (which has already happened in Scotland, but not in England)? How can we restore an affinity between people and the land, and increase opportunities for more people to have access to it as producers?"

Tony Hams, lead board member for protected areas, Natural England and Chair, Derbyshire Wildlife Trust:

"Our aim should be to ensure that the use of land respects and maintains our biodiversity, landscape and access interests, and how a well managed environmental resource can contribute to our economic and social wellbeing and thereby to sustainable development."

Mark Avery, Conservation Director, RSPB:

"The folly of recent bio-energy policy shows us what happens when we try to force production to answer all the questions. We must include conserving and enhancing wildlife, mitigating and adapting to climate change, managing water resources and quality, and providing outdoor space for people's exercise and spiritual enrichment as equal objectives, alongside production, in our land management policies. That is the only way to gain the environmental riches we hunger for, and be able to feed ourselves and our children, too."

Relu's project **Modelling the Impacts of the Water Framework Directive** has worked extensively with policymakers, including Defra, to examine the impact of changing land use upon both rural incomes and the environment. The team has investigated the impact of alternative measures to deliver the improvements in river water quality mandated under the EU Water Framework Directive. One of the key issues is the problem of diffuse nutrient pollution from fertilisers applied to farm land. Various measures are being considered, including reductions in fertiliser applications, changes in activities and alterations in farm practice. The project links economic models of farm activity and incomes to hydrological models of water pollution. Applying this model shows that there are win-win options (alternatives which deliver greater reductions in pollution at lower cost to farmers) and that a more sophisticated approach to policy (in particular changing land use in the most pollution vulnerable zones) can greatly improve the effectiveness of interventions.

Farmland birds depend on a range of resources in the landscape for their survival. Nesting sites, food resources and protection from predators are all required, but their availability in the landscape is often highly variable. One of the principal sources of variation in landscape features is likely to be individual farmer preferences and the **Management Options for Biodiverse Farming** project has asked farmers about a range of land management goals. Although maximising profits from the farm business was almost always the most important objective, many farmers said that other considerations mattered too, including risk mitigation, appearance of the farm, autonomy and business complexity. They have then modelled future scenarios, including the reduction or elimination of set-aside. Their model predicts which crops are likely to replace set-aside when it is lost from the landscape. This in turn affects which birds will be winners from increases in certain crops and which will be losers. The team can, therefore, predict how biodiversity will be affected by policy decisions.

What stands in our way?

Securing integrated land management based on an ecosystem services approach will require significant change in policies and processes. This will not happen if we remain entrenched in current ways of thinking.

Mindsets which insist on the pre-eminence of one particular interest, whether that is "food production" or "biodiversity", will not further the kind of holistic approach that is required. To optimise the delivery of all the services society seeks from land, it will be necessary to look ahead, be prepared to develop new knowledge and skills to meet the challenges and to collaborate. Securing sustainable "joined-up" delivery of services across boundaries – whether these are between individual land holdings or between administrative areas, will pose significant challenges.

There has been an emphasis on working with natural processes but this should not exclude using engineering solutions when these can be of benefit. We should not be forced into choices between "low-tech" and "high-tech". For example, modern satellite technology underpins the use of precision farming techniques to match fertiliser inputs to varying crop nutrients across a field, thereby minimising wastage and run-off.

Our systems for managing land use will be tested, and we must be prepared for that. There will be major challenges of disease, extreme weather and international conflicts. Above all, climate change will pose major uncertainties that must be factored into our approach to land use.

The **Energy Production on Farms Through Anaerobic Digestion** project suggests that rural communities in the UK could gain social and economic benefits if anaerobic digestion was adopted more widely and it could even mean less chemical fertiliser being applied to land and reduce the amount of manure and slurry polluting waterways. So what is holding farmers back? Researchers say that if the UK government is to see an expansion in the technology similar to that in some other European countries, we would probably need more financial incentives, with farmers rewarded for better management of agricultural residues, particularly manure. Recent government announcements have offered more support through the Renewables Obligation Certificates scheme and cash for demonstration programmes, but longer-term security of income to cover the capital investment is still lacking. Carbon trading could also have an effect, or subsidies linked to methane abatement. Environmentalists and anti-poverty campaigners have expressed concern about crops being grown to provide fuel at the expense of food production, but it would be possible to impose limits on the ratios of high and low energy inputs into the process to encourage the use of more waste products. The project is producing models that analyse the economics, energy production and land-use implications, as well as the potential social benefits and environmental drawbacks.

The **Merits of Consuming Vegetables Produced Locally and Overseas** project has been looking at the advantages and disadvantages of food produced in the UK compared with imports from Uganda, Kenya and Spain. Although debate has tended to concentrate on food miles, they found that this isn't the only issue we need to take into consideration: the picture is much more complicated. For example, they found that 48% of the energy used during the sowing, growing, harvesting, packaging, storage, transport and consumption of UK potatoes is expended in the kitchen. Simple actions such as putting a lid on the saucepan can help to reduce this. Storage, domestic transportation and season also have to be taken into account. Eating home-grown produce may sound more "green" but out-of-season vegetables grown under glass in the UK may consume more energy than those grown outside in Spain and imported.

How can policymakers decide where to focus resources? Relu researchers working on the **Social and Environmental Inequalities in Rural Areas** project have collated a large amount of information about social, economic and environmental conditions across rural England, in order to pinpoint areas of the country that are environmentally disadvantaged. Opportunities for recreation and access to services and affordable housing are often poor in rural areas, although the researchers did find that such disadvantages may be offset by aesthetic and amenity benefits and a strong sense of community, and are experienced differentially by different social groups. They recommended that where policymakers are targeting areas of high disadvantage, they should take account of localised inequalities so that they can focus on pockets of greatest need.

John Oldham, Head of Research, Scottish Agricultural College:

"In the most basic terms rural, and indeed other, land is used to meet the needs of our, and other species. It is only in relatively recent times that our species has reached a point at which we have exercised indulgent and sometimes negligent use of land. That is we have begun to use land to meet our 'wants' rather than simply to meet our needs and have not properly considered the long-term consequences of our current activities."

Paul Woodcock Regional Director for the Anglian Region of the Environment Agency:

"A climate change proofed tool kit aimed at reducing flood risk, through the right land uses, appears to be a prize worth striving for."

Mark Tinsley, Chief Executive, PC Tinsley Ltd vegetable growers:

"Farmers would prefer to work in an unsubsidised market driven "environment" but would qualify this with a requirement to be on a relatively equitable footing with their competitors. Competition is the most effective stimulus to efficient systems. We should be seeking to move to a situation in which outputs that can be traded should not be subsidised, whilst those that have intrinsic as opposed to market value will be supported by tax payers, for example habitat or flood protection."

Relu land use projects:

Angling in the Rural Environment
This project focuses on the role that angling, as a leisure activity, plays in the economy and the UK countryside. Angling is seen as important for rural employment, but rivers are under pressure from a whole range of human activities so their ability to sustain flora and fauna may be at risk. This project analyses the complex natural and socio-economic inter-linkages between river, fishing, biodiversity and institutions of governance and practice. The results will be used to inform policy on integrated development of the rural river environment.
Principal Investigator: Elizabeth Oughton, Newcastle University.
Other institutions: Aberystwyth University; University of Durham; University of Hull.
Research team: Chris Bear; Damien Bubb; Jonathan Bolland; Louise Bracken; Michael Carrithers; Sally Eden; Martyn Lucas; Jane Wheelock; Geoff Whitman.

Catchment Management for Protection of Water Resources
Reductions in water pollution have so far mainly been achieved through regulation and investment in waste water treatment, but the underlying water quality problem in much of the UK remains diffuse pollution derived from current and past land use plus atmospheric deposition. Best management practices and buffers that protect water courses and recharge zones can achieve much, but ultimately changes in land use may be needed in the worst affected areas. This project looks at the means, the governance needs, and the costs and benefits of alternative approaches, drawing on an analysis of international experience and investigation of two UK case study catchments.
Principal Investigator: Laurence Smith, University of London (SOAS).
Other institutions: University of East Anglia; University of Kent; Cornell University and New York State Water Resources Institute; New York State Department of Environmental Conservation.
Research team: Alastair Bailey; David Benson; Patricia Bishop; Dylan Bright; Marco Civitareale; Hadrian Cook; Jonathan Hillman; Kevin Hiscock; Alex Inman; Andrew Jordan; Tobias Krueger; Jennifer Morley; Keith Porter, Mary Jane Porter; Yuan Zhou.

Collaborative Deer Management
There are many associated costs and benefits in the management of deer. Deer management creates jobs for stalkers on forestry and sporting estates and people in the meat industry, and deer create particular landscapes that attract tourists. However in some areas, high deer numbers cause damage to sensitive habitats, to crops and gardens and cause road traffic accidents. Therefore there are many different attitudes to deer and conflicts on how best to manage them. This project is investigating how well people involved in deer management work together and how this can be improved so that the benefits are maximised whilst the costs are minimised.
Principal Investigator: Justin Irvine, Macaulay Institute.
Other institutions: Forest Research; University of Aberdeen; University of Edinburgh; University of St. Andrews; University of Kent; University of York
Research team: Helen Armstrong; Zoe Austin; Norman Dandy; Stefano Fiorini; Liz O'Brien; Brenda Mayle; Douglas Macmillan; Sharon Philip; Louise Ross; Jim Smart; Amy Turner; Rehema White; Piran White; Steve Yearley; Rene Van der Val.

The Effects of Scale in Organic Agriculture
A move to organic farming can have significant effects on wildlife, soil and water quality, as well as changing the ways in which food is supplied, the economics of farm business and indeed the attitudes of farmers themselves. This project addresses two key questions: firstly, what causes organic farms to be arranged in clusters at local, regional and national scales, rather than be spread more evenly throughout the landscape, and secondly, how the ecological, hydrological, socio-economic and cultural impacts of organic farming may vary due to neighbourhood effects at a variety of scales.
Principal Investigator: Sigrid Stagl, University of Sussex.
Other institutions: Cranfield University; The Organic Research Centre – Elm Farm; Henry Doubleday Research Association; Macaulay Institute; University of Cambridge; University of Leeds; University of Manchester.
Research team: Tim Benton; Stephen Carver; Ben Davies; Gareth Davies; Helen Durham; Doreen Gabriel; Richard Godwin; Laura Hathaway-Jenkins; William Kunin; Unai Pascual; Bruce Pearce; Dan Rigby; Steven Sait; Ruben Sakraban; Ulrich Schmutz; Lee-Ann Sutherland.

Energy Production on Farms Through Anaerobic Digestion
This project is examining the potential for the development of anaerobic digestion on farms, and the contribution that this could make to diversification of agricultural practice by enhanced land use planning for bioenergy production. The research addresses the policy issues, both within the broader European Community and the UK, to identify the drivers and obstacles that could stimulate or inhibit the development of on-farm digestion as part of a wider strategy for rural development.
Principal Investigator: Charles Banks, University of Southampton.
Other institutions: University of Reading.
Research team: Laura Clements; Donna Clarke; Philip Jones; Guy Poppy; Andrew Salter; Alan Swinbank; Richard Tranter.

Impacts of Increasing Land Use Under Energy Crops
Future policies are likely to encourage more land use under energy crops: principally willow, grown as short rotation coppice, and miscanthus, a tall, exotic grass. These crops will contribute to the UK's commitment to reduce CO2 emissions. However, it is not clear how decisions about appropriate areas for growing the crops, based on climate, soil and water, should be balanced against impacts on the landscape, social acceptance, biodiversity and the rural economy. This project integrates social, economic, hydrological and biodiversity studies in an interdisciplinary approach to develop a scientific framework for sustainability appraisal of the medium and long term conversion of land to energy crops.
Principal Investigator: Angela Karp, Rothamsted Research.
Other institutions: CEH Wallingford; Game and Wildlife Conservation Trust, University of East Anglia; University of Exeter.
Research team: Katy Appleton; Eleanor Blyth; David Bohan; Alan Bond; Allan Butler; Mark Cunningham; Trudie Dockerty; John Farrar; Jon Finch; Alison Haughton; Edie Jolie; Andrew Lovett; Victoria Mallott; Giles Martin; Dave McNeil; Mark Mallott; Andrew Riche; Paul Rosier; Rufus Sage; Ian Shield; Gilla Sünnenberg; Martin Turner; Geoff Wicks.

Implications of a Nutrition Driven Food Policy for the Countryside
Healthy eating is the mantra of the moment but are there ways in which we could enhance the nutritional qualities of the food we eat, and what would the effect be for the countryside if we all took on board the government's healthy eating advice? This project is investigating whether the type of pasture cattle graze on affects the fats in their meat, whether growing soft fruit and salad crops under new ultra-violet transparent film enhances the levels of antioxidants that can reduce cancer and what the consumer demand might be for such products.
Principal investigator: Bruce Traill, University of Reading
Research team: Mattieu Arnoult; Nicholas Battey; Laurie Butler; Stephanie Chambers; Eddie Deaville; Ian Givens; Michael Gordon; Paul Hadley; Kate Harvey; Philip John; Philip Jones; Kirsty Kleim; Alexandra Lobb; Julie Lovegrove; Paulina Macias; Mario Mazzocchi; Rebecca Morgan; Simon Mortimer; Matthew Ordidge; Alan Poots; Richard Tiffin; Richard Tranter; Joseph Tzanopoulos; Eleni Vysini; Alexandra Wagstaffe

Improving the Success of Agri-environment Schemes
Agri-environment schemes are intended to improve natural habitats but the results are mixed. This project is a five year study of how well wildlife habitats are created under such schemes, and whether training for farmers improves the outcomes.
Principal Investigator: James Bullock, CEH Wallingford.
Other institutions: University of Exeter; University of Reading.
Research team: Richard Broughton; Stephanie Harris; Shelley Hinsley; Matt Lobley; Morag McCracken; Simon Mortimer; Richard Pywell; Eirini Saratsi; Ruth Swetnam; Michael Winter.

Integrated Management of Floodplains
Recent flood events in Britain have heightened interest in exploring solutions that can join up multiple objectives such as managing flood risk, water resource management, enhanced biodiversity, enjoyment of the countryside, and support to rural livelihoods. The project is addressing these issues and re-examining a selection of agricultural flood defence schemes, previously studied by the research team in the 1980s, to identify and explain changes in land and water management that have occurred over the last 40 years.
Principal Investigator: Joe Morris, Cranfield University.
Other institutions: Open University; River Restoration Centre; Ecological Solutions.
Research team: Andy Blowers; Quentin Dawson; Tonny de Vries; David Gowing; Tim Hess; Peter Leeds-Harrison; Jenny Mant; Ben Moore; Helena Posthumus; Jim Rouquette; Paul Trawick; Graham Tucker.

Management Options for Biodiverse Farming
In this project, natural and social scientists are looking at the social, economic and political factors underlying farming practice, and the implications for biodiversity when farmers decide to change what they do or how they do it. They are using ecological models to predict how key biodiversity indicators such as weeds and birds will respond to the way the land is managed.
Principal Investigator: Bill Sutherland, University of Cambridge.
Other institutions: British Trust for Ornithology; Cranfield University; University of East Anglia; University of Reading; University of Sheffield.
Research team: Phil Atkinson; Eric Audsley; Alison Bailey; Ira Cooke; Rob Freckleton; Anil Graves; Elizabeth Mattison; Joe Morris; Ken Norris; Simon Queenborough; Daniel Sandars; Gavin Siriwadena; Phil Strachan; Paul Trawick; Juliet Vickery; Andrew Watkinson.

Merits of Consuming Vegetables Produced Locally and Overseas
Is importing food always a bad thing? This project is researching the advantages and disadvantages of consuming locally produced fruit and vegetables as opposed to fruit and vegetables produced overseas. Social and natural scientists are considering a range of relevant factors: greenhouse gas emissions, local employment, consumer perception of relevant attributes, nutritional quality of produce and community characteristics relating to local food cultures.
Principal Investigator: Gareth Edwards-Jones, Bangor University.
Other institutions: Centre for Ecology and Hydrology, University of Surrey, Makerere University, Uganda
Research team: Llorenc Mila i Canals; Anna Croft; Paul Cross; Graham Day; Rhiannon Tudor Edwards; Barry Hounsome; Ian Harris; Almudina Hospido; Natalia Ivashikina; David Jones; Georgia Koerber; Philip Nyeko; Claire Paisley; Deri Tomos; Monica Truninger; Andrew Wilson; Elizabeth York

Modelling the Impacts of the Water Framework Directive
This project brings together hydrology, economics and other disciplines to examine both the physical impacts of the EU Water Framework Directive upon rivers and how the changes in land use needed to achieve a reduction in pollutants in water are likely to impact upon already fragile farming communities. The project also applies a variety of innovative techniques to attempt to value the likely benefits of improving outdoor water quality.
Principal Investigator: Ian Bateman, University of East Anglia.
Other institutions: Askham-Bryan College; CEH Wallingford; Cranfield University; University of Manchester; University of Aberystwyth; Virje Universiteit, Amsterdam.
Research team: Eric Audsley; Sandra Barns; Rodney Beard; Amy Binner; Roy Brouwer; Emma Coombes; John Crowther; Helen Davies; Brett Day; Amelie Deflandre-Vlandas; Silvia Ferrini; Carlo Fezzi; David Hadley; Danyel Hampson; Stephanie Hime; Michael Hutchins; Andrew Jones; David Kay; Graham Leeks; Mervyn Lewis; Andrew Lovett; Colin Neal; Kerry Pearn; Paulette Posen; Dan Rigby; Daniel Sandars; Marije Schaafsma; Carl Stapleton; Dawn Turnbull; Kerry Turner; Bruce Willoughby.

Social and Environmental Inequalities in Rural Areas
This project is examining patterns of inequality in the distribution of social, economic and environmental goods and services in rural areas. They are considering how methods for measuring inequality differ within the natural and social sciences and exploring ways to resolve these differences and find a common approach. Having identified inequalities the team will be focusing on their implications, considering whether they can be regarded as unfair, and consulting with local residents about their perceptions of local inequality and injustice.
Principal Investigator: Meg Huby, University of York.
Research team: Steve Cinderby; Annamarieke de Bruin; Piran White.

The Sustainability of Hill Farming
Moorland ecosystems are particularly fragile. This project is investigating how we can manage them in a way that delivers sustainable hill farming communities while also protecting the environment. Taking the Peak District as a case study, the researchers are examining how farmers respond to policy changes and how they can design business plans to cope with such changes most effectively. The team is developing new modelling tools for examining the dynamics of moorland change across whole landscapes, how the actions of one farmer affect those of neighbours and how upland bird species rely on a diversity of habitats across the landscape.
Principal Investigator: Paul Armsworth, University of Sheffield.
Other institutions: Moors for the Future; University of Nottingham; University of Stirling.
Research team: Szvetlana Acs; Aletta Bonn; Martin Dallimer; Kevin Gaston; Nick Hanley; Phil Robertson; Dugald Tinch; Paul Wilson.

Sustainable and Safe Recycling of Livestock Waste
Dairy and beef farmers provide consumers with reliable sources of milk and meat but can we be sure that the animal waste is disposed of safely and without environmental and social risks? This project is investigating current perceptions of farmers, retailers, consumers and local downstream industries, such as tourism and shell fisheries, about pathogen transfers to the food chain. Changes in management practices could help to address the problem, and a farm-scale risk assessment tool is being developed to assess this. The project is determining the impacts of such changes on farm costs, and the potential costs to other stakeholder groups and the region as a whole.
Principal Investigator: Dave Chadwick, Institute of Grassland and Environmental Research.
Other institutions: University of Exeter, Lancaster University.
Research team: Rob Fish; Louise Heathwaite; Chris Hodgson; David Oliver; Michael Winter.

Sustainable Uplands: Learning to Manage Future Change
This project combines knowledge from local stakeholders, policymakers and social and natural scientists to anticipate, monitor and sustainably manage rural change in UK uplands. The result will be a choice of options to address future challenges that could never have been developed by any group alone. Factors driving future change are modelled with computers to develop detailed pictures of possible future social, economic and environmental conditions. Stakeholders and researchers then identify strategies that could help protect and enhance future livelihoods and the environment and evaluate them through computer models, site visits and other participatory methods.
Principal Investigators: Klaus Hubacek and Mark Reed, University of Leeds.
Other institutions: University of Aberdeen; University of Durham; University of Sheffield.
Research team: Nesha Beharry; Aletta Bonn; Sarah Buckmaster; Tim Burt; Dan Chapman; Pippa Chapman; Gareth Clay; Stephen Cornell; Andy Dougill; Evan Fraser; Jenny Hodgson; Joseph Holden; Brian Irvine; Nanlin Jin; Michael Kirkby; Bill Kunin; Oliver Moore; Christina Prell; Claire Quinn; Jan Sendzimir; Sigrid Stagl; Lindsay Stringer; Mette Termansen; Fred Worrall.

Testing a Community Approach to Catchment Management
This project investigates a specific catchment – Loweswater in the Lake District – and looks at how scientists, institutional stakeholders, farmers and residents can share expertise and work together positively for the benefit of their environment. They are considering questions such as whether the current "carrot and stick" initiatives are the best option to ensure that landowners look after the environment, and whether involving local people more in decision making and using their local knowledge and expertise would be a viable approach.
Principal Investigator: Claire Waterton, Lancaster University.
Other institutions: CEH Lancaster.
Research team: Kenneth Bell; Stephen Maberly; Lisa Norton; Judith Tsouvalis; Nigel Watson.

Understanding Environmental Knowledge Controversies
Scientists, and those who use their work, are having to think again about how science should inform democratic decision-making and the role of public engagement in this process. Taking the example of flood risk management, this project examines how and why the scientific practice of hydrological modelling becomes subject to scientific dispute and public controversy, and with what consequences for public policy. With hydrological models now capable of connecting local flood events to land management practices at catchment scale, the project is developing 'competency groups' as a new method for bringing the knowledge of local people with experience of flooding to bear on the modelling of flood risk.
Principal Investigator: Sarah Whatmore, University of Oxford.
Other institutions: University of Durham; Newcastle University; University of East Anglia.
Research team: Susan Bradley; Andrew Donaldson; Catharina Landstrom; Stuart Lane; Anders Munk; Nick Odoni; Neil Ward; Geoff Whitman; Penny Widdison.

The UK Research Councils' Rural Economy and Land Use Programme is an unprecedented collaboration between the Economic and Social Research Council (ESRC), the Biotechnology and Biological Sciences Research Council (BBSRC) and the Natural Environment Research Council (NERC). It has a budget of £24 million with additional funding provided by the Scottish Government and the Department for Environment, Food and Rural Affairs (Defra).

**Written and produced by Anne Liddon,
Science Communications Manager**

Assistance and contributions from Relu researchers and stakeholders and particularly from land use policy analysts Alan Woods and Vicki Swales are gratefully acknowledged.

**Rural Economy and Land Use Programme
Centre for Rural Economy
School of Agriculture, Food and Rural Development
Newcastle University
Newcastle upon Tyne
NE1 7RU**

**Telephone: 0191 222 6903
Email: relu@ncl.ac.uk
www.relu.ac.uk**

Rural Economy and Land Use Programme
Briefing Series No 9: Landmarks for Policy, published November 2009
Design: www.infinitedesign.com