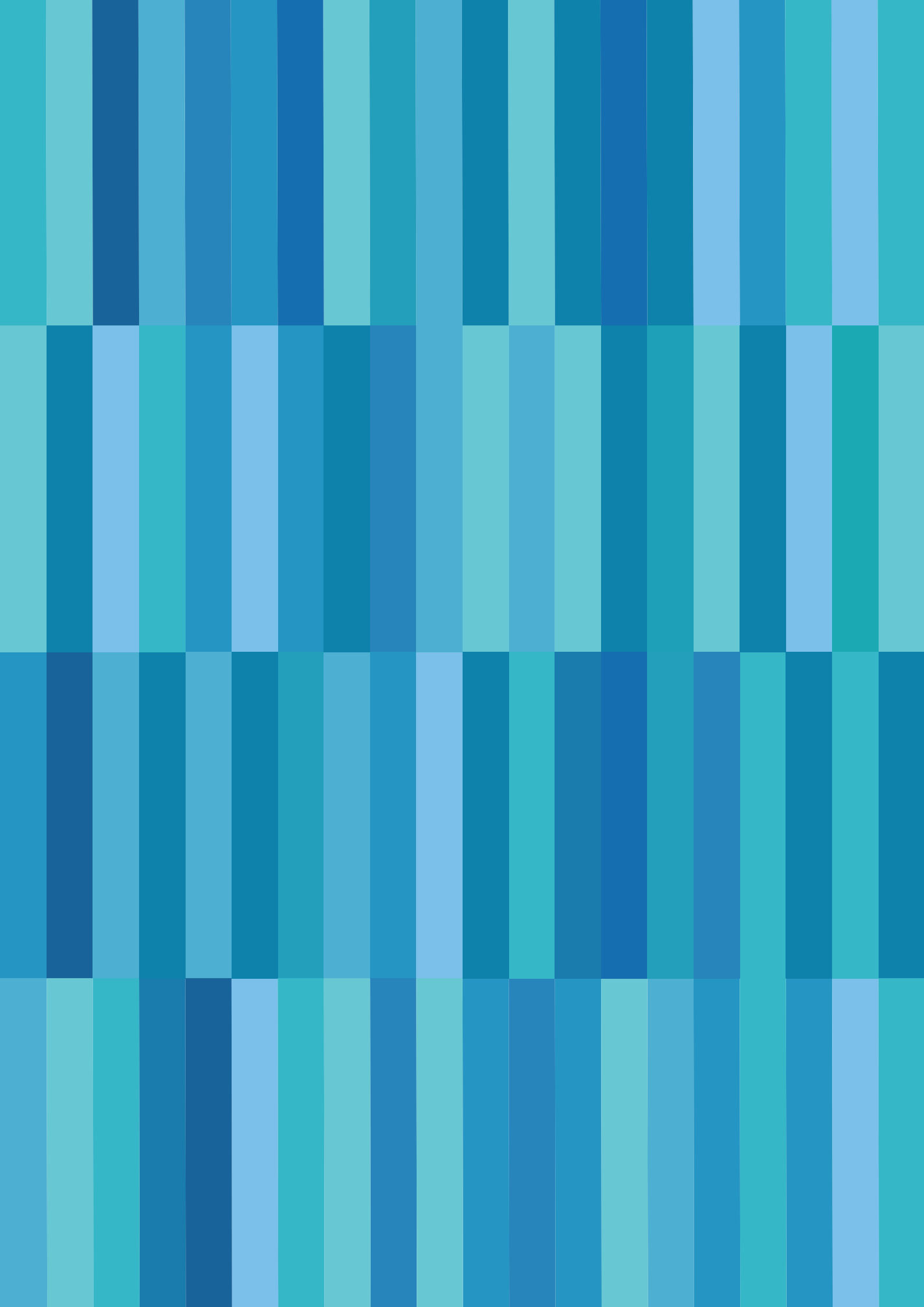
relu

Rural Economy and
Land Use Programme

# Water Framework:

## Implementing the Water Framework Directive



# Water Framework

## What is the Water Framework Directive?

The Water Framework Directive is one of the most far-reaching and demanding pieces of EU environmental legislation. It seeks to:

– Halt deterioration in the water environment
– Protect and enhance aquatic habitats
– Promote sustainable water use
– Reduce pollution of surface water and groundwater
– Mitigate the effects of floods and droughts

The overall aim is to secure 'good ecological status' for all water, taking account of biological and chemical quality, water quantity and the physical structure of water bodies. The Directive provides for three rounds of planning and action from 2009, with reviews in 2015, 2021 and 2027. It is being implemented through management plans prepared for designated river basins of regional scale. The plans draw considerably on valuable inputs from stakeholders.

## What does the Directive seek to achieve for river basins?

The Anglian District River Basin Management Plan illustrates the size of the task. It identifies 866 water bodies (including rivers, canals, lakes, aquifers, and some coastal waters, but excluding small streams and ponds).

The status of these water bodies has been assessed, where data are available, on each of over 30 different chemical and ecological elements. The overall status for any one water body is determined by the poorest result for an individual element. Hence, if a water body's status is 'moderate' for phosphate, but 'good' for all the other elements, its current overall status will be moderate. This 'one out, all out' approach means that of the 866 water bodies in the Anglian District, only 19% are currently classified as having good status, 69% are moderate, and 12% are poor or bad.

The Environment Agency expects that it will be possible to achieve 'good status' in 20% of water bodies in the Anglian District overall by 2015. Programmed improvements, which will shift water bodies from one class to a higher class, in relation to specific elements, include: 772km of rivers and seven lakes for phosphate, 602km of rivers for fish, 185km of rivers for diatoms, 126km of rivers for invertebrates, and 96km of rivers for ammonia. The ability to improve the remaining 80% of water bodies is currently limited by the Agency's understanding of the pressures on the water environment, their sources, and the actions required to tackle them. It is simply not yet clear why many stretches of rivers, or lakes, are failing to achieve 'good status' for one or more of the elements measured. These cases are being actively investigated, both to improve understanding and to define appropriate actions.

# Can an ecosystems approach assist implementation?

**Much work has already been undertaken to characterise water bodies and identify the actions needed if 'good status' is to be achieved**.

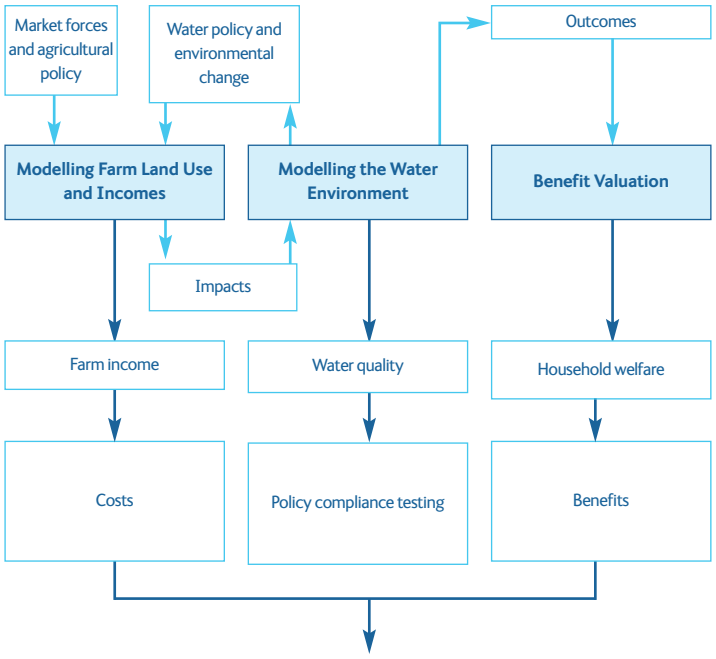
This work underlines the very close relationship between land and water; indeed, it will rarely be possible to achieve 'good status' simply by taking actions within water bodies alone. How land is used and managed will have to be reviewed across entire catchments, not just by the waterside. Achieving the aims of the Directive will impact on sectors and interests which are often remote from water itself.

The ecosystems approach provides a helpful framework for dealing with this complexity at various scales. It distinguishes four main types of service:

– Provisioning (e.g. producing food).
– Regulating (e.g. purifying water).
– Cultural (e.g. creating landscape beauty).
– Supporting (e.g. cycling nutrients).

This approach emphasises the holistic nature of the environment, and the need to view proposed actions to benefit the water environment in their wider economic and social contexts. It also offers a framework for adaptive management as external pressures change over time.

The ecosystems approach underlines the legitimacy of different services and the need for rounded assessment of how any planned action could affect each of them. Practical assessments – which avoid the extremes either of 'paying lip service' or 'paralysis by analysis' – could greatly assist implementation, by identifying synergies between different services and making conflicts explicit. This will in turn inform decisions on which management practices are likely to secure an optimum mix of benefits and costs (or trade-offs), taking account of the full range of ecosystem services.




This diagram illustrates the links between land use, water quality and benefit assessment modules within a wider modelling exercise to inform economic assessment of the costs and benefits of actions to implement the Water Framework Directive. The work is being undertaken through the *Modelling the Impacts of the Water Framework Directive* project. The model helps to examine how changes in environmental and policy drivers affect the use of farmland and in turn impact upon the water environment. It also examines the benefits of changes in water quality resulting from land use change. The model draws on Agricultural Census data for every 2km grid square in England and Wales from 1969 to 2004 and over 50,000 farm-years of data from the Farm Business Survey. Further critical data inputs include environmental and climatic variables, policy determinants, and input and output prices.

# What evidence can Relu projects provide?

**Findings and tools from several Relu projects can inform and assist implementation of the Directive, using an ecosystems approach.**

The projects sit within the context of the wider Relu programme and of other research, and cannot alone provide all the answers. However, their adoption of interdisciplinary approaches, and the active engagement of diverse individuals and communities in their work, distinguishes them from many other projects.

The projects also challenge deterministic views of the world in which policy interventions based on technical assessments lead to logical land management responses which in turn deliver expected environmental outcomes. The real world is far more complicated: the complexities surrounding cause-effect processes in natural systems are heightened by their inter-relationships and interactions with social and economic considerations.

The projects suggest that in order to implement the Directive, three areas need to be addressed: engagement, policies and governance.

# Strengthening engagement

**What interests need to be involved and how?**

The broad scope of the Directive means that many interests, both organisational and individual, with differing objectives, perspectives and levels of understanding, need to be involved in its implementation. For example, in relation to water quality alone, these include water companies, highway authorities, all businesses with discharge consents, land managers, and householders; in relation to flooding the relevant interests include all those whose actions could exacerbate flooding, as well as its victims.

While extensive engagement will be important in implementing the Directive, this does not necessarily mean involving everyone, everywhere, or all the time. Engagement needs to be practicable, taking account of the resources available and the timescales. This suggests targeting coupled with careful management of expectations. Important targets could include:

- **Geographical areas:** e.g. managing flood risk for a village; reducing nutrient enrichment of a lake; or tackling diffuse pollution from farms, septic tanks or highways in a catchment.
- **People:** those whose actions directly affect the water environment, or who are directly affected by it: e.g. farmers; people living in zones of high flood risk; or anglers.
- **Specific objectives:** e.g. gathering data to inform models; communicating issues; identifying practical options for action; building ownership of a problem; motivating local action; tackling specific controversies, whether long-standing or impending; or any combination of these.

Conventional approaches to tackling environmental challenges have tended to follow a linear path from diagnosis, development of 'preferred options' by acknowledged 'experts', through public consultation, to political decision-making, and finally implementation. This approach is often characterised as 'Decide-Announce-Defend'. Relu projects have challenged such approaches and shown that there are complementary ways in which different interests, organisational or individual, can be engaged in managing environmental issues. 'Engage-Deliberate-Decide' is one description often used to frame this approach.

**What good practices have Relu projects identified?**

The projects have identified various good practices for engagement. They stress the desirability of going beyond 'consultation' or 'participation' by putting the emphasis on 'learn' not 'tell', and on deliberation and co-creation of knowledge and planned actions. In particular:

- Everyone involved should be encouraged to recognise and show respect for the validity of different types of knowledge.
- People should be engaged from the outset, when challenges are first being aired, not after research, analysis and action plans have been finalised.
- The specific objectives should be made clear (e.g. whether it is to gather data to inform understanding and models, or to build momentum for collaborative actions).
- Engagement should also continue over time, with regular reviews and adaptation to take account of new information.
- Asking independent skilled mediators or facilitators to lead engagement can also be valuable in building trust between interests, particularly in contentious cases.

**What are the benefits of engaging diverse interests?**

The projects underline the benefits of involving diverse interests in actively developing ideas, models, scenarios and proposals, whether for a field, a farm, or a whole community.

Bringing these groups together bridges gaps between interests:

- Promoting better communication, understanding of different viewpoints, engagement and negotiation.
- Creating a more equitable relationship among the various interests, by establishing a common database of shared knowledge and understanding.
- Avoiding perverse effects and unintended outcomes by better understanding the complex motivations of different interests and their inter-relationships.

It results in more effective knowledge production by:

- Gaining valuable local data about how the environment works (e.g. what land floods first, what paths walkers actually use) to improve understanding and inform models.
- Identifying and co-creating a wider range of well-rounded and high-quality options for action than could ever have been developed by any one interest group alone.
- Gaining inputs to, and feedback on, scenarios for future land use and management.

Outcomes may then be improved because such engagement can help in:

- Developing proposals with better chances of success because they draw on and integrate different types of knowledge (e.g. 'local', 'professional' and 'scientific').
- Speeding local delivery of practical actions by securing involvement, and building ownership, commitment, and motivation.
- Encouraging effective self-regulation in adopting best management practices by changing perceptions, values, and behaviours.

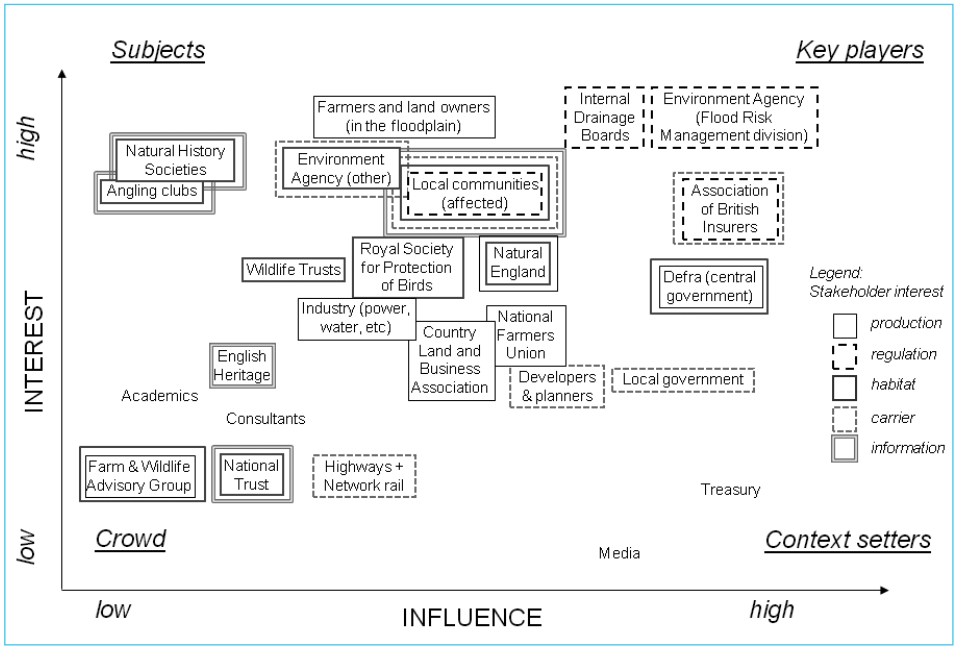
## What approaches and tools has Relu found most useful?

**These benefits have been secured through the development and use of a range of approaches and tools. While they have been developed in specific contexts, for particular purposes, they are likely to be helpful in dealing with other challenges in other places. Particular approaches and tools which merit further attention in implementing the Directive include:**

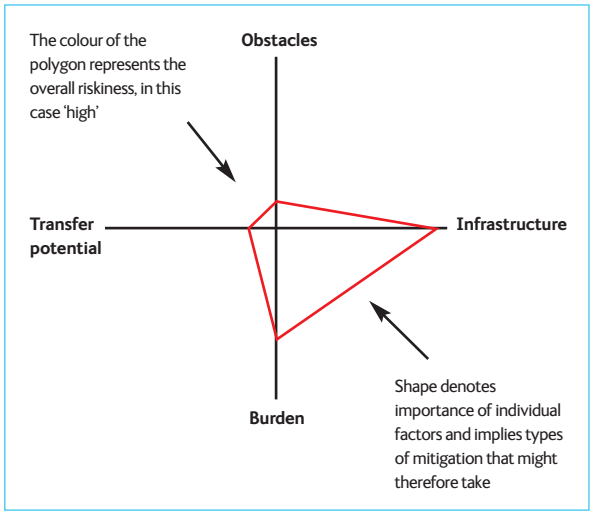
**Mapping stakeholders:** Several tools have been developed to 'map' the relative 'interest' and 'influence' of different stakeholders in relation to ecosystem services. This 'stakeholder mapping' helps in understanding the motivations and behaviours of different interests, and the scope to promote cooperation between them.

**Using aerial photographs and maps:** Working interactively, using hard copies of photographs or maps which farmers can annotate during discussions about current land management practices, challenges, and future options, is efficient and productive.

**Assessing and mitigating risks in land management:** A 'kite' tool has been developed to integrate scientific and behavioural information in managing livestock waste to reduce levels of pathogens in watercourses. These organisms can affect the health of swimmers on nearby beaches and, potentially, local tourism. The tool maps each of four components on a scale of 1–10 on its own axis: the microbial burden, transfer potential of pathogens, including risks posed by sloping land and other local topography, infrastructure such as manure storage facilities, and obstacles which limit the land manager's ability and desire to manage risk. The resulting 'kite' polygon highlights the risks and areas for action (see lower diagram).




**Mapping stakeholders:**
Example of a stakeholder map produced using a mapping tool (see Morris *et al*, 2009). Stakeholders are classified on the basis of their influence and interest. Four groups have been defined: 'crowd', 'subjects', 'context setters' and 'key players', with the latter recognised as having both the greatest 'influence' and 'interest'.




**Assessing and mitigating risks in land management:**
The colour (red, amber, green) of the resulting polygon shows the overall risk at farm level, while the shape indicates priorities for mitigating actions. In this example, the overall risk is high, and the risks arise principally from poor infrastructure (e.g. contaminated water draining directly into a stream from a farmyard) and burden (e.g. relatively high livestock numbers). Transfer potential is low (e.g. because fields are flat and well-drained), as are human obstacles (e.g. the farmer understands and recognises potential risks). The tool provides a basis for collecting relevant data, communicating the risks to farmers, and highlighting remedial actions. (Chadwick 2008)

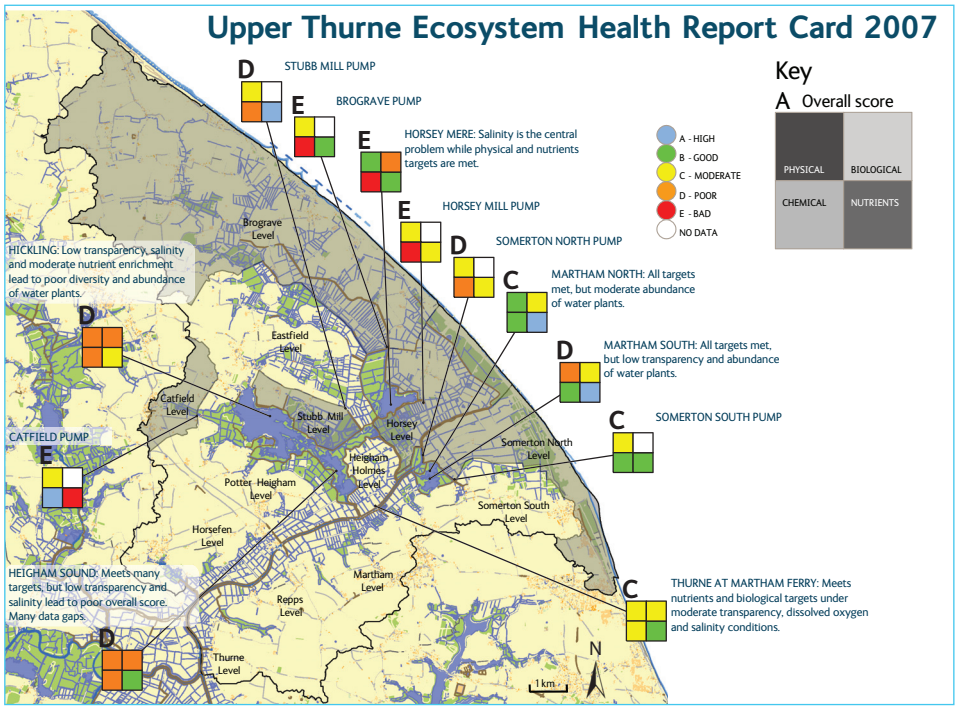
**Communicating data to inform actions to tackle diffuse pollution:** The Ecosystem Health Report Card (right) supports the integration of scientific measurements with local knowledge. It enables water quality 'failures' at river monitoring points to be linked, through discussion with local people, with potential causes within the catchment, and in turn to prompt remedial actions. Repeating the process periodically will enable the community to track progress in improving local water quality over time.

**Using community-led surveys:** Parish surveys have been used successfully, within a coordinated community project, to tackle phosphate pollution in an upland lake. The surveys have covered current fertiliser needs, domestic use of washing powders, and the condition of septic tanks. The results have promoted understanding, encouraged ownership of problems, and helped people take informed decisions about helpful actions.

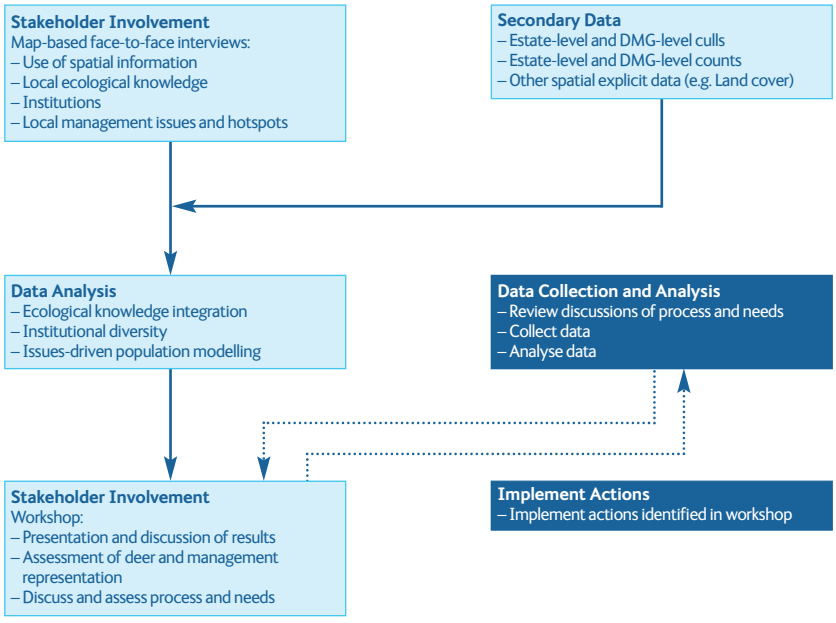
**Creating Participatory Geographical Information Systems:** These computer-based systems have been used to create well-informed and accurate spatial models and simulations, integrate local knowledge with scientific research, create mutually-agreed information for discussion with diverse interests, encourage the sharing of incidental information, and provide a basis for evaluating the impact of changes. Hand-held computer mapping devices may be particularly useful to take out into the field for meetings with farmers and local residents. These systems may be valuable in communicating and implementing policies to tackle specific river basin challenges.

**Establishing independent competency groups:** These groups have been used to integrate scientific knowledge and local experience in tackling controversial challenges. For example, they can enable local experience of flood events and land management practices to be taken into account in adapting standard scientific approaches to flood risk modelling. Co-creating models in this way enables scientists to explore scenarios with local people, discuss costs and trade-offs, identify and deliberate on options for action, and deliver solutions which are widely owned and hence more likely to be implemented.

Relu's Understanding Environmental Knowledge Controversies project has helped give new momentum to efforts to manage flood risk in Ryedale, North Yorkshire. Environment Agency officials talked of the issue having become 'stuck', and there was great concern among local people following serious floods. The project formed an independent 'competency group' to bring local people together with hydrologists to review and develop options (see Ryedale Flood Research Group, 2008). A proposal to install bunds to alleviate downstream flood risks is now being taken forward as a Defra demonstration project.




**Ecosystem Health Report Card:** The Ecosystem Health Report card consists of a map-based graphic (example shown above), and with data table on the reverse, both validated by scientists (see Smith and Hiscock, 2009). The card presents a 'score' for each monitoring point within a catchment for each of four groups of water quality parameters (physical, chemical, biological and nutrients). The overall score for each monitoring point is determined by the worst of the individual scores. The card informs land managers and other interests about water quality challenges and facilitates discussion of the causes of diffuse pollution and possible solutions. If the data are reviewed annually, progress can be readily tracked. The card helps to bring the debate about improving the water environment down to the level of individual parcels of land.




**Collaborative Frameworks:** Relu's Collaborative Deer Management project worked with deer managers using a participatory approach based on a Geographic Information System (PGIS) (see Irvine 2009). This enabled them to model specific deer populations at the landscape scale, exchange knowledge between stakeholders and scientists, build shared understanding, and develop an adaptive framework to evaluate the impact of land-use policy and climate change on deer management (see diagram above). This approach is potentially equally applicable to local collaborative management of the water environment.

# Strengthening policies

## What policy measures are available?

**Many different policy measures are available to support implementation of the Directive. They include:**

– **Providing information advice and training**: e.g. the Codes of Good Agricultural Practice, nutrient management plans, and Catchment Sensitive Farming Delivery Initiatives.

– **Promoting voluntary agreements**: e.g. the Voluntary Initiative for Pesticides, and the Campaign for the Farmed Environment.

– **Offering incentives**: e.g. grants for farm waste storage, and annual management payments under Environmental Stewardship schemes.

– **Investing in infrastructure**: e.g. by the water industry (drinking water, sewerage), and by the Government (flood risk management schemes) and developers (e.g. sustainable urban drainage).

– **Regulating land management through designations and rules**: e.g. Nitrate Vulnerable Zones, proposed Water Protection Zones, cross compliance requirements, abstraction licences, discharge consents and works notices.

– **Regulating built development through spatial planning regimes**: e.g. at regional and local levels.

– **Purchasing rights in the use of land**: e.g. easements or covenants under which land managers accept restrictions on how they manage land in return for payment.

– **Purchasing land outright** to enable direct control of its use and management, rather than through other owners and managers of land.

Concern is often voiced about a lack of coherence in the design and delivery of this wide range of policy instruments. The Directive may assist by encouraging a targeted approach to tackle specific pressures on defined water bodies or catchments by a fixed date. This could include assessing what measures are already in place, their relevance to the specific pressures, their impact to date, and how implementation could be improved to help secure 'good status' within defined timescales.

**CREDIT – Carbon Reduction and Investment Techniques for Peatland Restoration**

CREDIT is a proposed scheme to enable businesses to assist local projects which protect and enhance natural carbon stores. This includes protecting Britain's largest carbon store by investing in the restoration of peat bogs damaged by drainage and erosion. This will also bring wider environmental and social benefits. CREDIT will not be an offsetting scheme, so businesses will not be able to use any investment to count towards their own emission reduction targets. However, investing in CREDIT projects will demonstrate a real commitment to tackling climate change. The scheme is currently being developed in collaboration with consultants TerraCarbon.

## What gaps exist and how can they be filled?

**Relu projects are also identifying potential gaps in the range and content of policy measures, providing data to help assess their costs and benefits, and creating models and scenarios to inform policy debate and development. Contributions which merit further attention include:**

– **Using models:** Models can stimulate engagement, improve understanding, aid deliberation on options, inform targeting, and support policy decisions. For example, one model examines the impacts of different land management options on: farm gross margins (costs), household welfare (social benefits), and water quality (environmental benefits) (see Bateman et al 2010). The model should take account of social, economic and environmental drivers, including changes in these over time.

– **Co-creating scenarios for future conditions:** Scenarios can prompt new thinking about desired future states among different interests. They can combine insights from diverse stakeholders with model outputs (e.g. assessing the likely impact on the water environment of variations in social, economic and environmental drivers).

– **Combining diverse tools:** While there are some methodological challenges, there are benefits in bringing together different tools, including cost-benefit techniques, deliberative methods, qualitative and quantitative analysis, to create a 'big picture'. This integrated approach can be more effective than partial and/or disconnected initiatives and provides a more rounded account of the social and technical challenges and potential solutions.

– **Rewarding additional services:** Some ecosystem services provided by land managers have hitherto not generally been rewarded, despite their wider benefits to society. There is a case in particular for rewarding land managers through agri-environment schemes for taking positive action to reduce flood risk (e.g. to reduce run-off and hence peak flows, or to store floodwater to protect people downstream).

– **Calculating rewards:** Several projects have questioned why payments to farmers for adopting environmentally-sensitive practices are based on how much income they would thereby lose. An alternative would be to value ecosystem services in their own right, not simply in relation to food production. Payments could be based on spatially explicit, modelled relationships between management activities and ecosystem services (e.g. see Reed, 2010).

– **Identifying practical actions:** Restoring peatlands could enhance services such as managing flood risk, protecting the quality of drinking water, providing habitats, storing carbon, and rearing extensive sheep and game. The practical design of measures to enhance these services is assisted by a compendium setting out the costs and benefits of diverse restoration and management techniques (Defra, 2008).

– **Testing new mechanisms:** There is also a potential role for new policy mechanisms yet to be applied in land use management. There are proposals to raise funds for restoring peatlands initially through a Corporate Social Responsibility scheme (CREDIT, 2010), and potentially, in the future, through an accredited carbon offset scheme.

– **Encouraging collaboration:** New mechanisms are needed to foster collaborative action across several land-holdings. These would tackle the risk that separate agreements with scattered individuals might not be effective. Group agreements could incentivise farmers as a community to plan and secure coordinated action across an entire catchment, or critical parts of it. The agreements could draw on precedents, such as those promoted to improve the management of designated common land grazings.

– **Using water cycle studies:** Local and regional planners in the UK are now taking a more holistic view of water management. For example, water cycle studies are now providing comprehensive assessments of the impact of proposed development on all aspects of the water environment (including resources, quality, supply, treatment capacity, discharges, flood risk, and surface water management). These studies collate existing information, highlight gaps, and consider how sustainable development can best be achieved (Environment Agency, 2009).

– **Making direct investment:** Overseas experience suggests that there may be a role for direct investment in land by public bodies, to protect water catchments. Past examples in the UK include the purchase of upland gathering grounds by water authorities. This approach could also be extended to groundwater catchments affected by leaching of nutrients and pesticides. Alternatively, there is scope for water companies to work with farmers to protect these areas. This approach will be assisted by the recent approval of plans for over 100 'catchment management schemes and investigations' by 17 water companies. The aim is to manage the upstream parts of catchments to improve raw water quality rather than pursuing traditional, 'end-of-pipe', energy-intensive, hard-engineering, water treatment solutions (OFWAT, 2009).

– **Involving volunteers:** Mobilising the time, energy and skills of volunteers could bring significant benefits and reduce costs to the public purse. For example, anglers, fishing clubs and fishery managers have a wealth of knowledge about particular water bodies and an active interest in safeguarding water quality and improving fisheries. There is also scope to expand the work of River Restoration Trusts, and local initiatives such as RiverCare, which are actively engaging local communities in monitoring, managing and enhancing the water environment, particularly in towns.

# Strengthening governance

**Who is responsible for delivery?**

Responsibility for implementing the Water Framework Directive is widely distributed in the UK among diverse players, including Government Departments, public bodies, private businesses and individuals, voluntary organisations and community groups. For example, many different public bodies are responsible for spatial planning, managing highways and storm water, regulating water supply, treating waste water, advising land managers, offering incentives to improve land management practices, managing flood risk, and research. Separate planning and management processes have developed piecemeal for each of these areas, over the years.

River basin plans emphasise the need for coordination and partnership working among all the many interests in order to secure 'good status' for water. This applies both spatially (e.g. public bodies, and plans, often operate over different geographical areas), and over time (e.g. few planning and management processes are aligned with the timetable set by the Directive). While it is not necessary, and may not be desirable, for all relevant processes to operate on the same spatial and temporal scales, closer alignment could facilitate comprehensive and better-integrated catchment management.

**What are some of the challenges for delivery?**

Against this background, the challenges for public-sector officials in particular, in seeking to improve the water environment in any specific catchment, at a specific time, include:

- Multiple national policies which are poorly coordinated and may even conflict with each other, from diverse legislation and institutions. (e.g. agri-environment schemes initially failed to exploit potential synergies between actions to improve biodiversity and tackle diffuse pollution on farms, treating these as separate silos).
- Working across institutional boundaries, especially where this is not an established practice for the institutions themselves or for the communities with which they need to work. (e.g. securing a collaborative approach to surface water management between local authorities, water companies and the Environment Agency will be challenging).
- Policies negotiated and decided by organisations at national levels which take too little account of local variations and the associated costs and benefits.
- Policies based on contested concepts (e.g. 'sustainability') which officials have to seek to interpret and then apply fairly, and reasonably consistently, at a local level.
- Concerns from local interests who lack national representative bodies, and consequently have not been involved in developing the national policies which now affect them locally (e.g. tourist enterprises or smallholders).

**How do Relu projects suggest that these challenges can be overcome?**

Practical suggestions to try to overcome these challenges, and to improve working relationships and outcomes at a catchment level, working within existing governance structures, include:

- Getting local land managers and local staff from all relevant interests together at the outset of policy implementation.
- Identifying local issues as early as possible.
- Building, where possible, on existing networks and relationships.
- Developing local management solutions which clearly take account of the views and interests of groups which are not included in national policy-development processes.
- Developing more effective forms of two-way communication between national and local staff within public bodies, to support staff in engaging local interests effectively.
- Helping local interests to feed local issues and ideas into the development of national-level policies and plans.
- Recognising the importance of professional networks in helping to build informal contacts, and trust between different organisations.
- Actively setting up or seeking out local initiatives where public bodies can offer their experience to communities in a supporting, rather than a leading role.
- Using the media to communicate with, and engage, dispersed and unrepresented interests.
- Making more use of the statutory committees which advise the Environment Agency (in England and Wales) as independent routes for providing feedback from stakeholders in relation to each river basin.

**Do we need new governance structures?**

In some countries, the very many issues and activities involved in implementing the Directive are encompassed much more within the remit of local government institutions and their partners at local level. There may be opportunities to learn from this experience in developing better governance arrangements for implementing the Directive in the UK.

Whatever specific changes in governance arrangements might be initiated in the UK, the Directive must be implemented throughout the EU, and all Member States will accordingly be grappling with its requirements. It would at least seem sensible for them to share their experiences, so that all EU countries can learn from each other in striving to find the most effective and efficient means of securing the demanding objectives set by the Directive.

**Community-led collaborative action**

Relu's *Testing a Community Approach to Catchment Management* project, has brought together academics, local residents, institutional stakeholders and other interests into the 'Loweswater Care Project'. This group meets regularly 'to gain a better understanding of the diverse challenges faced by the Loweswater catchment and together to seek economically, socially and ecologically viable ways forward and put them into practice'. The group has initiated community surveys, influenced research, and achieved specific objectives such as installing a buoy to monitor water quality in the lake.

## Relu projects reviewed

**Testing a Community Approach to Catchment Management**: investigating how scientists, institutional stakeholders, farmers and residents can share expertise and work together positively for the benefit of a specific lake catchment. Principal investigator: Claire Waterton. c.waterton@lancaster.ac.uk

**Catchment Management for Protection of Water Resources**: examining the means, the governance needs, and the costs and benefits of alternative approaches to tackle diffuse pollution. Principal investigator: Laurence Smith. l.smith@soas.ac.uk

**Integrated Management of Floodplains**: exploring solutions to join up multiple objectives such as managing flood risk and water resources, enhancing biodiversity, and supporting rural livelihoods, focusing on a selection of agricultural flood defence schemes. Principal investigator: Joe Morris. j.morris@cranfield.ac.uk

**Modelling the Impacts of the Water Framework Directive**: examining how changes in land use to reduce pollution are likely to impact upon farming communities, and attempting to value the likely benefits of improving outdoor water quality. Principal investigator: Ian Bateman. i.bateman@uea.ac.uk

**Sustainable and Safe Recycling of Livestock Waste**: determining the implications for farmers, the food industry and tourism of changing land management practices to reduce pathogen transfers to the food chain from farm waste. Principal investigator: David Chadwick. david.chadwick@bbsrc.ac.uk

**Sustainable Uplands**: **Learning to Manage Future Change**: combining knowledge from policy-makers, scientists and local stakeholders to anticipate, monitor and manage change in the uplands. Principal investigators: Klaus Hubacek, hubacek@env.leeds.ac.uk Mark Reed. m.reed@abdn.ac.uk

**Understanding Environmental Knowledge Controversies**: examining how and why scientific modelling for flood risk management becomes subject to scientific dispute and public controversy, and the consequences for policy. Principal investigator: Sarah Whatmore. sarah.whatmore@ouce.ox.ac.uk

**Collaborative Deer Management**: investigating how well people involved in deer management work together and how this can be improved. Principal investigator: Justin Irvine. j.irvine@macaulay.ac.uk

**Angling in the Rural Environment**: analysing the natural and socio-economic inter-linkages between rivers, fishing, biodiversity, and institutions. Principal investigator: Liz Oughton. e.a.oughton@ncl.ac.uk

## Further information:


Bateman, I.J. (2009) Bringing the real world into economic analyses of land use value: Incorporating spatial complexity, *Land Use Policy*, 26 (1), 30-42

Bateman, I.J., Binner, A., Coombes, E., Day, B.H., Ferrini, S. Fezzi, C., Hutchins, M. and Posen, P. (2010) Integrated and spatially explicit modelling of the economic value of complex environmental change and its knock-on effects, presented at "Climate change impacts on biodiversity and ecosystems services" at the *4th World Congress of Environmental and Resource Economists (WCERE2010)*, Montreal, Canada, 28 June-2 July, 2010

Chadwick, D. R. (2008). Safe recycling of livestock manures. Relu Policy and Practice Note 4.

CREDIT. (2010). Carbon Reduction and Investment Techniques. See: www.see.leeds.ac.uk/credit.

Defra. (2007). Securing a healthy natural environment: an action plan for embedding an ecosystems approach.

Defra. (2008). A compendium of UK peat restoration and management projects. Research Project Final Report. Project SP0556. Available at: www.peatlands.org.uk.

Eden, S., and Barratt, P., (2010) Outdoors versus indoors? Angling ponds, climbing walls and changing expectations of environmental leisure Published Online: Feb 5 2010 DOI: 10.1111/j.1475-4762.2010.00943.x www3.interscience.wiley.com/journal/123275413/abstract

Environment Agency. (2009). Water Cycle Study Guidance. Available at: http://publications.environment-agency.gov.uk/pdf/GEHO0109BPFF-e-e.pdf.

European Union. (2000). Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Official Journal L327. 22/12/2000.

Fezzi, C., Hutchins, M., Rigby, D., Bateman, I.J., Posen, P. and Hadley, D. (2010) Integrated Assessment of Water Framework Directive Nitrate Reduction Measures, *Agricultural Economics*, 41: 123–134.

Hutchins, M., Fezzi, C., Bateman, I.J., Posen, P. and Deflandre-Vlandas, A. (2009) Cost-Effective Mitigation of Diffuse Pollution: Setting Criteria for River Basin Management at Multiple Locations, *Environmental Management*, 44(2): 256-267.

Irvine, J. (2009). Addressing conflicts over natural resources: using participatory GIS to facilitate consensus over wild deer management. Available at: www.macaulay.ac.uk/RELU/RELUposter3c.pdf.

Morris, J., Posthumus, H., Hess, T., Gowing, D. and Rouquette, J. (2009). Watery land: the management of lowland floodplains in England. Pages 135-166 in Winter, M. and Lobley, M. (Eds) What is land for? Earthscan, London.

OFWAT. (2009). Future water and sewerage charges 2010-15: Final determinations. Birmingham.

Environment Agency. (2009). River Basin Management Plans. Available at: www.environment-agency.gov.uk/wfd.

Reed, M. (2010). Sustainable uplands: re-shaping land use policy for our hills. Relu Policy and Practice Note 14.

Ryedale Flood Research Group. (2008). Making space for people: involving local knowledge in flood risk research and management in Ryedale, Yorkshire. http://knowledge-controversies.ouce.ox.ac.uk/news/ Making_Space_for_People.pdf

Smith, L. and Hiscock, K. (2009). Catchment management for the protection of water resources: The Ecosystem Health Report Card. Relu Policy and Practice Note 7.

Waterton, C., Norton, L. and Morris J., (2006) Understanding Loweswater: interdisciplinary research in practice *Journal of Agricultural Economics* 57, (2): 277-293.

Woods, A. (2009). Securing Integrated Land Management: Issues for policy, research and rural communities from the Relu programme. www.relu.ac.uk/research/Land_Use_Consultation/Securing_Integrated_ Land_Man.pdf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**The Rural Economy and Land Use Programme is a £25 million interdisciplinary research programme, funded by the UK research councils with additional support from Defra and the Scottish Government. It runs from 2003 to 2011 to investigate the strategic challenges facing the UK countryside.**

By Alan Woods. Contributions from many Relu researchers and officials in Government departments and public bodies are gratefully acknowledged.

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Rural Economy and Land Use Programme Briefing Series No 11
Water Framework: Implementing the Water Framework Directive, June 2010
Design www.infinitedesign.com.