Environment Agency

Evidence

An assessment of lessons learned in the communication and dissemination of emerging scientific issues to environmental policymakers Part 1.Comprehensive Report

Report: SC090005/R1

Better regulation programme

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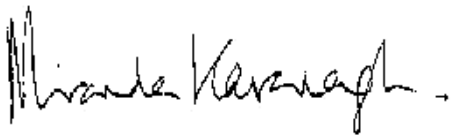

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Director of Evidence

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Contents

Acronyms

BERR	Business Enterprise Regulatory Reform
CAB	Sweden's County Administrative Board
CO_2	Carbon dioxide
Defra	UK Department for Environment, Food and Rural Affairs
DFID	UK Department of International Development
EC	European Commission
EQOs	Environmental Quality Objectives
ESA	Ecosystems Services Approach
EU	European Union
GM	Genetically Modified
HELCOM	Helsinki Commission
ICCAT	International Commission for the Conservation of Atlantic Tuna
IPCC	Intergovernmental Panel on Climate Change
LCA	Life Cycle Analysis
MA	Millennium Ecosystem Assessment
MARE	Marine Research on Eutrophication Programme
MBEO	Management by EQOS
MISTRA	Swedish Foundation for Strategic Environmental Research
NAO	National Audit Office
NERC	Natural Environment Research Council
NGO	Non Governmental Organisation
OECD	Organization for Economic Co-operation and Development
PSA	Public Sector Agreement
RELU	Rural Economy and Land Use Programme
SEPA	Swedish Environmental Protection Agency
SKEP	Scientific Knowledge for Environmental Protection
SNF	Swedish Society for Nature Conservation
TOR	Terms of Reference
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VASTRA	Swedish Water Management Research Programme
WMO	World Meteorological Association
WWF	World Wide Fund for Nature

Introduction

Imagine the scene...[1]

'Professor Lowther, the world expert on methane production in ruminants, has been asked to speak to the cross-governmental climate change mitigation committee when they consider strategies to reduce carbon emissions from farming. He walks into the room and throws a pile of research papers onto the table and tells the assembled group to read the papers as they contain all the answers they need.'

'Ministers are meeting to develop a policy, based upon the latest science, to stop the spread of sudden crop mildew syndrome. This is a new field but its two leading scientists are there to give advice. A discussion breaks out between the scientists about technical aspects of their respective research in this new and emerging field. At the end of the discussion with the scientists, the Ministers are clear what they should do – they should choose the solution that makes the most economic sense and causes the least public outcry.'

'Dr Jabonski has recently worked on a project to help inform policy making. The policymakers are very interested in the outcomes and ask Dr Jabonski to produce a summary of her work. Dr Jabonski is too busy to write something for the policymaker so she sends the technical summary from the report she is drafting. The policymaker isn't satisfied so employs a science journalist who has the skills to explain the science clearly. Offended that the policymaker felt that this was necessary, Dr Jabonski refuses to brief the science journalist but then complains that the final summary is inaccurate.'

The relationship between science and policy is often seen as difficult, as the fictitious examples above illustrate. Yet from climate change to food security, many of the biggest challenges facing the world today rely upon effective policy making, based upon the best science and evidence. We need to make sure that we have established the right level of communication and relationship between these two groups. This research project sets out to look at that communication process: to examine closely the communications involved in real-life science-to-policy case studies and to identify the lessons from the past that can help us deal with scientific issues that are emerging now and those that will emerge in the future. We'll meet Professor Lowther and Dr Jabonski again later on, when we'll see how applying these lessons might improve things in the scenarios described above.

[1] These example scenarios are stories created for illustrative purposes only and do not describe actual people or their actions.

Background – the current science-policy communication landscape

In most European countries today it is generally agreed that for environmental policy to be effective, the decision-making and actors involved need to be well informed by science. However, communication between science and policy has sometimes been ineffective in the past. The ambition to improve the use of science in policy making processes has much in common with the ambition to increase public participation: to limit inadequately informed and incompletely deliberated decisions, which can result in unnecessary costs, social conflicts and mistrust of the government.

In the 10 years since the first European 'Science-meets-Policy' workshop in London in 1998, the role of science in environmental policy making has been increasingly recognised. Scientists funded by taxpayers' money in several countries are now routinely asked to consider how they will communicate their results to policymakers. For example, in the UK the Natural Environment Research Council (NERC) and the Rural Economy and Land Use programme (RELU; co-funded by NERC, the Economic and Social Research Council and the Biotechnology and Biological Sciences Research Council) and in Sweden the Environmental Protection Agency (SEPA) and Swedish Foundation for Strategic Environmental Research (MISTRA) require all funding proposals to include a knowledge exchange plan. This plan shows how the researchers will maintain a dialogue with key stakeholders, including policymakers, throughout the project lifetime and also explain how the research outputs will be disseminated. These initiatives reflect an increasing desire to put in place systems that will ensure the effective use of science in policy making, while also commanding public confidence. Whilst there have been a number of such initiatives, there has not yet been a comprehensive evaluation of their effectiveness, and there remains a lack of consensus on 'best practice'.

Barriers to effective science-policy communication

Previous research (see Literature and Current Practice Review, Annex 2) has described how the main barriers to successful science-policy communication relate largely to the nature of environmental science, the nature of policy making, and the gap between them. Identifying what is 'normal' for each is an important starting point in understanding how the two can be brought to work more effectively together (Box 1).

Box 1. The nature of environmental science and the nature of policy making.

Environmental science	Policy making
1. Complex issues, many linkages to different issues and disciplines. 2. Pure science often does not account for broader contextual considerations. 3. Scientific findings are often inconclusive or only relevant under very specific conditions (not 'real life'), making them ambiguous and uncertain, with a large 'it depends' factor. 4. Results may be broad but not specific – 'it is a problem for the environment' rather than 'it will have X impact by Y date, and this is what the solution is'. 5. Good science often takes time and typically involves significant debate. 6. Scientists are good at communicating with other scientists but often poor at communicating with others.	1. Policy making is influenced by politics, which means there are ideological controversies, opposing views and vested interests. 2. Decisions are influenced not simply by science, but also by economics, public opinion and political priorities. 3. Policymakers cannot easily access science and often do not understand the nature of science (especially in terms of the importance of debating scientific outcomes and of uncertainty). 4. Policy making requires (or at least prefers) certainty of evidence, often within short timescales. 5. Policy problems are often poorly communicated to science; policymakers are rarely involved in shaping research questions.

The widespread recognition of these problems, and the consequent impacts on effective policy and practice, has led to real efforts to find solutions. A number of recommendations for improving the science-policy process have been described in the literature. These can be largely grouped into the following categories.

Increasing interface between scientists and policymakers: There is widespread agreement that scientists and policymakers need to increase and sustain their interactions, through partnership agreements, targeted forums, advisory groups and so on. This can help the two parties to understand better each others' working processes, and improve the direction, quality and impact of science on policy.

Use of translators, advocates and networks: Numerous studies recommend the use of intermediaries who can 'speak both languages' and compensate for the differences between science and policy making processes. These intermediaries can come from policy makers employing in-house scientists or from external organisations. Either way, this approach can ensure that research results are targeted and specifically brought to the attention of policymakers.

New skills, tools and roles for scientists: Better understanding of policy making processes and influences and how their science can be related to policy; including multi-disciplinary policy issues and interdisciplinary working skills and stakeholder

consultation more in research; better skills in communicating with non-scientists. This can all help scientists better target their research findings to where it can have policy influence.

New skills, tools and roles for policy makers: Better understanding of science and research processes; reinforcing roles and skills in identifying research needs and in strategically procuring and shaping research; better skills in interpreting research findings. This can all help to ensure that research findings are what policy makers need and understand.

Project aims and objectives

The aim of this study is to contribute to making environmental decision-making processes more effective, and to improve the accuracy and quality of outcomes so that implementation is more successful. Our approach was to use case studies to identify lessons from past attempts to influence environmental policy using science. We then discuss how these lessons might be used in other contexts, what is required of scientific advice for it to be taken up by policy makers and what could be done to accelerate the political decision-making process.

Project methodology

First we carried out a Literature and Current Practice Review (Annex 2) to identify the 'state of the playing field' at the start of the project. Then we carried out an inception survey of science and policy stakeholders to confirm that the assumptions about science-policy related communication highlighted in our literature review were correct. We used the recommendations for improving the science-policy process noted in our literature review to guide the selection and analysis of case studies. We carried out five in-depth case studies, but recognised that this number was unlikely to cover the full range of combinations of the above. So we complemented these main case studies with four mini-case studies that drew on a wider range of experience. For each of these studies, we developed narratives of the communication issues and events associated with each study from literature sources. These were then added to and refined through interviews with the key stakeholders involved. We then cross-compared the case studies to isolate themes and patterns before synthesising the main lessons and generating overall recommendations and guidelines.

Case study topics

Developing an Ecosystems Services-based approach to policy making (p 30) In this case, the UK Government commissioned research to inform a specific policy objective. Researchers produced an executive summary of their work targeted towards policy makers, but it was necessary to employ a professional translator as this policy summary was still too technical. The translator had a good understanding of both science and policy and formed a bridge between the two camps.

Climate Change policy and the role of the Intergovernmental Panel on Climate Change (IPCC; p 35) The IPCC has been successful in finding a way to provide an overview of scientific evidence that is both scientifically accurate and relevant to policy. It developed a clear and transparent system for dealing with the uncertainty and lack of consensus regarding particular pieces of evidence, which helped develop credibility and trust. It created a system that gave scientists direct access to government, and provided clear incentives for both scientists and policy makers to be involved in its work.

Management by Environmental Quality Objectives (MBEO; p 41) This study discusses the way the MBEO system has been shaped in Sweden as part of ongoing efforts to combine long-term environmental sustainability with relevant policy measures. The Swedish MBEO approach is a general model that facilitates science-policy communication by creating a platform for this to take place.

The Green Chemistry Project (p 44) In this case, communication activities were strategically targeted towards specific audiences at different stages of the process: from motivated potential users of the science initially to mass media and government departments at later stages. The project was driven by two motivated individuals with scientific backgrounds, one of whom worked for local government, and was financed by a local authority.

Eutrophication in the Baltic Sea – a science-policy communication perspective (p 47) This case illustrates communication issues associated with a slow-moving and complex environmental issue. Key communication activities included dialogues and mediation driven by both scientists and policy makers, with translators, champions, negotiators and advocates all playing different roles in pushing the policy process forward.

Co-production of research and policy – the MISTRA foundation (p 52) MISTRA's choice to invest in interdisciplinary research programmes is based on the view that such programmes are more likely to grasp the complexity of both environmental policy making and management of natural resources, and is therefore more likely to generate usable results. Key communication activities were dialogues between researchers and end-users/practitioners and the development of broad multidisciplinary programmes with an end-use focus.

Nanotechnology – feeding the outputs of dialogue into policy making (p 56) The main communication activities in this case were a series of public dialogue events held at various scales (from the Royal Institution to school children) during which the science was debated. Outcomes from these debates were relayed directly to policy makers with responsibility for making nanotechnology-related policy. The approach was driven by policy makers (UK Department for Environment, Food and Rural Affairs; Defra) and a professional science communicator (functioning as a translator), ensuring that project outcomes were timely in terms of policy process.

Using scientific evidence to create policy on tuna fishing in the Mediterranean (p 59) This case illustrates that it can be difficult for scientific evidence to compete against other forms of evidence in influencing policy. Particularly when science is telling the more challenging story and the problem is complex and institutional structures are lacking.

Life Cycle Analysis (LCA) as a tool for enabling communication between science and policy (p 63) This mini-case illustrates how scientists have attempted to provide a tool for communicating complex multidisciplinary scientific data in a simple manner to help policy makers make comparisons between different ways of dealing with a complex problem.

Lessons Learned

The case studies have generated a complex picture of the many factors that affect the ways in which science and research feeds into policy making. Some of these factors echoed the criteria identified in the literature review, while others were new and additional. Some factors relate to communication, but a number (and arguably the most significant) relate to wider matters – such as the process by which policy is made and the context within which this process takes place.

While the purpose of this study was to look at the communication lessons specifically, it is not always possible to separate these out from the wider matters. In particular, many of the communication lessons learned are closely related to the policy making model used. The lessons presented in this section therefore include wider lessons about the policy making process, as well as the communication lessons that we were tasked to look at.

Finally, we should emphasise that the specific combination of factors and qualities identified are important to particular examples and scenarios. Although we believe that these represent significant success factors, adding these factors together does not necessarily equal a best practice model. The actions following from the lessons learned are developed further in the recommendations section, but we believe that it is worth noting at this stage that the lessons do not point towards a one-size-fits-all recipe.

1. The model of policy making used is vital and should be based upon an ongoing dialogue, rather than an end-of-pipe model

Researchers complain that they can't access the right people at the right time (and vice versa), which suggests that what we have described as an 'end-of-pipe' model of policy making is in use. In this model, the researchers produce findings that are then fed to the policy makers (with or without an intermediary).

Research considered in the literature review identified the importance of the relationship between researchers and policy makers, and made valuable suggestions for improving this relationship. These suggestions included involving the researchers in commissioning the evidence for policy making and extending the policy makers network. The case studies support these suggestions, as well as the claim that the relationship between scientists and policy makers is key.

Those examples where research has been most successful in feeding into policy making take this relationship further and challenge the 'end-of-pipe' model of policy making. Instead, the good practice model that emerges from the case studies is one of dialogue and co-production. In this model, the policy makers are in contact with the researchers at an early stage, in order to help shape the research commissioning process, and maintain contact throughout, so that shared understanding is developed over time. As well as improving the relationships, this approach is important, particularly in the context of adaptive policy management, as it allows policy to be shaped by (or at least anticipate) the latest, and even nascent, findings. The case studies demonstrate that there are a number of ways in which this model can be encouraged.

Box 2. Dialogue and co-production driven by a policy maker – Ecosystems Services Approach at Defra.

The Ecosystem Services Approach case study provides a good example of a co-production model, specifically in this case driven by an enlightened and motivated policy maker. The research commissioning team (scientists based within a policy team) were aware that the research programme was sufficiently important and that time and effort had to be put in to making sure that the findings influenced policy. Throughout the research programme, the Defra policy makers were conscious of their relationship with the researchers and understood that, as this was a new area of both research and policy, they were 'learning together', describing it as an ongoing discussion. As part of this, the policy team facilitated two workshops during the 'report back' stage, to help shape the key messages emerging from the research for the policy makers.

2. Communication needs to be ongoing

Even without the dialogue model of policy making, researchers cannot take a 'hit and run' approach to serving policy better. Instead relationships (and therefore the ability to serve policy) need to be built up over years, through regular contact and monitoring.

Box 3. Nanotechnology.

Throughout the three-year Small Talk project, covered in the nanotechnology example, the project team worked to make contacts with the key individuals in government involved in policy on nanosciences, maintaining the dialogue and building relationships with these individuals for the duration of the project. Key policy makers were regularly updated on lessons and attitudes learned, as well as being invited to comment upon the value of the various outputs of the project. As a result, the project team was invited in to discuss its findings with policy makers on several occasions, both during and after the project.

Similar long-term communications with policy makers also emerge as being key in the IPCC and MISTRA case studies – discussed further below. In the Eutrophication case study, the scientists that were physically located in the same city as key policy makers developed stronger relationships with them, so proximity may also be an important factor.

3. Institutional structures can enable better communications

Following on from the previous point, there is evidence that organisational structures can be used to cement and enhance both these relationships and ongoing communication between research and policy.

Box 4. MISTRA.

In order to make their research results useful in practice, the researchers involved in MISTRA programmes are expected to conduct their research in dialogue with practitioner groups that are concerned with or might benefit from the research. From the planning stage onwards, and especially at the start-up of a MISTRA programme, dialogue is encouraged in various ways between the researchers involved and the people who intend to use the results. Before a funding decision is taken by MISTRA, every research proposal undergoes an evaluation to ensure that the programme is valuable for the groups that are supposed to benefit from them.

As such, the MISTRA Research Foundation has built an institutional structure that makes the links between the two groups very solid indeed. The Foundation was in fact established with the overall mission of contributing to finding solutions to environmental problems in collaboration with end-users. In this way, policy-input is embedded in the structure and function of the organisation. According to the Foundation's evaluation, in those programmes that have had the most policy impact, researchers have worked closely with end users throughout. They have developed a shared view of the problem to be addressed and how to go about doing this, as well as meeting regularly to maintain and deliberate that common view. Furthermore, the programme boards that manage the programme's fund and direct scientific activities are dominated by potential users of the results, rather than scientists. This is a significant departure from the way in which research funds are usually managed, but in the view of the people we interviewed for the case study it is one of the most important ways in which end-users and researchers interact.

Box 5. Environmental Quality Objectives.

The environmental quality objectives (EQOs) are a mechanism by which the success or otherwise of Sweden's environment policy can be monitored – by both experts and non-experts. The Swedish Government has overall responsibility for the work with the EQOs. At the national level, the Swedish Government has set up an Environmental Objectives Council to coordinate efforts and to monitor progress towards the goals. Every year, the Council reports to the Government on how efforts to achieve the objectives are advancing, whether they are likely to be reached and with what speed, and what further action is required. The Government in turn reports how the work is continuing to the Parliament, which regularly confirms and approves the measurements to reach the goals. Every fourth year, the Council conducts a systematic review of the current evidence, submitting an extended comprehensive evaluation to the Government for use as a base for decisions about revising measurements and as a means of control. The comprehensive evaluation reports are used in formulating Sweden's Environmental Objectives Bill. By agreeing the review and policy making process in advance, and making it transparent to all stakeholders, the EQO process permits researchers to know precisely when and where their evidence will be needed and to plan accordingly.

The IPCC, International Consortium for the Conservation of Atlantic Tuna (ICCAT) and Helsinki Commission (HELCOM) are further examples of permanent international policy platforms that are involved in the sustainable management of common resources or are working on important common environmental problems. Other informal structures to help this dialogue take place in a reasonably systematic way also exist, such as annual conferences, government-initiated working groups engaging key researchers in giving advice to policy makers and large research programmes.

4. People who translate scientific material into a form that is readily accessible to policy makers can play a valuable but more complex role than previously understood

Policy makers and scientists tend to communicate in different ways that reflect the needs of their own discipline – they do not necessarily speak the same 'language'. For this reason, successful communication of scientific issues with, or to, policy makers may, according to the literature, involve the use of translators who convert technical communications into plain English. In this instance, the 'translator' is someone who converts material between the 'language' of science and the 'language' of policy, much in the same way that someone might translate material between French and German. Our case studies support the importance of that role, but with the following caveats.

a. The role of the translator is more than just explaining things clearly

Translators are usually involved to improve the clarity of the message and to present it to the right people. The importance of providing an unambiguous message has been identified among the case studies as a factor affecting whether an approach is successful (this is discussed further later). However, we believe the case studies show that a translator's significance goes beyond simply 'explaining things properly'. It also encompasses their credibility and analytical roles too:

- bridging science and policy groups, building understanding and synthesising messages;
- helping policy makers interpret scientific results;
- initiating dialogues between groups to help them understand each other better and allow them to form a common view of an issue.

Box 6. Ecosystems Services Approach.

The Ecosystems Services Approach case study perhaps takes the closest look at the role of the translator. Given the importance of the research, the policy team at Defra were keen that the findings were presented in a way that could be easily understood and used by themselves and their colleagues. They therefore asked the researchers to produce an executive summary of their research reports, targeted at policy makers. After several discussions and drafts, many of the summaries were still too extensive and technical and so the policy team decided to involve a 'translator'. They employed a professional science communicator to present the key messages of the research to policy makers. The communicator was also asked to produce an overview of the research, identifying and distilling any themes and overarching messages that were emerging.

The policy lead considered the role of the translator important as they 'didn't want to give the deeper "science message" away – we wanted policy messages DERIVED from science'. In the views of the policy team, this translator didn't need to know the science, but needed to understand the scientific process or scientific psychology, as well as policy language, needs and goals, the political context and the subtleties of language in this context too. They also needed to think carefully about balancing language and have the credibility to negotiate with both the researchers and the policy makers. This helped to ensure that the researchers were not offended by the simplification of their work, while the policy makers received information in an accessible and understandable way.

b. A range of individuals perform the translation role

Successful translators appear to come from a range of backgrounds. They may be professional science journalists or communicators, either working within or brought in by the policy making team (as in the Ecosystems Services case study). Some are science advisors working for the government – often embedded in the policy teams, acting as research commissioners. Or they might be totally external to the process, working within non-governmental organisations (NGOs) or independent institutions (as in the Green Chemistry case study) where their translator role overlaps with that of an advocate.

Perhaps surprisingly, successful translators are not always people who have had any special training for this role – indeed it is difficult to see what kind of training would prepare someone for the role. While some case studies involved professional communicators, these skills needed to be coupled with scientific understanding and knowledge of the policy process. In most of our case studies, the translators were people who had had a long involvement with the issue in question and had built up extensive networks of contacts, or people who were otherwise motivated to carry out this role.

c. Characteristics of successful translators

We identified a range of characteristics exhibited by successful translators in our case studies.

- Able to build effective networks.
- Able to identify and access relevant key players (policy, commercial and media players).
- Having identified key players, able to build relationships with them.
- Understands how policy works, so can ensure material produced is policy-relevant.
- Able to communicate a clear, credible message on a variety of levels (policy, research, to media, business, general public).
- Capability to listen to and learn from others.
- Are seen as credible by scientists, policy makers and other key stakeholders.

5. Translators need a mandate from researchers and policy makers in order to be effective

Communication can only occur between scientists and policy makers when both sides want to take part. Translators can only be effective when there is agreement from both sides – science and policy – that they are needed.

In the Eutrophication case study, a number of people took on the role of translator between science and policy. However, they were never officially appointed or commissioned as translators or provided with the full support, mandate and resources to act as such. The translators believe that the process would have been more efficient if they had received the full support of the Swedish Government.

The MISTRA study shows how the programme framework can give a clear mandate to translators so that it doesn't have to be negotiated on a case-by-case basis, overcoming typical institutional obstacles.

The nanotechnology case study was interesting because it was commissioned by the

UK Government indirectly and not by the policy makers in this area. Nevertheless, the project team used the government funding as a means of giving their actions the status and legitimacy to engage with policy teams.

In the case of Ecosystems Services, although the policy makers were fully engaged, the translators needed to build status and credibility with the researchers involved. It was only once the translators had proved that they had sufficient knowledge of the science that some of the researchers felt able to engage with them.

6. Advocates can play an important role

As we explained earlier, we have made a distinction between translators (who are impartial channels) and advocates (who champion one particular perspective). The case studies suggest that while translators are effective at feeding research into policy making, external advocates can also play a significant role in enhancing the chances of research feeding into policy.

a. Opening policy windows

The Green Chemistry case study shows how advocates' ability to champion can open policy windows and put something on the policy agenda. The Green Chemistry project was set up to encourage the reduction and removal of certain harmful chemicals in household substances. The main strategy was to use market forces to change policy, by helping customer and consumer groups to demand less harmful product alternatives. Within this strategy, the scientist involved with the project was also working as a translator and advocate, promoting less harmful substances in advance of others. The project had considerable success in achieving the phase-out of a number of hazardous chemicals, not only in Sweden but in the whole of the EU.

b. Competing with other evidence

The Fisheries and Climate Change case studies highlight how important advocates are when scientific evidence is competing with other, less challenging evidence and when the timescale of a problem is in the future. In both cases, the science was pointing towards the need for significant changes that will affect the lifestyles and livelihoods of people now, in order to safeguard the future. This scientific evidence was competing against social and economic evidence, which is often more vivid and compelling. The NGOs helped bring the scientific data to life, demonstrated that there was support for action, and created the political space for policy making that has been crucial in encouraging decision-making based on this evidence.

They might, however, bring potential problems into the process too. In the case of the Eutrophication study, as well as scientists themselves, the advocates also included the mass media. While they were undoubtedly effective in putting the issue on the policy agenda, their role was potentially problematic. While scientific opinion was unresolved at that time, the mass media got behind and championed one particular perspective. As a consequence, it is possible that the decision space created by the media could have been too small to allow the right decision to be made – the policy makers might have felt forced to satisfy the media cries, even if that meant basing a decision on the wrong scientific advice.

The Eutrophication case study clearly shows that unprofessional, biased media coverage of important environmental issues can cause great harm to policy processes important to society. The media has a lot of power to influence public opinion and a free press is an important part of a democracy. However, it is also important that journalists take responsibility for what they write on scientific results. The coverage of environmental issues needs to be well balanced and professional for fruitful policy

processes to take place.

The Green Chemistry project provides an example of where advocates have used the opportunity to influence public opinion via the media to speed up the policy process.

Wider contextual/scientific issues

As we have already argued, getting the communications right is important, but it is not the only factor involved in helping research feed into policy making. A range of other, often external, factors are also important. The case studies have shed important light on these factors, generating a number of lessons about the wider context within which the science-to-policy process takes place.

1. Policy making structures must exist

First and foremost, the structures to make policy in a particular area must be in place. While this is taken for granted in northern European, this is not necessarily the case in many other parts of Europe. For example, in the Fisheries case study, we found that although there is a growing body of scientific evidence that indicates the need for quotas for tuna fishing in the Mediterranean in order to maintain population levels, it was not always clear that policy makers with interests in such issues exist in some countries.

It is also likely that such a policy vacuum exists more commonly for new and emerging areas of science – such as synthetic biology – which should be on the policy radar but is yet to find a policy home (due to a lack of appointed policy departments or personnel responsible for the emerging issue).

In these instances, a piece of research evidence could meet all of the other 'success criteria' listed, but would still find difficulty in having an impact upon policy because there is no receiver of the information on the policy side.

At the same time, we need to recognise how policy making has evolved over the past 40 years, with scientific evidence playing an increasingly important role. Policy makers have been on a steep learning curve and as a result structures and processes are being put in place and constantly improved, and this is likely to continue for the foreseeable future.

2. Status and quality of the science

Provided there are policy structures in place, the status of the science appears to be a significant factor in dictating its success in influencing policy. Previous sources have identified the importance of the credibility of the science and the scientists themselves. But the case studies detailed in this report identify a nuanced interpretation of 'credibility' that touches on questions regarding the handling of uncertainty: credible science appears to be agreed science.

Take the example of the Climate Change case study, which looked at the work of the IPCC. The first evidence that concentrations of carbon dioxide (CO_2) in the atmosphere were increasing emerged during the 1960s and 1970s and was published in the scientific literature. But the IPCC wasn't established to provide decision-makers and others interested in climate change with an objective source of information until 1988. Furthermore, despite the panel producing regular reviews of the science and pointing to the increasingly urgent need for action, it took the publication of the fourth

assessment report in 2007 (which gave a 98 per cent certainty that climate change was man-made) to generate a seriousness amongst the policy making community that hadn't been seen before. Up until then, the issue was seen by many as being contested and so, outside the main environment departments, could be overridden by more pressing economic evidence.

If this is compared with the story presented in the Fisheries case study, where scientific evidence is constantly trumped by other evidence, or with the Eutrophication case study, where controversy amongst scientists is leaving policy makers unclear how to act, a picture emerges of a clear need for consensus if a particular area of science is to compete with other sets of evidence. Consensus was also the motive behind the independent international scientific assessment of current knowledge about the environmental problems in the Baltic Sea commissioned by the Swedish Environmental Protection Agency (SEPA). However, the process lacked some of the features of the IPCC process, including clear statements of uncertainties and the level of consensus in the group of experts. The Fisheries case study also shows a similar assessment function in the long-established organisation ICCAT. In this case, the conclusions presented by the ICCAT scientific committee on the status of the blue fin tuna stock were not respected when it came to distributing the total allowable catch between countries. This may partly be explained by the low quality of the monitoring data but is also an example of where the asserted uncertainty has been used by individual member states to gain advantages in the negotiations that take place to distribute the quotas – a classical tragedy of the commons. The interesting question is will more precise data make a difference in the future? The previous management failures with other common migratory fish species suggest few options other than strong legal enforcement, precautionary low quotas and sanctions. However, the obvious lack of trust between the scientist/policy maker group and the fishermen also points to a need to consider well-planned communication actions as an important part of the solution.

It is perhaps unsurprising that public policy needs to be based on sound evidence. But it is also problematic for two reasons. Firstly, it doesn't recognise that this is how science works. When scientists contest one another's work, policy makers might see two groups of scientists who are so unclear about which one is right that they conclude that both bits of science must be unreliable. In reality, what they are watching is a fundamental part of the scientific process and part of the checks and balances that are so important in moving science forward.

Unfortunately, if policy is to be based upon the latest science, then policy making will often need to make use of this contested 'science in the making'. It is therefore important that policy makers are helped to understand this and are equipped with the knowledge and skills to be able to negotiate these debates and to judge when the contested science can be useful.

At the same time, however, scientists don't need this debate to be entirely public. In most cases, there is considerable shared ground between the different camps and scientists can work with one another on areas where policy is needed. This will allow them to find demonstrable shared ground and to explain more clearly to policy makers where the balance of opinion lies, as was the solution in the Eutrophication case study.

3. Significance

The issue that the research addresses needs to be significant to catch policy makers' attention – it needs to be on the wider public or political radar, or needs to have the potential to impact upon such an issue.

The Ecosystems Services Approach case study provides evidence of this. Developing

an ecosystems approach forms the basis of one of two cross-governmental Public Sector Agreement (PSA) targets that Defra is responsible for. The research programme was commissioned as part of the department's Action Plan for delivering the PSA target and so the importance of the research to policy making was evident from the start.

4. Timeliness and windows of opportunity for policy change

Policy windows are transitory opportunities during which the likelihood of adopting new policy is greater than usual because of a change in political context or because a new problem captures the attention of governmental officials and those close to them (Kingdon 1984). Research that produces results at opportune moments, when (or before) policy windows are open, is likely to have more impact too. For example, contrast the impact of the Small Talk project, which was looking at attitudes to nanotechnology at the same time as the UK Government was making policy in the same area, with the research considered in the Fisheries case study, which could not even find a policy home. Alternatively, consider the different impacts that the third and fourth IPCC reports made – the fourth coming shortly after the Stern Review and while the US presidential candidates were developing their campaign messages and the UK Government was drafting its Climate Change Bill.

It is however possible to create open windows in ongoing policy processes, particularly those policy processes taking an adaptive management approach (Holling 1978). For instance, we have already mentioned the role of advocates in opening policy windows. But the MISTRA case study also demonstrates how the funding of the Marine Research on Eutrophication Programme (MARE) and the Swedish Water Management Research Programme (VASTRA) was timely in respect of the implementation of the EC Water Framework Directive in Europe. The results and tools produced by these programmes were used in the policy process.

It also has to be acknowledged that both research and policy processes sometimes take time to be successful. In the case of science, debate and scrutiny of the results are necessary parts of the process for reaching scientific consensus. In the case of policy making, these time constraints are often the result of the democratic process. While not wishing to short-circuit democracy, effective planning and a thorough understanding of these processes can help researchers navigate more effectively through these channels. For instance, tools such as scenarios can help summarise knowledge or make a timely assessment of present research for policy makers.

In the case of the slowly evolving policy process that led to the Baltic Sea Action Plan (Eutrophication case study), the scientists involved where very frustrated that things were moving so slowly. But in the end they also realised that all the small steps were necessary for the countries involved to develop mutual trust and negotiate the final document.

5. The wider public agenda and competing or reinforcing perspectives

Alongside all of these issues, the wider public agenda within which the policy or research sits is of vital importance. Is it on the media's agenda and are they taking a particular position? Where is public opinion on the matter and is there an NGO championing a particular perspective? Are there wider values or issues at play with which the research or evidence interacts, conflicts or complements?

As we've mentioned above in the Fisheries case study, scientific arguments often find it difficult to compete with economic arguments. Conversely, when the economics are on your side, they can add much power to your perspective. For example, the UK's Stern review concluded that acting to stop climate change would have less risk to the economy than not acting. This has been a powerful catalyst for pushing evidence such as the IPPC report into the mainstream policy agenda and encouraging policy makers across government to act upon it and seek further research findings in this area.

Imagine the scene once again...[2]

'Professor Lowther, the world expert on methane production in ruminants, has been asked to speak to the cross-governmental climate change mitigation committee when they consider strategies to reduce carbon emissions from farming. He explains that he has recently published a paper that contains many of the answers the policy makers need. He has brought copies with him, but as it quite long and technical he has also written a one-page summary and offers to run through the key points at the meeting, inviting the audience to ask clarifying questions. The policy makers listen carefully to the interesting presentation and, with this knowledge, have a valuable discussion of the various policy options. Afterwards they all agree that Professor Lowther was a very useful person to have involved and ask if he would keep them up to date with any future developments.'

'Ministers are meeting to develop a policy, based upon the latest science, to stop the spread of sudden crop mildew syndrome. This is a new field but its two leading scientists are there to give advice. Although they have recently published papers arguing for different policy solutions, the two scientists focus the discussion on the areas of science that they agree upon and the science that the policy makers can be most confident about. At the end of the discussion the scientists and policy makers were clear that the science didn't point to one single solution. They agree that wider evidence of the effect each policy would have on local communities, jobs and the wider environment also needs to be considered, and the policy revisited when any further scientific evidence emerges.'

[2] As before, these example scenarios are stories created for illustrative purposes only and do not describe actual people or their actions

‘Dr Jabonski has recently worked on a project to help inform policy making. The policy makers are very interested in the outcomes and ask Dr Jabonski to produce a summary of her work. Dr Jabonski is too busy to write something for the policy maker so she sends the technical summary from the report she is drafting. The policy maker isn’t satisfied so employs a science journalist (translator). The translator succeeds in making Dr Jabonski aware that although the policy makers want to understand her conclusions, they have a limited knowledge of the subject. Together, Dr Jabonski and the journalist spend time discussing the shape of the research and the findings with the policy makers, so that they are able to make the best use of it. The policy makers believe that colleagues in other areas of government would find the research useful so they commission the science journalist to write a piece about the project to bring the research to life for those who haven’t been so closely involved. At the end of the project, the policy makers are well aware of the findings and have used the research in their recent review of policy in the field.’

Annex 1. Methodology

Literature and current practice review

As extensive literature on the environmental science-policy process and experience to date already exists, we conducted a brief literature and current practice review to identify the 'state of the playing field' at the start of the project. This helped us to ensure that this work is based on the widest possible understanding and knowledge of the science-policy communication arena, is not constrained by the personal knowledge of the team and does not simply 're-invent the wheel'. It also allowed us to complement previous and ongoing work. Our review noted a number of previous recommendations for improving the science-policy process. These recommendations formed an important framework for our selection and analysis of case studies, allowing us to take a good look at how a range of these recommended approaches are working in practice.

Inception survey

During the inception phase of this project we developed a simple stakeholder questionnaire, which was widely distributed by email to 170 contacts involved with either scientific research or environmental policy. These contacts were drawn from the team's networks, provided by the Environment Agency, and from literature and web searches. This allowed us to confirm that the assumptions about science-policy related communication drawn from our literature and current practice review were correct and that our ideas about possible case studies reflected those of the wider stakeholder group.

A synthesis of the survey responses is provided in Annex 4. The responses were enlightening and useful in informing our case study selection. However, response numbers were limited to a total of 16 completed questionnaires returned from 170 stakeholders that were contacted. We believe this was due to a number of factors: the impersonal nature of the survey mail-out; language constraints among non-native-English speakers who find the questionnaire more time-consuming to complete; and the pre-Christmas workload of many professionals.

Inception survey interviewees were invited to view our inception report on a Ning website that was developed for use as a forum for stakeholders of the project, so that they could see how their input had aided its development.

Case study selection – a process in three steps

To help us learn and draw conclusions as effectively as possible from previous experience, we used the literature review and inception survey as key starting points in setting criteria for selecting our case studies. The major condition for selecting case studies was that they should provide sufficient information and learning about the constraints and opportunities of promising (and less promising) science-policy communication processes and methods. We felt it was important to unpack evidence from both successful and unsuccessful processes in order to develop a meaningful set of lessons that highlight practices to promote and to avoid. The communication processes illustrated by the case studies relate to the nature of the environmental problem at hand (regarding aspects such as complexity of the problem, range of scale) and to the societal/political context in which the problem is managed.

First step – fundamental conditions

- A science-to-policy process that is mature enough to offer lessons.
- Information available – ease of accessing information and people, contacts, availability of subject knowledge, language, case study reviewer available and so on.

Second step – two main criteria

- Themes – mainly identified environmental problems and the related policy-making processes, but policy making processes from other sectors of society also considered.
- Communication processes – various communication techniques employed.

Third step – spread of

- Degree of success in the science-policy communication.
- Range of geographic scales – local, national, regional, European, global.
- Range of political contexts – multi-lateral, central or local power in policy decision-making, or multi-layered.
- Types of science-to-policy processes – slow or fast emerging environmental issues.
- Range of complexity of issue.
- Range of sectors involved – such as agriculture, forestry, chemical industry, citizens.

We created a matrix table to gain an overview of the status of each of a 'long list' of potential case studies. We then 'scored' these prospective studies according to the criteria above. We ranked the long list based on these scores to highlight the top candidates for investigation. These top candidates seemed most likely to provide sufficient information and learning about the constraints and opportunities of promising (and less promising) science-policy communication processes and methods. We carried out five in-depth case studies, but recognising that this number was unlikely to cover the full range of combinations of the above we complemented these main case studies with mini-case studies that drew on a wider range of experience.

Case study methodology

The first step in each case study investigation was to develop a narrative of the communication issues and events associated with each study from the literature sources. These were then added to and refined through interviews with the key stakeholders involved. Producing a draft narrative before carrying out interviews enabled us to focus our thoughts efficiently, as well as guide our interviewees in considering the type of issues that were relevant to this project. As our case studies were investigated by several different people, we developed a 'how to' guide (Annex 5) detailing the steps required to undertake our case studies. We also developed a stakeholder interview guide (Annex 6) to ensure that our interviews were focused, efficient and generated the information needed to develop a meaningful set of lessons and to allow us to make comparisons between case studies. The stakeholder interview guide detailed the scope of the questions to be asked during interviews and was aimed at drawing out the science-policy narrative from our interviewees for each case.

One of our case study narratives was developed by Melanie Smallman, who was

closely involved with the process in question as a translator, so we felt that this case required independent verification by someone outside of the process to confirm its objectivity. To this end, an LTS colleague, Suzanne Mawson, conducted the interviews of stakeholders involved in the process in order to ensure that they believe the case study we have produced is a fair and objective reflection of the communication process.

We had originally planned to conduct the case study interviews as a mixture of telephone, email and face-to face meetings. However, as interviewees tended to be extremely busy and/or, overseas, we conducted all of our interviews by telephone, which seemed the most appropriate fit for our stakeholders' schedules.

Analysis

Once the case studies were finalised, each core team member reviewed each case study and made their own key observations from their perspective. As we all have different perspectives and backgrounds, we believe that this allowed us to make the most of our case studies. We then cross-compared the case studies to isolate themes and patterns before synthesising the main lessons and generating the overall recommendations and guidelines.

Annex 2. Literature and practice review

Summary

The main barriers to successful science-policy communication relate largely to the nature of environmental science, the nature of policy making and the gap between them. Identifying what is ‘normal’ for each is an important starting point in understanding how the two can be made to work more effectively together.

The nature of environmental science

1. Complex issues, many linkages to different issues and disciplines.
2. Pure science often does not account for broader contextual considerations.
3. Scientific findings are often inconclusive or only relevant under very specific conditions (not ‘real life’), making them ambiguous and uncertain, with a large ’it depends’ factor.
4. Results may be broad but not specific – ‘it is a problem for the environment’ rather than ‘it will have X impact by Y date, and this is what the solution is’.
5. Good science often takes time and typically involves significant debate.
6. Scientists are good at communicating with other scientists but often poor at communicating with others.

The nature of policy making

1. Policy making is influenced by politics, which means there are ideological controversies, opposing views and vested interests.
2. Decisions are influenced not simply by science, but also by economics, public opinion and political priorities.
3. Policy makers cannot easily access science and often do not understand the nature of science (especially in terms of the importance of debating scientific outcomes and of uncertainty).
4. Policy making requires (or at least prefers) certainty of evidence, often within short timescales.
5. Policy problems are often poorly communicated to science; policy makers are rarely involved in shaping research questions.

The widespread recognition of these problems, and the consequent impacts on effective policy and practice, has lead to real efforts to find solutions. Our review notes a number of recommendations for improving the science-policy process. These can be largely grouped into the following categories.

Increasing interface between scientists and policy makers: There is widespread agreement that scientists and policy makers need to increase and sustain their interactions, through partnership agreements, targeted forums, advisory groups and so on. This can help the two parties to understand better each others' working processes and improve the direction, quality and impact of science on policy.

Use of translators, advocates and networks: Numerous studies recommend the use of intermediaries who can 'speak both languages' and compensate for the differences between science and policy making processes. These intermediaries can come from policy makers employing in-house scientists or from external organisations. Either way, this approach can ensure that research results are targeted and specifically brought to the attention of policy makers.

New skills, tools and roles for scientists: Better understanding of policy making processes and influences and how their science can be related to policy; including multi-disciplinary policy issues and interdisciplinary working skills and stakeholder consultation more in research; better skills in communicating with non-scientists. This can all help scientists better target their research findings to where it can have policy influence.

New skills, tools and roles for policy makers: Better understanding of science and research processes; reinforcing roles and skills in identifying research needs and in strategically procuring and shaping research; better skills in interpreting research findings. This can all help to ensure that the research findings are what policy makers need and understand.

Main Review

Introduction

Underlying the objectives of this study for the SKEP (Scientific Knowledge for Environmental Protection) ERA-NET is the goal of making environmental decision-making processes more effective, and to improve the accuracy and quality of outcomes so that implementation is more successful. This objective is based on the existing knowledge that communication between science and policy is often ineffective, and that science can be a weak factor in informing policy. It is important that environmental decision-making is well informed by science. As well as highlighting emerging issues, the potential value of improving the use of science in policy decision-making processes is to avoid inadequately informed and incompletely deliberated decisions, which can result in unnecessary costs, social conflicts and mistrust of the government. This Literature and Practice Review highlights some of the general conclusions concerning barriers to effective science-policy communication, as well as recommended ways to overcome these barriers. The review also brings in some key concepts and ideas that will inform our case studies and help us to explore examples of good practice in the communication of emerging environmental issues in the policy arena.

Why does communication between science and policy often fail?

Several explanations are noted in the literature for the limited use of scientific knowledge in environmental policy making and the difficulties of translating science into policy.

1. The nature of environmental issues

Environmental problems are complex and their causes are deeply interwoven with processes supporting the structure of society, in the activities of institutions, organisations, companies and in the everyday life of individual citizens. These causes are seldom readily observable by the public, and cause-effect chains are often obscure and poorly explained (Leeuwis 1999; Lundgren 2000; Lafferty and Meadowcroft 2002).

Decisions affecting environmental processes are among the most challenging for society to process, due to the following attributes:

- structural complexity
- multiple, conflicting and uncertain values
- long time horizons
- open-access structure
- incomplete and uncertain knowledge
- high stakes
- time pressure.

(Funtowitz and Ravertz 1992; National Research Council 1996; Dietz and Stern 1998; Renn 2003).

The National Research Council (2003) points out that a further challenge is in addressing the linked nature of environmental processes and environmental decisions across time-scales, physical scales and institutional scales. Researchers and policy makers have only seriously considered this challenge in the past decade (Cash and Moser 2000; Young 2002; Berkes 2002).

When it comes to solving environmental problems, there are limits to the extent that science can provide the evidence-base required for policy making (Mulgan 2003). Science, by its very nature, is inadequate on its own to deal with the complexity of environmental policy making (Fahey 2005).

2. The nature of science and the professional culture of scientists

Science is a puzzle-solving process, focusing on formulating and exploring problems that can be solved within existing scientific paradigms (Kuhn 1970). Pure scientific studies seldom take broader contextual considerations into account, since scientists are experts on specific, narrowly-defined areas. Scientific findings are often inconclusive, in that they only explain a ‘small part of the jigsaw’ and are relevant only under specific instances. They are also subject to academic debate and uncertainty. Whilst this may be adequate for specific technological problems (Sorrell 2006), it is typically insufficient as an evidence-base for the broader perspective of policy making (Levitt 2003; Mulgan 2003; Fahey 2005).

Science does not provide guarantees as additional research can always be carried out to clarify environmental problems, as well as their origin and solutions. Uncertainty, debate and discussion are important parts of the scientific process, especially in relation to new and emerging scientific issues – it is this testing process that produces

good science. There may be broad scientific awareness and agreement upon the fact that a process or phenomenon is harmful to the environment, but the degree of consensus decreases in relation to questions about how harmful it may be. This disagreement may be critical in relation to questions about what to do about the problem. In this case, scientists as well as politicians are carriers of values and preferences (Lundgren 2000).

To try to make science useful and accessible to policy and public, scientists may oversimplify results and conclusions, and downplay ambiguous results and uncertainties. In this situation, important contextual information can be lost and the image of science as an authority can be distorted (Wynne 2001; Shackley and Wynne 1996).

Though the importance of communication with politicians and public is recognised by research funders and within research institutions, traditional measures such as the number of published scientific articles are given priority when judging the successfulness of a scientific career. Therefore, scientists are generally poorly motivated to contribute to policy, since qualifications like communicative skills and reports written for non-academic target audiences are hardly taken into account at all (Jöborn *et al.* 2007). As a result, scientists often do not understand or consider the processes of policy making, and find it difficult to relate their research explicitly to political priorities (NAO 2003).

3. The nature of politics and the professional culture of policy makers

The world of politicians is far from uniform. Governments and governmental institutions with responsibilities for managing the diversity of environmental problems are characterised by fragmentation, segmentation and ideological controversies. There is also insufficient co-ordination within and between different political levels, countries, institutions and departments (Lundgren 2000).

Politicians often cannot base decisions on scientific evidence alone. They have a challenging job of balancing competing economic, environmental and political priorities with public opinion. Consequently, they often base their decisions on a much wider evidence-base than science alone. For example, policy recommendations for systematic changes in managing environmental issues in society often collide with forces that are interested in maintaining the status quo and result in resistance from powerful parts of society who see their investments being threatened (Caldwell 1970; Wildavsky 1979; Dale 2001).

This may explain why science seems to only have a successful influence on policy when research results correspond with public efforts and interests (Lawton 2007), and why policy development is often informed by economic factors more than by scientific findings (Levitt 2003; Hindmasch 2006).

Box 7. Scientific evidence losing ground against economics and society – an example.

A concrete illustration of this point has been developed by Ruth Levitt (2003) in her study of factors informing UK policy on genetic modification (GM). The 2003 GM debate purported to take into account scientific evidence, economic evidence and public opinion. However, the scientific evidence was insufficient or inconclusive, so the policy was eventually based on economic factors and public scepticism. Levitt argues that there is no linear relationship between evidence, policy and practice; the evidence is often glossed over or selectively reinterpreted based on stakeholder interests, with complex factors coming into play to determine this process. Because research science is rarely very accessible to non-scientists, it is hard for policy makers and the public to understand that shifting ideas are about working through theories, not simply incompetence or personal agendas. But these uncertainties, debates and discussions are problematic issues for policy makers, who prefer certainty for 'evidence-based policy' (Shackley and Wynne 1996). This can contribute to emerging scientific ideas being rejected by policy makers as too risky or inconclusive (Lawton 2007; Rayner 2006).

Policy making contexts can also vary, from stable policy areas to emerging or novel policy fields. Emerging issues are where new policy needs to be made and policy makers often need to make the policy based on science that is still being debated by researchers and that requires more research. Mulgan (2003) points out the importance of acknowledging the limitations of evidence-based policy making within these contexts. He points out that democratic will cannot be ignored even if it lies contrary to existing evidence; that full revelation in political decision making, while appearing to be open and trustworthy behaviour, runs the risk of undermining mutual respect and can be counter-productive; and that researchers and policy makers work on different time-scales – while researchers are thinking in terms of long-term societal gains, policy makers have a short-term need to meet public demands. The difference in the length of timescales relevant to policy making and research also contributes to policy makers using non-scientific evidence in making their policy.

The picture we have derived from the literature is consistent with the findings emerging from research by Holmes and Clarke (2008) and from other recent studies of environmental ministries and regulators across Europe. The underlying currents that determine the everyday actions of researchers and policy makers are not appropriately aligned, particularly in relation to strategic research aimed at underpinning future policy making. However, there is widespread agreement that better policies can be made if they are appropriately informed.

How could science better inform and influence the policy processes?

Clearly, neither the worlds of science nor policy are able to deal with environmental problems on their own. Communication, cooperation and mutual support (not only among scientists and policy makers but also between these two groups and other stakeholders and the public as well) is necessary for enhancing the science-into-policy process. Both groups need to learn more about the conditions and professional world of the other.

The work by Holmes and Clark (2008) looked directly at how to improve the effectiveness of science for informing environmental policy making, and is an important foundation for this study. Holmes and Clark make four practical recommendations: developing a stronger role for policy makers and their advisers in developing research questions and agendas; making it easier to find and access relevant experts and previous research and advice; strengthening interpretation capacity across the science-

policy interface, developing skills and providing an attractive career path; and developing the policy community as more discerning customers for science and providing more 'policy pull'.

Box 8. Overcoming communication barriers between science and policy (Holmes and Clark 2008).

Holmes and Clarke (2008) found that contact between science and policy needed to be improved, so that scientific evidence could be used much earlier in the policy process and
policy makers could be involved in establishing research priorities. Without this interface, policy makers have a tendency to ask the wrong questions of scientists, or the right questions in the wrong way – questions that are not big enough or in the right timeframe for research to consider, or framed using a particular model or perspective. Currently, research often doesn't produce policy-relevant outputs. Also, publishing research in academic literature was not sufficient for policy makers to be able to access it. For many policy makers, peer reviewed journals are too specific and they don't have the time to read sufficiently widely. Furthermore, many government departments do not have access to electronic journals and so much academic literature is unavailable, unlike grey literature, which is much more easily accessed. Added to that, there is a question of style and tone, with policy makers preferring material that is written specifically from a policy perspective, in plain language. This, Holmes and Clarke (2008) conclude, highlights the need for translators to work as intermediaries between scientists and policy makers. Other questions raised by the research involve access and quality. How do policy makers judge whether research or researchers are good? How do they find the right scientists to take advice from and vice versa?

Use of translators

Scientific translators are widely recommended in order to compensate for the differences between the two realms of science and policy. In-house scientists, working alongside policy makers, often act as translators and should be trained in briefing and communication. A similar role, recommended by Nutley (2003), could be played by intermediary bodies helping to improve research findings.

Box 9. Translating science for policy – an example.

In the UK, a Chief Scientific Adviser has been appointed for each government department, with responsibility for ensuring the quality and effective use of scientific evidence in policy making.

New roles and skills for scientists

Holmes and Clark note the need for scientists to make their science more accessible, to develop science-policy communication skills and to make this part of their career path. Numerous reviews support this, pointing out the importance of encouraging the development of new tasks, skills and a somewhat different role for scientists.

Better understanding of the culture of politics: Scientists need to understand that their special areas of expertise are not always at the top of the agenda for policy makers. They need to learn more about the world of policy decision-making in order to take into account and appreciate that policy makers have many interests to consider. (Letey 1999; Lawton 2007). In this way, they can better link their research outcomes to policy priorities.

Broadening research questions and increasing interdisciplinarity: Through a better

understanding of the nuances of policy making, scientists can take policy needs into account in formulating research projects. This will help them to consider how research can approach questions relevant to policy and thereby support and contribute to policy processes (Letey 1999; Holmes and Clark 2008). This typically means increasing the interdisciplinarity of scientific research, collaborating with scientists from different fields (Norse and Tschirely 2000), and consulting stakeholders and including their perspectives (Hindmarch *et al.* 2006; Fahey 2005).

Increasing scientists (responsibility for) collaboration and communication: Scientists typically require improved skills (training) in communicating ideas and results to non-scientists. Up-to-date overviews and syntheses of current knowledge in relation to policy questions should be readily available for policy makers (Holmes and Clark 2008).

New roles and skills for policy makers

An important condition for more effective use of science in policy processes, which is discussed in several publications, is that policy makers also need to learn more about the professional culture of scientists (Alario and Brun 2001).

Increased collaboration between policy makers and scientists: The nature of scientific problems means that environmental decisions must often be based on emerging, uncertain or insufficient evidence. Consequently, collaboration and communication between those delivering the evidence and those who are supposed to use it is necessary (Fahey 2005). The more policy makers know about the way that research projects are designed, research questions formulated and research findings interpreted, the more informed will be their judgements about the relevance of these findings to policy.

Thus, there should be opportunities for researchers and policy makers to transparently discuss research processes, and the usefulness of models and results (including uncertainties, timescales) (Bradshaw and Borchers 2000; Letey 1999; Wynne 2001). Nutley (2003) recommends sustained interactions between policy makers and researchers through partnership arrangements, and suggests that this can increase the quality of the research and its impact on policy. This would ensure that Holmes and Clark's recommendations – that policy makers play a stronger role in developing research questions and agendas, become more discerning customers for science and provide more 'policy pull' – are more realistically possible.

Improving procurement of research: A report by the UK's National Audit Office (NAO; 2003) noted that Government departments typically need to clarify their strategic research aims and be more systematic about commissioning and managing research. They also need to be better at using the results of the work they commission.

Box 10. Improving the link between policy makers and science – some examples.

The UK Office of Science and Technology issued their *Guidelines 2000: Scientific Advice and Policy Making* and the 2005 *Guidelines on Scientific Advice and Policy making*. Defra has developed an extensive review and challenge programme, including evidence-based policy making training for civil servants and the setting up of an expert advisory panel (Science Advisory Council). The Royal Society has set up an 'MP-Scientists pairing scheme'. While there is evidence of progress being made as a result of some of these initiatives, a concern remains that there is still scope for improving the link between researcher outputs and policy makers.

Different countries, different contexts

Nash *et al.* (2006) note that policy is the result of interactions between different organisations about the course of action that should be taken. The sum of these interactions constitutes the policy process. The shape the interactions take is a reflection of the wider environment or political context, including aspects such as the distribution of power, the range of organisations involved and their interests, and the formal and informal rules that govern the interactions among different players. Political context shapes the ways in which policy processes work.

It is clear that the political contexts across Europe differ a lot. The requirements for good governance in terms of institutional trust and legitimacy are very important for effective communication between science and policy (Berkes 2002; Gundersson *et al.* 1995). In this respect, countries such as the UK and Sweden are not necessarily typical. Countries have different policy making processes and involve different players at different levels. Some countries have a decentralised policy-process, whilst policy making is purely a central government activity in others. In the wider European context, some policy is also made by the European Commission.

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Annex 3. Case Studies

1. Developing an Ecosystems Services-based approach to policy making

Summary

In this case, the UK Government commissioned research to inform a specific policy objective. Researchers produced an executive summary of their work targeted towards policy makers. However, this policy summary was still too technical and so it became necessary to employ a professional translator. The translator had a good understanding of both science and policy, forming a bridge between the two camps.

Key Points

- The translator carried out a series of dialogues throughout the project between scientists and policy makers; these dialogues helped both scientists and policy makers to understand each other's point of view and move forward.
- The translator had scientific credibility, as well as the communication skills needed.
- The translator was able to produce an overview of the research, identifying and distilling themes and overarching messages, that policy makers could understand and that researchers agreed was accurate.
- Realisation that policy makers wanted policy messages derived from science rather than a deeper scientific message.
- Research programme built between researchers and policy makers jointly.

Background – defining the problem and its impact

The benefits that environmental systems bring to people's lives are traditionally very difficult to take into account in policy making – they are often described as 'externalities' by economists. Over the past decade, policy makers have, however, become increasingly aware of the valuable role such factors play and of the importance in finding a way to consider them in decisions.

In particular, the Millennium Ecosystem Assessment (MA), initiated in 2001, stimulated much thinking in this area. The MA set out to assess the consequences of ecosystem change for human well-being and the scientific basis for actions needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being. More than 1,360 experts worldwide contributed to the MA. Their findings,

contained in five technical volumes and six synthesis reports, provide a state-of-the-art scientific appraisal of the condition of and trends in the world's ecosystems, the services they provide (such as clean water, food, forest products, flood control and natural resources) and the options to restore, conserve or enhance the sustainable use of ecosystems.

The bottom line of the MA findings was that human actions are depleting Earth's natural capital, putting such strain on the environment that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted. At the same time, the assessment showed that, with appropriate actions, it is possible to reverse the degradation of many ecosystem services over the next 50 years, but that the necessary changes in policy and practice are substantial and not currently underway.

As a result of this work, an 'ecosystems approach' to policy making has been promoted. This is a way of looking at whole ecosystems, rather than just individual species or processes, in decision-making and for valuing the goods and services they provide. The aim is to ensure that we can maintain a healthy and resilient natural environment now and for future generations. Defra launched its own ecosystems approach in *Securing a healthy natural environment: an action plan for embedding an ecosystems approach*, which was published in December 2007.

Nature of the issue

The challenge ahead for Defra was to build a greater understanding of how this approach can work in practice and to encourage policy makers across and throughout the different tiers of government to take up the approach. This required a significant change in thinking, language and action.

Policy context

While Defra was committed to embedding an ecosystems approach in policy making, it recognised that this represented a significant shift in approach. It therefore commissioned a programme of research from 2005 to develop a robust interdisciplinary evidence base relevant to an ecosystems approach and to demonstrate how an ecosystems approach can be applied in practical terms through a series of case studies.

Communications history

Given the importance of the research, the policy team at Defra were keen that the findings should be presented in a way that could be easily understood and used by themselves and their colleagues. They therefore asked the researchers to produce an executive summary of their research reports, targeted at policy makers.

After several discussions and drafts, however, many of the summaries were still too extensive and technical. So the policy team decided to involve a 'translator' and employed a professional science communicator to present the key messages of the research to policy makers. The communicator was also asked to produce an overview of the research, identifying and distilling any themes and overarching messages that were emerging.

To achieve this, the science communicator worked closely with the policy team, wider policy community and researchers to ensure that messages were engaging, policy-

relevant and accurate. Two workshops were run – one with policy makers, one with researchers – to test the emerging messages.

To present the findings, including the feedback from these workshops, the science communicator produced three short briefing notes – one presenting the research for policy makers, one that also considered next steps and future research needs for the research community, and another focusing specifically on valuation techniques for the economists within Defra.

Interface between science and policy

Defra has used different models over the past years to link scientists with policy makers. Currently, the primary receivers of scientific information are trained scientists embedded in the policy areas. The embedded scientists can disseminate to policy people – arguably acting as translators of research – but the policy team recognise that there is always a barrier at some stage when moving from communicating with a scientist to communicating with a non-scientist (can be earlier or later). They argue that it's important to have a relationship so that information can be clarified, negotiated and presented in the best way possible.

Throughout the research programme, the Defra policy makers were conscious of this relationship. This is a new area of research and policy and so there was a sense of the two groups 'learning together', such that by the end of the programme the Defra policy makers were on close working terms with many of the researchers.

As well as the nature of the work that necessitated this relationship, the Defra policy makers themselves were former scientists and so understood the way research colleagues worked and their language.

The policy makers at Defra were also keen to make this relationship a key part of the process, with the policy lead in Defra describing it as an ongoing discussion. As part of this, they facilitated two workshops during the 'report back' stage. The first workshop was with a wider circle of policy makers (from within and without Defra). This provided an opportunity to consider the research in a policy setting and to clarify the precise needs of policy makers from future presentations of findings. The views from this workshop were then fed into the second workshop where the researchers themselves helped to shape the key messages emerging from the research for the policy makers.

This discussion with the researchers was also used as an opportunity to clarify messages and conclusions. There were some instances where the translators misunderstood the key points emerging from a particular piece of research – the researchers were able to discuss and clarify this during the workshop. Many of the research projects looked at barriers to adopting an ecosystems approach; some of the stakeholders consulted felt that things needed to be embedded in statute but others disagreed. The policy team gave this issue back to the research community to consider further.

Translators, advocates, networks

The policy team commissioned about 18 projects. While they were keen to look back and review the research projects' outcomes, they were faced with hundreds of pages of information that needed synthesizing. Instead of these extensive documents, they wanted to produce something that policy makers would find useful and something that would be useful for researchers to determine future plans. Something that would provide answers to some key questions: where are we; what can and should we be doing; where do we need to go next in research?

Alongside that, Defra had done some research with stakeholders to determine their understanding of the ecosystem-based approach. The research findings indicated that the language was too complex for non-technical stakeholders to be able to gain a full understanding. There wasn't anything in the middle to bring both sides together. The translator provided summaries of the science that included all the important information but also isolated the key messages.

The policy lead considered the role of the translator important as they 'didn't want to give the deeper "science message" away – we wanted policy messages DERIVED from science'.

Skills of the translator

Despite the existence of 'translators' within the department, an external expert was also brought in. In the views of the policy team, this translator didn't need to know the science, but needed to understand the scientific process or scientific psychology. The expert also needed to think carefully about balancing language, ensuring that the researchers would not be offended by the simplification of their work while the policy makers would receive information in an accessible and understandable way.

At the same time though, such a person should, the policy team argues, understand how policy is made and have experience in the sorts of things that the organisation is trying to do, so that they can understand the policy language, needs and goals too. The translator also needs to understand the political context and subtleties of language, anchoring the science in words that policy makers feel comfortable using, as well as understanding the right way to structure outputs. For instance, the policy makers point out that they like to read the conclusions of research first, but this isn't how scientists are taught to present their research.

Discussion

Key factors that helped the science feed into policy making

Reviewing the story of this case study, we identified four factors that played key roles in feeding this particular science into the policy making process:

1. Significance

Developing an ecosystems approach is a significant challenge for Defra. It forms the basis of one of two cross-governmental PSA targets that the department is responsible for. The research programme was commissioned as part of the department's Action Plan for delivering the PSA target and so the importance of the research to policy making was evident from the start.

2. Timeliness/planning

Again, as part of the research management process the research programme was planned to report back at a policy-relevant time. The research had to be concluded in good time for the next round of policy reviews in this area, allowing it to feed in and influence the process effectively. This planning wasn't always perfect, however – some research projects proved inconclusive or pointed to further research needs, for example, but both sides recognised that this is an unavoidable feature of science.

3. The translator as a discussion facilitator

As presented by the researchers themselves, the research findings were largely indigestible by policy makers. If the research reports hadn't been presented in a shortened format that the policy makers found readable, the programme would have had very little impact on policy.

While the impact of the briefings produced by the translator is yet to be assessed, as insufficient time has elapsed, it is clear that the translator played a different yet also important role in offering new chances for policy makers and scientists to interact and build their understanding of one another. This included through workshops that were primarily designed to clarify the translator's understanding but effectively helped to establish discussions between the two groups.

4. Skills of policy makers

The policy makers involved in this particular case study already had a well developed understanding of the value of the relationship between themselves and the researchers. They were keen to understand the research findings and were prepared to put time, effort and resources into building the necessary relationships and to clarify and perfect the key messages for dissemination.

Issues for further consideration

1. Impact of the translator

The involvement of an external translator undoubtedly had an impact on the relationship between the researchers and the policy makers. For some, this was seen as a good thing –a neutral person to complain about the 'unreasonable' demands of the other party and to mediate to some extent. For others, it provided an added tension – something that the policy makers themselves have acknowledged. Scientists often don't want to simplify things, for fear of losing accuracy, but policy makers live in a constrained world and need key details. On the other hand, the policy makers want clarity where there sometimes isn't any.

The policy makers pointed out that these tensions seemed to disappear when the research is presented in the context of a discussion rather than a 'translation'. The researchers were able to clarify and satisfy themselves that the policy makers had understood the subtleties regardless of the language and the policy makers could more clearly understand when and why their questions weren't being answered.

The policy team also argue that reactions vary from area to area. Often studies that were more policy-oriented in their inception can be communicated more easily or willingly, for instance.

2. Improving scientists' communication skills and their willingness to communicate

One of the messages that come back to us from our interviewees quite strongly is how important it is that researchers have a better understanding of the policy making process, so that they are better able to respond to the needs of policy makers. They also need to develop their communication skills to be able to tailor their language and presentational style to the policy making audience – research won't be taken account of if it's not presented in a style and format that is accessible to policy makers. Sometimes this means compromising on the precise meaning of the research.

This case study also raised the issue of resources and priorities. One researcher, for instance, complained that too much of their time had already been spent explaining the research to the policy team and that they were not prepared to help or check the work of the external translator without further payment. Attitudes such as this can act as a barrier to getting science into policy.

3. Resources for policy makers

Looking at the example above from a slightly different perspective, it raises an important point about whether the duty should always be on the scientists to simplify their work or whether there is an issue about policy makers' skills, knowledge and resources. When dealing with complex areas of policy with strong scientific underpinning, perhaps it is reasonable for scientists to expect greater parity in understanding with policy makers – perhaps some things can't be explained in two pages of bullet points.

In the UK, part of the push for this distillation comes from the current UK civil service model which requires policy makers to move role every 18 months to two years. In this context, non-technical summary briefings are essential. But this is important research in support of an important policy area. It is possible that a more extensive understanding of the subject and evidence base might generate different thinking and policy direction. Rather than considering the need for new skills or roles for policy makers, as suggested by current literature in this area, it is arguable that we should instead consider how the policy makers can be given sufficient time and motivation to build a much deeper understanding of the evidence than can be provided by a summary briefing.

2. Climate Change policy making and the role of the Intergovernmental Panel on Climate Change (IPCC)

Summary

The IPCC has been successful in finding a way to provide an overview of scientific evidence that is both scientifically accurate and relevant to policy. It has developed a clear and transparent system for dealing with the uncertainty and lack of consensus regarding particular pieces of evidence, which has helped develop credibility and trust. It has created a system that has given scientists direct access to government, and provided clear incentives for both scientists and policy makers to be involved in the IPCC's work.

Key Points

- The IPCC increased the interface between science and policy.
- The IPCC functions as a translator by gathering all the credible evidence together in one place and providing information on the level of consensus for this evidence. However, the IPCC are not advocates, and interviewees felt that this would be an inappropriate role for the IPCC as it has to remain independent, objective and policy neutral.

- New skills/roles for scientists include producing policy-relevant material such as Technical Reports that tell policy makers what action to take given the evidence provided in the Assessment Reports.
- New skills/roles for policy makers in producing policy summaries based on scientific evidence, getting involved in the process of review and appraisal of scientific evidence, and directly commissioning research to answer policy-driven questions that are generated as part of this process.
- IPCC processes are dynamic and adaptive, with the IPCC active in addressing areas identified as needing improvement. This probably helps with engendering goodwill as well as allowing processes to evolve and improve.
- Translators are required and should be involved early on.
- Timely reports coincided with other important communication events about climate change (Al Gore, Stern Report).
- Serious notice of the IPCC was only taken by policy makers when a high level of consensus and certainty was reached. Until the fourth report, which gave a 98 per cent certainty for climate change being the result of man's actions, credibility was still given to the climate change deniers.
- Government buy-in and the United Nations (UN) umbrella have also increased the IPCC's credibility.
- Wider context – the IPCC has had increasing impact as climate change rises up the wider public agenda, through the work of NGOs, media and (very importantly) Lord Stern.

Background – the nature of the problem

Human activities have caused the temperature of the Earth's surface to rise rapidly since the late 1800s and this trend is expected to continue unless action is taken to curtail damaging activities (http://unfccc.int/2860.php). All countries will be affected; however, impacts will strongly differ within and between regions (Copenhagen Climate Congress 2009), with the most vulnerable – the poorest countries and populations – suffering earliest and most (Stern 2006). Meeting the challenges of climate change is an immense task that requires complete societal transformation (International Scientific Congress on Climate Change 2009).

Science context

The scale of the threat to life on earth suggested by the emerging evidence was unprecedented and this, alongside the huge economic and political implications of the issue, led to controversy over the interpretation of the evidence. As the body of evidence increased and strengthened, a scientific consensus emerged that human-induced climate change was a reality. Today, great uncertainty remains about the effects and scale of the likely impact of climate change. The issue is extremely complex and broad, and, although the preliminary evidence originated from meteorological

research, current research now spans all aspects of the natural sciences, technological sciences, and social, political and economic sciences. Previously, climate change-related research questions were developed solely by scientists, but more recently governments have commissioned research to aid their policy making.

Policy context

In the policy arena, climate change is currently regarded as a serious global threat that demands an urgent global response, including deliberate policy action to motivate the take-up of options to cut greenhouse gas emissions (Stern 2006). Policy interest in the issue is high, and evolving at a range of scales from domestic and regional to proposals for an international level post-Kyoto agreement. Policy makers now influence the shaping of research by providing funding to address specific questions; they are also involved in communicating climate change science to the general public and influencing public opinion.

In addition to building scientific evidence, several events probably contributed to the increasing prominence of this issue on the political agenda: Sir David King (2004), the former Chief Scientific Advisor to the UK government, published an article in which he debunked the idea that reducing carbon emissions will make us poorer as 'a myth', arguing instead that tackling climate change can create economic opportunities and higher living standards. In 2006, Lord Stern argued that although the economic costs of stabilising climate are significant they are manageable, while delay would be dangerous and more costly. Also, extreme weather events, including floods, droughts and storms, are happening more frequently, so that the impacts of climate change are becoming more obvious to both the general public and to policy makers (Stern 2006).

Communication activities, events and history

The role of powerful advocates

The first evidence that concentrations of CO_2 in the atmosphere are increasing emerged in the scientific literature during the 1960s and 1970s. The World Meteorological Organisation (WMO) held the first World Climate Conference in 1979, but it took years more before the international community responded (http://unfccc.int/2860.php). In 1988, the WMO and the United Nations Environment Programme (UNEP) created the IPCC to provide decision-makers and others interested in climate change with an objective source of information. The roles of the WMO and UNEP were critical: these organisations had access to governments and functioned as powerful advocates for the science, facilitating the set up of a panel that represented many nations.

The impact of powerful detractors and high profile champions on public opinion and policy

Although climate change research is frequently published in high profile scientific journals, the issue has often been a point of controversy in the mainstream media. The US media in particular has not always reflected the emerging scientific consensus due to the concerted efforts of a powerful countermovement (McCright and Dunlap 2001). For instance, the Global Climate Coalition (an energy industry lobby group) and a number of 'contrarian' scientists responded to the publication of the second IPCC assessment report, which stated that 'the balance of evidence suggests that there is a discernable human influence on global climate (Houghton *et al.* 1995)', by launching a major organised attack designed to discredit the report's conclusions (Edwards and

Schneider 2001). This countermovement sponsored press conferences and public speeches to promote their position and was highly active in an effort to halt the US endorsement of the Kyoto Protocol (McCright and Dunlap 2001).

More recently, the publication of material such as the *Report on the Economics of Climate Change* in 2006 by Lord Stern, a well respected mainstream economist with no 'green' agenda prior to the commissioning of the report by the UK Office of Climate Change, along with the release of Al Gore's climate change documentary *An Inconvenient Truth* and the subsequent award of the Nobel Peace Prize jointly to Al Gore and the IPCC in 2007, have helped give the issue credibility in popular opinion. The rhetoric used in association with the issue of climate change has also changed over the years. The objective of the UN Framework Convention on Climate Change (UNFCCC), as stated in 1992, may have been to stabilise concentrations of greenhouse gases in the atmosphere at a level that would prevent 'dangerous anthropogenic interference' with climate (UNFCCC 1992). But this sort of language was not popularly used until much later when Sir David King, the then UK Chief Scientific Adviser, convened a symposium entitled 'Avoiding Dangerous Climate Change' in 2005. The word 'dangerous' has been frequently applied to the issue in the media since then, perhaps helping to keep climate change alive and pressing in popular opinion.

The IPCC's communication activities

The IPCC's main communication activities involve producing reports that bring together a multidisciplinary overview of the current state of the science and include a summary for policy makers. Reports are written by scientists and reviewed by policy makers who agree the policy summary line by line. The IPCC does not collect scientific data or carry out scientific research and so is able to provide policy-neutral but policy-relevant resources for policy makers (http://unfccc.int/2860.php) while avoiding claims of scientific bias. In its reports, the IPCC aims to reflect the range of credible scientific opinion and if possible identify a consensus. Where consensus cannot be reached, its role is to summarise the major viewpoints and the reasons for disagreement. In this way, the IPCC performs the role of translator of the current scientific knowledge to the policy community. The IPCC also functions as a bridge between scientists and policy makers. Hundreds of scientists all over the world contribute to the work of the IPCC as authors, contributors and reviewers. Governments participate in the review of IPCC reports and in its Plenary Sessions, where decisions about the work programme are taken and reports are accepted, adopted and approved (http://unfccc.int/2860.php).

This widely inclusive, extremely intensive peer review process has opened up the debate on climate change to a far wider range of actors than is normally consulted within science, creating a fair, thorough and powerful method for reaching consensus on the knowledge required for good policy (Edwards and Schneider 2001). Balanced participation of scientists from all parts of the world is advantageous since policy makers from developing countries in particular question the legitimacy of material exclusively prepared by Northern scientists (Siebenhüner 2003). A small number of countries with clear political or economic interests – the major oil producing countries, for instance – have tried to weaken certain statements in the reports. But this has been minimised by the IPCC's policy of including the name of the dissenter in report texts, which puts them at risk of a loss of reputation and credibility if they cannot provide sufficient technical or scientific evidence for their positions (Siebenhüner 2003). This consensus approach is proving to be a powerful tool for demonstrating credibility and the reports are regarded by most scientists and political leaders as the single most authoritative source of information on climate change and the potential impacts on environment and society (Edwards and Schneider 2001).

Insights from interviews

Researchers and policy makers alike see the IPCC process as successful, with interviewees believing that IPCC involvement speeds up the process of getting science into policy by reducing the lag between production of evidence and policy being made. The IPCC has taken a dynamic approach, with processes evolving through attempts to increase inclusivity and transparency, creating an environment of trust and credibility. Researchers and policy makers both have incentives to take part and maintain the process. It is prestigious for a scientist to be involved in an assessment report as an author or to have their work included in an assessment report. By accepting a report, parties to the convention accept its scientific content, which provides an incentive for policy makers to be involved in agreeing the summary.

Communication innovations – policy makers' point of view

- *IPCC reports provide a broad multidisciplinary view*

The reports combine natural, physical, economic and social sciences, allowing policy makers to access a broad range of current evidence.

- *Policy maker summaries*

The summary is regarded as very useful; policy makers can use it to get an overview of the material before targeting the more specific information they need in the main report.

- *Uncertainty statements (very certain, certain, uncertain) and likelihood of scenarios (likely, very likely)*

Policy makers found the use of ranges instead of simple points on a graph and the qualification of statements with a level of certainty helpful because they indicate the level of consensus among the scientific community about an issue and the level of uncertainty about a piece of evidence. This made it easier for policy makers to develop informed opinions about individual issues.

- *Technical and best practice reports*

Although the assessment reports summarise the current status of the science, they do not discuss how to deal with the issue. The provision of technical reports is seen as a useful innovation because these advise what action to take in light of the evidence.

Innovations – researchers' point of view

- *Direct access to government*

Scientists felt the advantage of having government agents directly involved in IPCC is that when they had something to say via the Assessment Reports, governments had to pay attention. Interviewees felt that this decreases the time lag between providing scientific evidence and policy being made, which they saw as a very good outcome.

Climate science has moved away from 'blue-skies' research. Although new research is still necessary, it is funded by research councils and (within Europe) the EU, who require a full impact statement on policy need. Policy is now driving science and the science produced is a good fit with policy needs. Interviewees see this as a positive step.

- *Inclusivity is likely to incentivise future good practise*

Interviewees believed that the inclusivity of the IPCC process, with countries all across the globe becoming involved, helps foster responsiveness of policy makers to the science, which will help incentivise good practice. Interviewees are hopeful for a post-

Kyoto agreement and feel that the IPCC processes have laid the ground work needed for developing countries to respond positively to the inclusion of best practice proposals in the upcoming negotiations in Copenhagen.

Interviewees' suggestions for how the processes could be improved

- *Scope to increase inclusivity*

Efforts to increase the participation of developing country experts in IPCC processes need to continue and efforts to translate reports into more languages need to increase. The main reports are currently available in six languages, and some have been translated into a further 15 languages. However, local policy makers in many countries speak a different language to those currently covered.

- *Translators earlier*

If translators were employed before draft reports go for review by policy makers this could save time by cutting down the number of potential areas for misunderstanding.

- *Need for advocacy to effect bottom-up change*

The IPCC are not advocates, and interviewees felt that this would be an inappropriate role for the IPCC as it has to remain independent, objective and policy neutral.

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3. Management by Environmental Quality Objectives

Summary

This study discusses the way the MBEO system has been shaped in Sweden as part of ongoing efforts to combine long-term environmental sustainability with relevant policy measures. The Swedish MBEO approach is a general model that facilitates science-policy communication by creating a platform where this can take place.

Key Points

- The MBEO system has been successful in creating a platform for communication between actors from political and scientific spheres who otherwise would not have access to one another.
- Opportunities for systematic reviews of science to take place and feed into policy making on a regular basis is built into the approach, enhancing the possibilities of making science relevant for politicians and *vice versa*.
- The MBEO system is evaluated every four years, creating new policy windows based on the most recent scientific review.

Background

Many European countries use MBEO to guide policy making and to support the integration of environmental concerns within general governance processes. In the MBEO procedure, politicians determine environmental objectives and interim targets, which are then implemented and assessed by environmental officials at local, regional and national scales.

MBEO assumes communication and collaboration between science and policy, both in the process of determining objectives and targets and in the process of monitoring and evaluating the results. This study discusses the way the MBEO system has been shaped in Sweden as part of ongoing efforts to combine long-term environmental sustainability with relevant policy measures. The Swedish MBEO system can be seen as a general model that, at least theoretically, provides and facilitates platforms for science-policy communication. The aim here is to describe the MBEO system and to discuss how it stimulates science-policy communication between the Swedish Government, which has overall responsibility for running the programme, and the Environmental Objectives Council, which has been set up to coordinate efforts and monitor progress towards goals.

The administrative structure of MBEO

Sweden's environmental policy is based on 16 EQOs for different areas that were adopted by the Swedish Parliament in 1999 and 2005. The objectives are very broad, encompassing themes like ‘Flourishing Lakes and Streams’ and ‘Clean Air’, and describe the ecological and cultural qualities that Swedish policy makers agree are required to achieve sustainable development. To make the EQOs more precise, and to establish a tangible framework for progress, the Swedish Parliament has also

formulated a number of interim targets at the national level. These indicate the direction and timescale of the actions to be taken by focusing on concrete environmental objectives. Progress towards these objectives is monitored and evaluated and new interim targets are developed on an ongoing basis.

The Swedish Government maintains overall responsibility for running the EQOs programme. At the national level, the Swedish Government has set up an Environmental Objectives Council to coordinate the efforts and monitor progress towards the goals. The Council consists of representatives of central government agencies (such as the Swedish Environmental Agency and The National Board of Health and Welfare), the Swedish Research Council, county administrative boards, local authorities, non-governmental organisations and the business sector. The Environmental Objectives Council presides over all work associated with the EQOs. The Council's principal roles are to monitor and evaluate progress towards the EQOs, to identify conflicts either between different EQOs or between EQOs and other objectives adopted by the Parliament, to ensure coordinated application of the objectives at the regional level, and to propose indicators for the EQOs.

Every year, the Environmental Objectives Council reports to the Government on how efforts to achieve the objectives are advancing, whether they are likely to be reached and at what speed, and what further action is required. The purpose of this is to identify the most important driving forces behind environmental problems. In turn, the Government reports on how the work is continuing to Parliament, which regularly confirms and approves the measures to be taken in order to reach the goals. Every fourth year, the Council provides the Government with an extended comprehensive evaluation, which is used as a basis for decisions on revising measures and means of control. The comprehensive evaluation reports are used to formulate Sweden's Environmental Objectives Bill.

In cooperation with the Environmental Objective Council, Sweden's 21 County Administrative Boards (CABs) are responsible for monitoring regional goals and making them concrete. The CABs also support the 290 Swedish municipalities in formulating local environmental goals and measurement programmes. These municipalities have overall responsibility for local adaptation of the goals and are expected to undertake the measures required for their attainment. General information about the EQO work, including trends and results, are available to the public through the Environmental Objectives Council website (http://www.miljomal.nu/).

Communication challenges and possibilities

The Swedish MBEO system can be seen as an 'environmental bureaucracy'. Within this bureaucracy, responsibilities for goal setting, defining indicators, monitoring, evaluating and providing feedback is spread among various different sectors and actors, each with different responsibilities, perspectives, experiences, specialities and missions. For the Swedish MBEO procedure to function as a basis for policy decisions requires continuous, well developed and purposeful horizontal and vertical communication, not only between administrators and officials at different levels within this 'environmental bureaucracy' but also between scientists and politicians.

On a local and regional level, several aspects of the communication among actors within the system have been identified as problematic and in need of improvement. For instance, the broad nature of the EQOs can lead to a wide range of interpretations, and misinterpretations, of the measures that need to be taken and in what order. The MBEO approach is quite a recent innovation and is a working model under development, which means there is scope for continued improvements where a need is identified.

On the national level, however, including the work within the Environmental Objective Council, the Swedish MBEO system has contributed to the creation of a platform for communication between actors (from both political and scientific spheres) with different environmental responsibilities, which otherwise would not have existed. The formal process, and frequent reports from the Council to the Government, has built an opportunity to conduct systematic reviews of science, which feed into policy making on a regular basis and enhance the possibilities for making science relevant to politicians.

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4. The Green Chemistry Project

Summary

In this case, communication activities were strategically targeted towards specific audiences at different stages of the process, from motivated potential users of the science initially to mass media and government departments at later stages. The project was driven by two motivated individuals with scientific backgrounds, one of whom worked for local government, and was financed by a local authority.

Key Points

- This project took a bottom-up approach to influencing policy by creating an ongoing dialogue that influenced public opinion. In effect, this project created its own policy window.
- Central to the success of this project was the production of a clear and credible message, which included solutions to the problem and tackled risk and uncertainty by providing clear, unambiguous comparisons between alternative products.
- The drivers of this project functioned as translators and advocates for the science, and were able to communicate on a variety of levels.
- This project was innovative in the way it connected stakeholders that would otherwise have had difficulty accessing one another.
- Clearly targeted audience for communication, driven by well connected and media savvy people. The Green Chemistry project itself looked like a network constellation – it was financed by both business organisations and public authorities.
- This approach could be used with a few clearly defined target groups for other environmental issues. The key approach would be to prepare and engage both industry and consumer groups to show policy makers that there are ways to address these issues that could be supported through legislation.

Background – about the project

The Green Chemistry Project (GC-project) ran between 2000 and 2006 in Gothenburg, Sweden. The initiative was developed by an environmental toxicology consultant working with an environmental engineer from a County Administrative Board (CAB) and was financed by regional authorities. The aim of the project was to replace commonly used products that contain hazardous chemicals with environmentally friendly alternatives. The project strategy was to create public demand by directing consumer groups towards less harmful alternative products and then let the power of the market take over. This project used consumer preferences to build a critical mass of public

opinion concerning the use of hazardous chemicals, which then filtered into policy making and resulted in the phasing-out of a number of hazardous chemicals, not just in Sweden but also across the European Union (EU).

The working model and its communication approach

The working model that was developed within the project contains three steps that overlap and run in parallel.

Step 1 – research and selection of appropriate products

Products that were commonly used, sold in high numbers and that contained chemicals of great danger to the environment and/or human health, where at least one less harmful alternative product was already available on the market, were selected for the project. Detailed research was then gathered, comparing the harmful product against its less harmful alternative for a variety of different criteria including toxicity and product performance. Market actors and their attitudes towards alternative products were also investigated at this stage.

Step 2 – bringing together interested manufacturers with motivated users

While the research stage of this model is often found in surveys of the environmentally important aspects of suspected hazardous products and their use in society, the second step is more innovative and traditional projects seldom take their work this far. The challenge at this stage, according to those involved in the project, was to identify and 'press the right buttons' to speed up the process of displacing the products that are dominating the market with less hazardous alternatives. At this stage, interested manufacturers and motivated users, identified during the research stage, were brought together. The manufacturers were informed about the potential market for more environmentally friendly alternative products and the advantages of investing in their development. Users and consumers were provided with information about safer alternative products and the importance of asking for them.

Step 3 – Providing clear comparative tests and communicating the results

At this stage, attempts were made to influence wider public opinion. Tests were carried out to compare the environmental impacts and technical performance of both the commonly used products and the less harmful alternatives. The testing was carried out in a transparent and unbiased way, providing clear, reliable and undisputable results. These were publicised on websites and at press conferences and other forums that were easily accessible to consumers and policy makers, which facilitated the spread of information. Once public awareness and debate about the product and its alternatives reached a certain critical mass, it became conceivable for policy makers to implement various additional measures. These included: imposing taxes in support of the environmentally friendly alternative products; legislating towards restricting or banning the use of the relevant hazardous chemical; or developing environmental labelling criteria.

The Green Chemistry Project in action – how this small-scale project led to an EU-wide ban on the use of cancer-causing oils in car tyres

In 1994, a report by the Swedish Chemicals Agency and the CAB of Västra Götaland highlighted the fact that many tonnes of cancer-causing oils were being used to

produce European car tyres. The GC-project attempted to catalyse a shift towards non-poisonous oils in car tyres in cooperation with tyre manufacturers located in Sweden. A method for analysing the content of cancer-causing oils in tyres was developed and the results of this analysis published on the GC-project website.

The analyses were costly to perform, so the GC-project instigated collaboration with an insurance company that financed the testing of all tyres of interest on the market. The GC-project published lists of these results, which steadily built mass media interest in the problem. Because of the attention the publications were receiving, and the direct link the project had made with tyre manufacturers, the production of tyres containing less poisonous oils started to grow.

In 2002, the GC-project held a press conference in Stockholm on the problem of cancer-causing oils in car tyres and the possible alternatives, resulting in headlines in several important Swedish newspapers. As a result of this media interest, the Swedish Environment Minister set up an investigation to explore the possibility of a national prohibition on cancer-causing oils in car tyres. However, the investigation showed that this would have little impact since the production and marketing of tyres is international. At the same time, yet another manufacturer introduced a new tyre free from harmful oils and announced that it had started to phase-out the manufacture of tyres containing harmful oils. In 2003, strengthened by the change in policy among tyre manufacturers, Swedish and German politicians joined forces to put the issue on the agenda of the European Parliament, in order to develop a directive against the use of these oils in tyres.

While this was happening, the GC-project continued publishing lists of test results on its website. It functioned as a sounding board for the Swedish Chemicals Agency and tried to influence encourage car tyre producers to replace poisonous oils with less harmful alternatives. The project also arranged a seminar for companies that were large users and purchasers of tyres, which served to raise awareness about the problem and its possible solutions.

Meanwhile, the EU process had got caught up in a discussion regarding which oils should be included in the proposed directive. The GC-project lobbied different groups within the EU Parliament for a directive covering oils that were cancer-causing. In June 2005, the EU Parliament decided to ban all cancer-causing oils in car tyres from 2010 (Directive 2005/69/EC of the European Parliament and of the Council of the 16th of November 2005).

5. Eutrophication in the Baltic Sea – a science-policy communication perspective

Summary

This case illustrates communication issues associated with a slow-moving and complex environmental issue. Key communication activities included dialogues and mediation driven by both scientists and policy makers with translators, champions, negotiators and advocates all playing different roles in pushing the policy process forward.

Key Points

- Controversy arising from disputes between scientists made policy makers unsure about what type of policy was required and hampered progress.
- This case demonstrates the importance of scientists building long-term relationships with policy makers to influence policy successfully. This may be easier when scientists are located in close proximity to policy makers.
- Advocates and champions can be important in highlighting the issue.
- In this case, the media played an important role in informing the general public about this issue, but also hindered communication by enflaming the ongoing conflict between scientists.
- This case highlights the importance of having access to people who perform a translator role in communicating science to policy.
- Timely, strategically-financed, interdisciplinary research allowed the co-production of knowledge and the development of a decision support tool that was useful for the international negotiations leading up to the Baltic Sea Action Plan.
- Strategically linking science with policy through long-term stakeholder engagement and gradually developing translators with well-established networks in both arenas probably helped catalyse recent policy developments.
- It is important to recognise that some things take time, but even small steps are steps forward!

Background – the nature of the issue

Human activities including fertiliser use, transportation of goods and people, and burning fossil fuels result in nutrients being released into the environment. When these nutrients accumulate in water bodies they can cause toxic algal blooms, decreased biological diversity, collapse of commercial fish stocks, hypoxia and anoxia of water

and sediments, bad odours and decreased recreational use of coastal seas.

A complex problem with many actors

More than 85 million people live in the Baltic Sea drainage area and anthropogenic discharge of nutrients into the Baltic Sea has been substantial. The Baltic Sea is very sensitive to excess nutrient discharges because it has almost no tide; so nutrients that find their way into the sea stay there for 30–50 years. This build up of nutrients has been linked with the collapse of fish stocks and massive recurring algal blooms.

Unfortunately, there is no quick fix to this problem. It is a complex issue involving a large number of stakeholders, including farmers, industry and the general public, with potentially competing priorities. This complexity has hindered the development of effective policy instruments, which need to combine and link local, regional, national and international decision-making processes whilst at the same time acknowledging the need for different approaches in different sectors and on different scales.

Key communication events

The science-to-policy communication related to eutrophication as a severe environmental problem emerged gradually over at least the past 50 years. A long and exhaustive series of science-policy communication events finally led to the signing of the Baltic Sea Action Plan in 2007, which aims to protect the Baltic Sea environment. This case study represents a mature policy process in which many related directives and instruments have been developed in recent years. In this case, we explore key communication events that have contributed to, or hampered, this process.

A long-running controversy

The cause-effect relationship and the best way of dealing with eutrophication have been debated fiercely among the scientific community since the 1970s. This controversy has for many years been part of a recurrent media debate that often coincides with the summer holidays, when massive algal blooms occur in the Baltic Sea. Individual researchers, or groups of researchers, have argued about the issue in the comment columns of daily newspapers, putting forward opposing research results as well as their own opinions about the best way to mitigate eutrophication.

For many years, this scientific controversy has frustrated policy makers and left them unsure about which evidence to use in developing policies to address the issue. Policy makers have made several attempts to help scientists overcome this dispute. In one instance, a policy officer at SEPA launched a mediation initiative to try to build a consensus between the scientists involved in the dispute. This mediation was well-planned, with negotiations led by a skilled moderator; however, the results were somewhat surprising since the conflict mainly turned out to be between individual people rather than between ideas.

Science-to-policy research programmes

Although the problem of eutrophication is not a new one, it was not until the late 1990s that social scientists, political scientists and economists started to study the drivers behind the problem and consider possible societal responses. The two strategic environmental research programmes, VASTRA and MARE, involved ambitious interdisciplinary research on eutrophication in Sweden. The Swedish Foundation for Strategic Environmental Research funded MARE, which developed a decision support

tool called the Baltic Nest Model. This programme was jointly managed by a managing director with a translator role, who worked both at a university and for SEPA, and a scientific director, a champion from the fields of ecosystems research and eutrophication science. The managing board of the research programme consisted of key policy makers and scientists. One of the policy makers was later involved in the negotiations that led to the Baltic Sea Action Plan and so the Baltic Nest model decision support tool was introduced into the policy negotiations, forming a direct link between science and policy processes.

Stakeholder dialogues

Recent communication approaches have included targeted science-stakeholder dialogues and targeted forums, as part of the Baltic Sea Action Plan processes, with HELCOM working groups taking a similar approach.

Key roles in the communication processes

The media

The media have taken an interest in the issue of eutrophication ever since the appearance of algal blooms has prevented the public from sailing and swimming in the Baltic Sea during their summer holidays. The media highlighted the issue to the general public, discussed the underlying causes, effects and measures required to deal with it and alerted people when algal blooms appeared. However, they also fuelled the scientific conflict by reporting on it in an unbalanced way.

Translators

Individuals that perform a translator role were involved in all of the processes described above. Usually they were part of an interdisciplinary research team or a trans-sectoral policy group that performed translation-related tasks. They included science advisors and civil servants who summarised and synthesised knowledge about eutrophication, and researchers working on implementation or from a system analysis perspective. Co-production of knowledge and translation of research results into clear, policy-relevant messages were often the result of collaborative work, with translators leading and facilitating the work and then finalising the project summary.

These translators gradually gained the skills to help move this science-policy process forward, though seldom through any formal training. More usually these individuals ended up functioning as translators through the length of their involvement in the process, their position or their networks, as well as their aptitude for the role, rather than being formally employed to perform this function. These translators were successful because of their capability to listen and learn from others, supported by the policy group's capacity to adapt and develop new modes of working. Some of the translators held positions at various different organisations over the years of this process, perhaps going from a university to an authority and then to an NGO, gaining insights into different ways of working as well as building extended networks of contacts.

Champions

Several academic champions played an important role in communicating scientific evidence on this issue to policy makers. Key individuals perceived as having great

integrity in the field built relationships with national policy makers and promoted key scientific breakthroughs to them. Being based in the capital city and regularly meeting with policy makers seem to have been important factors in developing good relations and trust. Scientists based away from the capital had less regular contact with national politicians and key civil servants.

Negotiators

The negotiator in this process was an important receiver and key user of the scientific evidence provided by translators. Once the MARE research programme had combined the efforts of a science champion who had acquired insight into the policy process, a policy maker with a science background working as a translator and a well informed negotiator, the policy process began to move forward. In this case, the scientific evidence provided by translators was fed into the HELCOM process by the negotiator.

Advocates

Several powerful NGOs played an important role in relaying messages about the eutrophication problem to the general public and key stakeholders. Campaigns launched by the World Wide Fund for Nature (WWF) and the Swedish Society for Nature Conservation (SNF) received a lot of attention. These organisations have been particularly innovative in their approach to communicating with the general public. For instance, the WWF arranged for a message about the eutrophication issue and what should be done to improve things to be played on the summer ferries that take holiday makers to Baltic Sea islands.

The famous conductor Esa-Pekka Salonen has also been an important advocate for this issue, having organised an annual Baltic Sea Festival for the past seven years. This festival has received a great deal of media attention and has given the issue visibility.

The Swedish National Farming Association has also been involved in an extensive information campaign advising farmers on good nutrient management.

Conclusions

This case study describes a science-policy process that has gradually evolved over many years to become multi-layered, mature and well-orchestrated, to the point where today regulatory bodies and policy makers actively seek new knowledge and commission policy-relevant research. We have identified how powerful advocates, negotiators, scientific champions and translators have all played critical parts in this process. Scientists and policy makers moved between different jobs, linking processes at different levels, building relationships, and developing communication skills and effective personal networks. Despite these institutional developments, it was probably the media interest generated by the appearance of toxic algal blooms that played a major role in stimulating the policy process to move more quickly, finally resulting in legislation.

Eutrophication is a complex problem and as one of the policy makers we interviewed pointed out: 'To be able to get something done you need to understand that you can only take small steps at a time. Things take time and you have to be happy for every small step forward. If you move too fast you may end up locking the whole communication process and the ongoing negotiations.'

The legislation that now protects the Baltic Sea against eutrophication is the result of more than 40 years of communication and interaction between science, policy and practice. The communication successes in this case have been the result of the persistent, concerted efforts of a number of devoted people. The controversies and conflicts fuelled the scientific debate and inspired new research aimed at exploring and understanding the complexity of the problem, which ultimately has supported informed policy and action.

Recommendations based on this case

Case study interviewees believed that earlier investment in strategic trans-disciplinary research and the establishment of permanent arenas for researchers, policy makers and other stakeholders to meet, debate and work together could have been speeded up this process.

It seems that the least institutionally supported role in the process described above was that of the translator. In this case study, the individuals that took personal responsibility for performing this function had no mandate and little formal back-up for this work. Increasing the status of, and giving full support to, translator roles and functions within government authorities and at research organisations could make processes like this more efficient.

Producing assessments that provide an overview of the current state of the science, and also mediating between different groups, may help overcome problems associated with a lack of scientific consensus or with scientific controversies, as well as potentially increasing the legitimacy of scientific evidence communicated to policy makers.

6. Co-production of research and policy – the MISTRA foundation

Summary

MISTRA's decision to invest in interdisciplinary research programmes is based on the view that such programmes are more likely to grasp the complexity of both environmental policy making and the management of natural resources, and are therefore more likely to generate usable results. Key communication activities include dialogues between researchers and end-users and developing broad multidisciplinary programmes with an end-use focus.

Key Points

- Representatives of potential end-user groups need to be involved throughout the whole research cycle.
- A shared understanding among all participants of the problem to be addressed and of how to deal with it is key to a successful programme.
- Translators who are able to communicate between groups that have different knowledge systems can help build a 'common view' among stakeholders.
- Frequent opportunities for programme participants to meet and communicate help to develop and maintain this shared vision.
- Managers of multidisciplinary research programmes should be trained in communication leadership to help them guide the communication between different actors.
- Communication efforts should seek to foster an appreciation of different knowledge systems and an appreciation of the importance of communication to a programme's success.

Background – about the project

MISTRA was established in 1994 with the mission to solve existing environmental problems and prevent new ones arising by investing in high quality interdisciplinary research designed in collaboration with end-users. Here, we have focused on those MISTRA research programmes that involve knowledge support for policy making and resource management. These programmes aim to generate policy-relevant results that will help end-users in policy and public agencies to manage environmental problems and natural resources. We examine and discuss the communication efforts and measures MISTRA has undertaken to support policy relevant programmes, and determine how well these have worked.

MISTRA's co-production approach

MISTRA's innovative approach involves communication and collaboration between researchers from different fields and between researchers and end-users, with a view to overcoming communication barriers and producing results that are useful in practice. All researchers involved in MISTRA programmes must engage with practitioner groups that have an interest in the work or might benefit from the results. Three key elements of the programmes are important in this co-production approach: 1) involving end-users in the development of the research programmes; 2) investment in interdisciplinary and long-term programmes; and 3) the constitution of Programme Boards and selection of Programme Managers. These three activities are described and discussed below.

1. The involvement of end users in planning and maintaining the research programmes

Dialogue between researchers and the intended users of the research is encouraged from the project planning stage. This dialogue is intended to deepen understanding of the wider impacts of the target issue so that the project has broad relevance; and provide researchers with a sound practical basis for their studies so that the research is more likely to generate results with a practical use.

Every research proposal must include a communication plan that describes how researchers will create arenas for communicating with end-users. Before MISTRA makes a decision to fund research, every proposal undergoes an evaluation to ensure that the communication plan is realistic and relevant and that the research can demonstrate its value to the groups that are intended to benefit from it.

Experiences so far
Not all the funded programmes have succeeded in constructively involving end-users and generating end-user relevant research. One reason for this that was expressed during our interviews was that researchers have such a lack knowledge on relevant questions for policy making that it can be extremely difficult to bridge this gap between viewpoints. The programmes that have managed to involve potential end-users in the entire research cycle have succeeded by creating a shared view of the problem to be addressed, what they are trying to solve and how to go about solving it. The successful programmes were organised in such a way that participants were able to meet frequently to maintain and deliberate that common view, right from the early planning stage. Despite these successes, time and effort were still required to make research results implementable in practice. End-users may also need to acquire additional knowledge about the conditions within which research results are produced; building relationships with the researchers may be a good way to develop such an understanding.

2. Investment in interdisciplinary, broad-based and prolonged programmes

All of the major research programmes that MISTRA invests in are large-scale and interdisciplinary. As they generally span between six and eight years, these programmes are long compared to programmes funded by other Swedish research foundations. MISTRA has taken this approach because the foundation believes that the solutions to many important environmental problems are likely to demand research that is cross-disciplinary, broad-based and therefore time consuming. MISTRA also believes that for environmental problem-solving, it is not enough solely to involve researchers capable of discovering and developing the technical/scientific components of a solution. Technical competencies must be complemented by expertise in policy

formulation and communication. Therefore, these broad-based, interdisciplinary programmes are expected to stimulate innovative new solutions to old challenges and involve new forms of cooperation. Additionally, the MISTRA foundation believes that the long timescales of the programmes support the creation of durable, robust research environments. This ensures the research results are used in practical applications and to stimulate further research.

Experiences so far
Despite a large amount of effort, some MISTRA programmes never really achieve genuine interdisciplinary integration, consisting instead of a set of individual projects loosely organised under a large umbrella. Scientists are often required to function in unfamiliar ways, perhaps collaborating for the first time with colleagues who work in other disciplines about which they know relatively little, in order to gain funding. Differences in knowledge systems both between social and natural scientists and within these fields make it difficult for individuals to cooperate successfully. Generally, the criteria for successful integration of different research disciplines within a programme mirror those for successful integration of science with policy making (see above). Again, the programmes that foster a process of regular dialogues and frequent meetings between research participants, and that develop and maintain a shared idea of programme goals, do better at integrating different knowledge systems and component projects with one another.

3. The role of Programme Boards and Programme Directors

Programme Boards and Programme Directors play an important role in linking different research disciplines together, as well as linking research with practice. These are factors that the Programme Boards and Directors bear in mind when guiding and promoting communication.

The Programme Boards are responsible for managing the programme funds and for directing scientific activities. The composition of the Boards varies, but they are usually dominated by potential users of the results rather than scientists. So for policy-relevant programmes the Board may consist of partners that have served as civil servants at a national or local level. Also, many Board members have extensive experience of working with researchers in their capacity as ‘buyers’ of research and already have some understanding of the conditions in which research is generated. The choice of the members of the Programme Board is a critical factor in supporting and ensuring the creation of arenas where researchers from different disciplines can meet, as well as stimulating the involvement of end-users.

The Programme Directors play a key role in maintaining a focus on programme goals over several years and working with future users.

Experiences so far
The degree of involvement of Programme Boards in programme operations varies – some are intimately involved while others meet occasionally but leave management to the Programme Director. Some members view serving on the Board as an important service activity while others regard it as just another task that they have to perform. However, we have not been able to ascertain any relationship between the degree of commitment of members of the Programme Board and overall programme success. Instead, according to the stakeholders we spoke to, the programmes which are successful are those that involve ‘translators’ of one form or another. Translators may be Programme Directors, a member of the Programme Board or an employed communicator. Some researchers within the programme itself have also performed this role. In these cases, translators have been able to bridge the gap between end-users and researchers, and facilitate the creation of a common view that both groups can

share. This person is also able to serve as a go-between in gaining acceptance for the research findings and ensuring that they are put to use more quickly.

Over the years, MISTRA has become aware of the important role that Programme Directors play in supporting communication between programme participants who may have different perspectives and experiences. They also help the participants to develop a sense of mutual respect for different knowledge systems and an appreciation of the need for sustained communication among all stakeholders. The foundation has recently published a guide in communicative leadership and organised a leadership development programme to support Programme Directors in performing this function.

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7. Nanotechnology – feeding the outputs of dialogue into policy making

Summary

The main communication activities in this case were a series of public dialogue events held at various scales (from the Royal Institution to school children) during which the science was debated. Outcomes from these debates were relayed directly to policy makers with responsibility for making nanotechnology related policy. The approach was driven by policy makers (UK Defra) and a professional science communicator (functioning as a translator), ensuring that project outcomes were timely in terms of policy process.

Key Points

- Networking with the large number of individuals involved in policy making and building relationships with the right people was key to the science translator's success at informing policy.
- The benefit of developing a relationship with the policy makers was that the translator was regularly able to access the relevant policy makers to update them on lessons and attitudes learned.
- The translator focused on making outputs as valuable as possible to policy makers; knowledge of how policy works and the target audience were key in this case to ensuring that policy-relevant outcomes were identified and presented on policy makers' terms.

Background – about the project

The outputs of public dialogue events and social intelligence are increasingly being looked upon as part of the policy makers' evidence base, but feeding this information into policy making is often seen as problematic by dialogue practitioners and social researchers. This mini-case study looks at one example of public dialogue that successfully fed into policy making and considers the factors that contributed to this success.

Small Talk was a collaborative project that aimed to provide coherence to a range of activities around the UK focused on discussing nanotechnologies with the public and scientists. The project, which comprised more than 20 separate dialogue events, ran from September 2004 to March 2006.

The project organised and coordinated a range of events, provided a central resource for science communicators interested in nanotechnology, and explored the role of science communication and practitioner-led dialogue in policy development. The events ranged from large-scale debates at the Royal Institution to more intimate conversations between scientists and school children.

The project's primary objective was to explore whether current UK science communication activities provided an appropriate arena for upstream dialogue and whether such activities could produce outcomes relevant to policy makers.

Policy context

Nanotechnology was a new and emerging field, which the UK government felt offered potential benefits to the economy, society and environment. Policy makers were concerned, however, that without careful handling there was a risk of a public backlash against the technologies, similar to the backlash against genetically-modified crops.

Communication history

The Small Talk project was devised and delivered by science communicators with a good knowledge of social research techniques, rather than a group of academics. This meant that the importance of good communications was at the forefront of the project.

Throughout the project, the team worked to make contacts with the key individuals in government involved in policy on nanosciences, maintaining the dialogue and building relationships with these individuals for the duration of the project. Key policy makers were regularly updated on lessons and attitudes learned, as well as being invited to comment upon the value of the various outputs of the project. This helped to make the project outputs as useful to policy makers as possible.

As a result, Small Talk played a role in the UK government's actions to facilitate dialogue with the public on nanotechnologies and was mentioned in several government reports on the subject. The project team was invited to discuss findings with policy makers on several occasions, both during and after the project. The attitudes and opinions identified by the research have also had an impact on thinking within both the EU and the Organization for Economic Cooperation and Development (OECD), with the project director being invited to present findings up to three years after the end of the project.

What factors helped the research influence policy?

1. Long timescale

Small Talk was a three-year project and the project director remained engaged with the work for more than five years. This gave sufficient time for good relationships to be built with policy makers, such that they now regard the project team as a source of expertise. The timescale also allowed the outputs of the dialogue to be presented as part of an ongoing narrative. This suggests that organisations wanting to dip in and out of different issues or topics for dialogue are therefore likely to have limited success in linking to policy.

2. Clear understanding of the needs of policy makers and the importance of good communication (arguably the role of the translator)

The project team was very clear about what policy makers wanted out of the project and maintained regular contact with the policy makers (and other projects) to keep this understanding up to date. The team understood that policy makers simply wanted to

know what people thought about nanotechnology-related issues and so presented information relating to this on a regular basis and in an easy-to-understand format. As a group of communicators, the team also approached this as a communications campaign – working out who they wanted to speak to, what they wanted to say and the best way of reaching them, as they would have done for any other communication activity.

3. Understanding how policy works – and how it really works

The project team realized that to influence policy, they needed to understand IN DETAIL how legislation and public policy is conceived, formed, debated, approved and implemented. More importantly, they recognised that government legislation is rarely written by the elected representatives themselves. Outside the formal procedures and structures, there are tens of thousands of civil servants, local government officers, political staff and advisers who are involved in shaping and influencing public policy. They got to know who these people were and how they work, and invested time and effort into networking with them.

8. Using scientific evidence to create policy on tuna fishing in the Mediterranean

Summary

This case illustrates that it can be difficult for scientific evidence to compete against other forms of evidence in influencing policy when science is telling the more challenging story, the problem is complex and institutional structures are lacking.

Key Points

- If the scientific evidence is weak, or lacks a clear message, it is difficult for it to compete with other evidence that tells a more comfortable story.
- This problem is long-term in nature – policy makers tend to be more concerned with the here and now.
- NGOs are helping to champion science and increase its impact.
- It is difficult for stakeholders to regain credibility once this is perceived to have been lost.
- Importance of buy-in by all key stakeholders.

Background – about the issue

Atlantic bluefin tuna have been fished in the Mediterranean for the past 9000 years and are a valuable commodity, fetching high prices at market. The International Commission for the Conservation of Atlantic Tuna (ICCAT) is charged with regulating fishing of the species, but ICCAT has been unsuccessful in its efforts to establish sustainable management of tuna, with stocks declining dramatically in recent years.

About ICCAT – feeding scientific information into policy making

ICCAT was established in 1969 to coordinate research and management of tuna and billfish in the North Atlantic. ICCAT's mandate includes compiling fishing statistics from member countries and other entities that fish for tuna, coordinating research, assessing stock numbers, developing science-based management advice and providing a mechanism for contracting parties to agree on management measures.

ICCAT's approach to incorporating scientific evidence into policy is a decision-making process in two parts involving two separate bodies: a scientific body (fisheries scientists) and a decision/political body (mainly EU administrators). The scientific body provides advice and management recommendations (such as catch restrictions) to the political body. The political body then finalises the management recommendations after taking socioeconomic factors into consideration. In practice, this often results in the allowable catch being set much higher than the level recommended by the scientific body.

Communication History

1. Weak messages

Until 2006, the ICCAT scientific committee was very cautious in its management advice because of acknowledged weaknesses in the data provided by its member countries. The advice they provided seems to have been so cautious that policy makers did not realise the extent of the problem. Thus when in 2006 alarmingly low tuna stocks prompted the ICCAT scientific committee to provide much stronger and clearer advice, this apparently came as a surprise to policy makers. It may also be that until the message from the scientific committee reached a certain degree of strength, competing factors, such as strong lobbying by fishing organisations and other stakeholders, won out when it came to finalising the catch quotas.

2. Scientific advice not perceived as credible

Another issue is that there was a perception among policy makers that the data ICCAT use to produce their management recommendations are of low quality and so their management recommendations are unreliable. The assessments on which the scientific committee bases its advice are based on standard methods in fisheries science. However, the input data for these assessments are often incomplete. A representative of the European Commission's Directorate-General of Maritime Areas and Fisheries described two problems with the advice provided by ICCAT's scientific board: 1) low quality data is used to provide detailed advice; 2) since the quality of the data is not good enough to inform decisions properly, scientists provide subjective advice based on their own opinions about the stock status.

While the scientific community has published articles in scientific journals attempting to draw attention to the expected population crash of the Mediterranean-spawning bluefin tuna in the near future, it has also discussed the inadequacy of ICCAT's assessment methods (Fromentin 2003; Fromentin and Powers 2005; MacKenzie *et al.* 2009; Safina and Klinger 2008).

3. Low stakeholder buy-in

Most countries that fish for Atlantic bluefin tuna are ICCAT members. However, non-signatories don't comply with ICCAT's sustainable management guidelines and there have also been reports of non-compliance among signatory countries. Under-reporting and failure to report catches has been an on-going problem, along with illegal fishing. Late reporting of catch data to the ICCAT scientific committee by some of its signatory countries, and a lack of long-term monitoring series and of knowledge about the basic ecology of the species have hampered assessments of stock size. All of these issues decrease the reliability of the stock assessments and the quota system that's based on them.

4. The role of advocates

Several NGOs, particularly the WWF, have been active in trying to raise the profile of this issue. The WWF published pages related to the issue on their website (Blue Fin Tuna in Crisis), as well as several reports describing the failed management of this species (*Race for the last bluefin* 2008; *Liftin the lid* 2008). The WWF's role has been to amplify the voice of ICCAT's scientific board and to try to instil confidence in the scientific information provided to policy makers and the media. The WWF also publishes information based on its own research, aimed at policy makers and the

general public, highlighting the scale of illegal, unreported and unregulated catches and the overcapacity of the tuna fishing fleet. The WWF has focused on using the media to influence public opinion, as well as campaigning against restaurants and retailers who sell bluefin tuna. A representative of ICCAT's scientific committee believes that NGOs have had a positive influence on the Commissioner's attitude towards this issue. As a result, the Commission has now approached the WWF for support in putting pressure on member states to act. The ICCAT scientific committee also values the role the WWF has played in highlighting and clarifying aspects of the issue.

Conclusions

This case study illustrates the difficulties involved in trying to control fishing in international waters, where there is open access to a shared resource. In many ways, the problems described are at an institutional level, where socioeconomic and economic issues 'win out' over scientific evidence in determining the management measures taken.

There have clearly also been major issues with the quality and the communication of scientific evidence. Presumably, once scientific credibility is questioned or lost, it is difficult to regain that trust. In this case, the NGOs have played an important role in reinforcing the scientists' credibility by supporting the scientific advice and by presenting their own evidence of non-compliance by the member states.

Many of the ICCAT member states seem to lack powerful policy institutions acting at the local scale, or if such institutions do exist there is no obvious target group for ICCAT's communications.

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9. Life Cycle Analysis as a tool for enabling communication between science and policy

Summary

This mini-case study illustrates how scientists have attempted to provide a tool for communicating complex multidisciplinary scientific data in a simple way to help policy makers make comparisons between different ways of dealing with a complex problem.

Key Points

- LCA is a powerful communication tool that can illustrate the consequences of different policy options.
- Tool outputs are sometimes still too complex for policy makers.
- There are concerns that this tool can be misused – the complexity of the output makes it possible for policy makers to interpret scientific evidence in a way that suits their interests.

LCA as a communication tool

This case study describes how LCA has been used by scientists as a tool for communicating scientific information to policy makers in order to inform policy decisions relating to sustainable waste management. Sustainable management of waste is a complex problem with environmental, social, economic and technical dimensions, so policy making in this area is also complex and requires that many different factors are taken into consideration. LCAs investigate the environmental impacts of a product or process over its whole lifetime, from the cradle to the grave. Scientists have used LCAs to provide policy makers with an holistic view of the waste management problem, and to illustrate the negative and positive sides of different management solutions, so that the least damaging option may be found.

How LCA has been used to inform policy decisions

In 2005, the Swedish Environmental Protection Agency (SEPA) was interested in the possibility of carrying out more frequent kerbside collections as a means of increasing rates of recycling household waste. So it commissioned scientists to carry out some LCAs to assess the environmental and economic implications of this approach. The LCAs showed that although recycling rates would increase, the transport that would be required to carry out the collections would lead to greenhouse gas emissions that could outweigh the benefits from increased recycling. These analyses helped policy makers to weigh up the advantages and disadvantages of kerbside collection. As a result of these analyses, the plans for increasing kerbside collections were dropped.

SEPA has often commissioned LCAs, and has the ability to interpret the output of these LCAs and present it to policy makers. In this way, it functions as an important translator between scientists and policy makers, and hopefully reduces the likelihood of the results being misinterpreted.

Problems with this tool

Despite LCAs having been successfully used by scientists to provide information that informs policy making, there are several problems related to its use. The results generated by an LCA depend on subjective methodological choices related to components such as timescale, assumptions made and the source of the input data. As LCA results are connected with great uncertainties and require many different scenarios, there are also risks that the tool outputs are still too complex for policy makers. This raises concerns that the complexity makes it possible for policy makers to interpret scientific evidence in a way that suits their interests.

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Annex 4. Synthesis of Inception Survey results

Q1: General issues: What in your opinion have been the most important environmental science/policy issues in the past 30 years?

Summary of Responses:

14 Climate Change

11 Biodiversity loss/ unsustainable use of natural resources

10 Pollution and the use of chemicals

4 Ozone depletion

3 Sustainable development

1 Water Framework Directive

1 Communicating risk and uncertainty to the public

1 Peak oil

1 Changing behaviours

Q2. Give three examples of current/emerging environmental issues based on your personal working experience.

Q3. To what extent do you think scientific evidence is/has been used effectively in policy-making in these cases? Why do you think this has been the case?

"**Score**" is the score in Q3 relating to effectiveness of the use of science in policy-making to address the issue (4=high, 1=Low).

Narrative is from Q3, relating to effectiveness of the use of science in policy-making to address the issue

Respondent	Issue 1	Score	Narrative
1	environmental impact of consumer goods/lifestyles	3	This is a fast growing field of research and a few years ago politicians/bureaucrats accepted that developments in this field as crucial for SD.
2	IPPC	1	NO RESPONSE
3	climate change	3	Climate: IPCC has been great success - but there is still a knowledge gap - how to frame productive negotiations around such a complex issue with plenty of externalities.
4	moving towards integrated river basin management	2	The nature of competing water uses and lack of clear direction on how to integrate decision making that provides for win/win outcomes or informed decision making around trade-offs is difficult, takes time, trust and resources and often takes more time than political election cycles.
5	rapid climate change / tipping points	2	Emerging issues are usually dealt with poorly because it takes time for consensus to emerge. However, this has been exploited in issue 1 and 2 by an army of gain-sayers funded by business as usual vested interests.
6	Air pollution and health impacts	4	Issue 1: research has led to a kind of consensus on the effects and their evaluation Issue
7	climate change	4	IPCC for climate.
8	Impact of climate change on flooding	1	1. Attention so far has focussed mainly on temperature changes, with flooding potential a subsidiary issue. In addition, scientists concerned with this have almost no idea of the information and ideas that non-scientists need to understand what is going on.
9	climate change	4	NO RESPONSE

10	Anthropogenic climate change	4	The creation of the Intergovernmental panel on Climate Change is a model of how scientific evidence should be fed into domestic and international policy-making.
11	LRTAP/Acid protocol	4	Issue 1.It was an agreement within the scientific community of the acid rain problem. Scandinavia was affected particularly of acid rain from UK. How to convince UK-politicians-which country not necessary was affected? UK politicians consulted their researcher of which several had collaborated with Scandinavian researchers. All these researchers agreed on the problem and its solution. This put pressure on the UK-politicians! In addition the problem was communicated in a way that the politician could understand the language of the researcher. The common concept was "critical load" of acid rain on Scandinavian water and soil. Also the researchers communicated with prognostic models (many were meteorologists)-What happens if we do nothing??? These ways of communicating become important.
12	climate change	1	1) the policies do not address the changes in behaviour that are required
13	Ecosystem Services - concept and application	3	Issue 1 - Ecosystem Services - concept and application: Overall scientific evidence is in my view being applied reasonably well. Certainly in conceptualising the approach. Application is more difficult and in attempts to to this the science is necessarily simplified (to make progress). Whilst this is helpful in the early stages it's important that applying a fuller understanding is important. Problems still remain in valuations and here this is more difficult for various reasons. Not least because the experts do not find applying their expertise in this very applied way gives them appropriate career rewards.
14	Directing environmental focus based on ecology rather than chemistry	2	The environmental outcomes have not been well defined or regulators and business have not shared their issues and priorities effectively or collaborated appropriately
15	ecosystem services - payment for		Ecosystem services - with the development of REDD groups looking further into payments for biodiversity & water & other services. Serious difficulties in valuing these services means they likely be undervalued in many cases.
Respondent	**Issue 2**	**Score**	**Narrative**
1	mass/organizational learning processes/transdisciplinary research	2	Here I'm more pessimistic, because large scale learning processes are as well crucial as expensive.

2	renewable energy and efficiency	3	NO RESPONSE
3	development policy	1	Development policy - particularly international development is mainly driven by ideology. There are some indicators, but they are pretty weak overall. The main ideology is "GDP growth" which runs countries into ecological ruin and produces non-sustainable outcomes (in North and South).
4	water for food production	1	Issue 2: somebody else will grow it anyway or those who need can't afford to pay for it, old time thinking about one of the most critical issues for the future
5	resource depletion (water, soil, oil)	2	Emerging issues are usually dealt with poorly because it takes time for consensus to emerge. However, this has been exploited in issue 1 and 2 by an army of gain-sayers funded by business as usual vested interests.
6	Air pollution and ecosystem impacts	2	2: there is still a need of research on the impacts and their evaluation Issue
7	biodiversity loss	3	Millennium Assessment and alternative mechanisms for getting scientific info into policy not as successful (partly b'c biological diversity is a much more complex and multi-faceted problem than climate change).
8	Sustainability and Higher Education Institutions	1	2. There is a lot of talk and very little action. The effort has also swung too far away from science into socio-economic aspects, such that the required scientific underpinning has almost disappeared.
9	toxicology	3	NO RESPONSE
10	Agricultural biotechnology	2	Policy for agricultural biotechnology in the UK does not appear to command widespread public support. The GM field-scale trials were a laudable attempt to provide scientific evidence for policy-making, but crucial aspects were not properly through (e.g. the trial of a crop that was resistant to a herbicide that was due to be phased out anyway). Regulation of the commercial applications of agricultural biotechnology is perceived by the public to be too lax.
11	Montreal protocol	3	Issue 2.The correlation between CFC(fluor-carbon)and ozone-hole was an scientific important observation(also gave a Nobel Prize). A fairly uniform market and that one product could be exchange facilitated the abatement.
12	threats to biodiversity	2	2) the policies do not integrate biodiversity protection with broader policy objectives

13	Climate Change - adaptation and mitigation	4	Issue 2 - Climate Change - adaptation and mitigation: In my view the science is generally being applied well to policy. The IPCC assessments use the best science advice and evidence available.
14	mitigating and adapting to climate change	4	The environmental outcomes have not been well defined or regulators and business have not shared their issues and priorities effectively or collaborated appropriately
15	marine protected areas & no take zones	3	Marine protected areas - terrestrial protected areas cover roughly 10x more area than marine & yet the level of reliance on coastal communities on marine protein. with the increase in acidity in tropical regions this is going to cause increase poverty and starvation. UK is 2 years behind in releasing its own marine bill - developing countries even further.

Respondent	Issue 3	Score	Narrative
1	accelerating processes	1	Here I'm pessimistic: Many environmentally problematic developments are accelerating, but the adaptability of society and our democratic political system are very limited, the reaction of e.g. lawmakers is slow
2	SD	2	NO RESPONSE
3	urban planning	1	Urban Planning: Cities are not prepared for the future, but essentially designed by "cars" (or around cars).
4	climate change impacts and adaptability	2	Issue 3: in many instances the pace of development is outstripping climate change, but not much discussion is taking place about the adaptability, resilience, flexibility of natural resource management systems to make up for the changes in climate we will all experience.
5	biodiversity loss in relation to ecosystem services	3	Issue 3 differs because ecosystem services are a way of linking biodiversity loss with adverse consequences for humans.
6	Relation of air pollution and emission of GHG	2	3: there is a need of research on synergies and conflicts of these 2 issues
7	adverse impacts of nanotechnology	1	Nanotechnology isn't on the screen yet b'c it's so new and there haven't been any disasters yet.

8	Role of environmental professional bodies	1	3. Scientific understanding, as for 2, has been swamped by other dimensions of 'sustainability' which although important seem to have replaced, rather than added to, the constellation of issues that need to be handled concurrently. Also, crucially, there are too many environmental professional bodies, each too small and weak to make a sustained case for change. Again, the 'environmental science' voice is lost against the larger more powerful voices of business management concerns.
9	resources	2	NO RESPONSE
10	Nanoparticles	2	The environmental impact of nanoparticles is an emerging area of knowledge. The report by the Royal Society and Royal Academy of Engineering on nanotechnology and nanoscience identified a number of priority areas for research on nanoparticles, but the UK Government appears to be reluctant to fund the work. It looks like the Government is waiting until there is more public concern before acting, which does not appear to be an optimal strategy for maintaining public confidence in evidence-based policy-making.
11	Helcomwork	2	Issue 3.My impression is that there is a lot of scientific information. However there is a lot of controversy for some science!! It does not exist a common concept-as for acid rain problem (critical load)-that both scientists and politicians can agree on. Also prognostic way of working is absence. The lobbing from fishing industry is strong (unemployment among fishing people!).
12	environmental risks of GM crops	4	3) a discrete single issue with a strong science base
13	Effective land use planning	2	Issue 3 - Effective land use planning: Evidence here is being used less well. The problem is a practical one. The environment is a complicated place and its difficult to find a good way for policy makers to bring the science together into a coherent framework that will help them make good, evidence based decisions on land use. Superimposed on this difficulty is the need to take account of possible futures. One approach that looks like it might facilitate addressing these challenges is the Ecosystem Services Approach. By recognising the multiple services that land provides and developing a common currency to allow trade offs it it likely to be a very valuable tool in developing future land use plans that reflect all needs.
14	ensuring that environmental priorities are not lost in the current economic climate and that regulations are not a barrier to innovation	1	The environmental outcomes have not been well defined or regulators and business have not shared their issues and priorities effectively or collaborated appropriately

15	fisheries quotas	1	Fisheries quotas - most recent issue is the recent setting of quotas for tuna in the Mediterranean. The scientists' recommendations were completely ignored and levels have been set far higher than recommended which will likely lead to a collapse in fisheries.

4. Can you give other examples where scientific evidence has been successfully used in policy?

biofuels
IPCC - building consensus on the problem HDI in Human Development - using indicators for measuring progress: for instance also in epidemiology and public health.
In Alberta, Canada a multi-disciplined approach has developed the scientific and policy underpinning for a provincial and regional place based approach to wetland policy and management ... and many stakeholder organizations are working in the early days of integrated watershed management where learnings are being translated in policy and in some cases voluntary actions which exceed the requirements of existing legislation. It may be that Australia's Water Act 2007 is one of the most relevant examples of twinning natural and social sciences with policy and legislation, the current version after 10 years of often difficult trial and error.
Banning CFCs is the obvious example, with leaded fuel and tobacco-related diseases showing some success despite vested interests.
Research on the emission of NOx and the implied policies e.g. NOx charges
Scientific evidence plays a marginal role to push the process forward by affecting situations in which there are already political forces aligned to make a change or when the costs of change are small or concentrated on those without a political voice. Scientific evidence is generally used more effectively in the health realm because there is a longer history of using science in this realm and because health is a tangible private good in which people have a large interest.
Removal of CFCs
The identification of the ozone hole and of the role of CFCs, leading subsequent international action, in the form of the Montreal Protocol, is a model of the use of scientific evidence in policy-making. The use of epidemiological modelling to assess strategies for controlling and eliminating foot and mouth disease in the UK in 2001 was a successful use of scientific evidence to formulate policy in very demanding circumstances.
Climate change...biodiversity...
A good case study would be Natural England's Upland Futures Project. It is developing the evidence base for 'ecosystem services' in the uplands: i.e. what services and benefits do we get from nature?; where are they located?; where do the benefits flow to?; what are the trends in their supply and demand?; how does land use and management affect provision? etc. Natural England will use this information to construct an 'ecosystem services Atlas' for the Uplands to help with the rationale for the vision
control of CFCs; control of acid deposition; control of point sources of pollution
Air quality mgt waste mgt particularly to reduce dependence on landfill

5. Can you give other examples where scientific evidence hasn't been used effectively in policy making?

Economic issues are built on applying ideology, little scientific evidence. or contrary scientific insight is ignored.
From my personal perspective this is most often the default position, the scientific, policy and political communities speak very different languages are not apt to go out of their way to collaborate or cooperate or to even talk -- and political decision-making often trumps an academic scientific approach.
Nuclear power / nuclear waste disposal genetically modified organisms
Policies related to emissions from the transport sector in general and road transport in particular
Too many to mention - Climate change, badgers, BSE, Marine pollution, nitrous compounds in atmosphere, transport issues, GM, Biofuels etc .
EU fish quotas in the past few years have patently been agreed by deliberately ignoring the available scientific evidence about the sustainability of fish stocks.
The controversy about anthropogenic contribution to climate change is miss-used
Policy on set aside.
urban / rural planning transport
Setting environmental standards

6. Previous research has identified the following as barriers to science influencing policy more effectively.

Thinking about the specific cases you have described, could you please rank the factors according to how important you believe them to be, with 1 being not at all important and 4 being very important.

*data are the number of responses

Overall for all respondents and issues	Rank			
	1	**2**	**3**	**4**
Relevance of research to policy	10	10	8	15
Timeliness of the research findings for policy	5	15	8	15
Quality of the research	2	13	12	15
The research was communicated clearly	6	15	12	9
An 'intermediary' championed the research to policy makers	9	11	6	17
Researchers had been involved in defining the policy needs	7	15	16	5
Incentives had been provided to encourage the researchers to talk to policy makers	14	15	8	5
Researchers had previous contacts with the policy makers (or vice versa)	10	9	12	7
Other reasons (Please give details)	1	1	2	6

Overall, results suggest that the critical barriers to science effectively influencing policy are different in different cases, and/or are perceived to be of different importance by different people

Other isolated barriers:

1. Importance can also be negative - ideological research with close contact to policy maker has undue influence.
2. Failure or unwillingness to understand that complex systems are inherently unpredictable and that there will be no easy, short-term answer
3. Failure / unwillingness to understand the finite nature of resources.
4. A belief that biodiversity was an optional extra that can be sacrificed for financial gain.
5. Lack of resources for research is one of the reasons
6. Lack of knowledge.
7. Policy makers were able to solicit, understand and make use of information about the uncertainties in the research.
8 Outcomes not made clear and hence poor specification of nature, quality and timescale around science needs.

Annex 5. Case studies ‘How to’ guide

For science-policy communication to improve, the communicators need to consider a number of issues more thoroughly, issues relating to the route that science takes from origin to influence. Assuming we are starting from the science/research point of view, issues to consider include:

Starting point for writing the first version of the narrative in each case study:

1. Defining the environmental problem.
2. Mapping of science policy context using the structure from the Inception report:
3. Understanding the science context.
   - Where did the research question originate – scientists, research councils, policy-makers? Why/how did they come up with this question?
   - Is it a specific issue or a broad issue?
   - Is the research multi-disciplinary or narrow in focus?
   - Is the science well developed and certain, or uncertain and under debate?
   - Is the science acceptable (to policy and/or public) or unpalatable? Why?
   - What is the publication profile of the science – “Nature” or low profile journals?
4. Understanding the policy context of the issue.
   - What is the current policy interest in the issue?
   - Is the issue linked to a stable/static policy interest, is there an interest in policy development, or is it a fast moving, ‘hot’ issue?
   - Are policy-makers involved in shaping the science?
   - Why?

Questions to ask in the interviews in order to identify and select communication process focus:

5. Understanding the science-policy interface. Which, if any, of these factors was important?
   - Relevance of research to policy
   - Timeliness of the research findings for policy
   - Quality of the research
   - The research was communicated clearly
   - An ‘intermediary’ championed the research to policy makers
   - Researchers had been involved in defining the policy needs
   - Incentives had been provided to encourage the researchers to talk to policy makers

- Researchers had previous contacts with the policy makers (or vice versa)
- Other reasons (Please give details)

6. Understanding the media interest in the issue.
   - Does the issue have a media profile? Why is the media interested?
   - Where does the media get its information from?
   - Is the media consistent? Does it reflect scientific consensus? Why?
   - Who is listening (responding) to the media?
7. Understanding the impacts of the science.
   - Are impacts direct or indirect?
   - Are impacts clear for wider society or just for specific sub-sectors?
   - What re the economic impacts? On who?

Summing up and making up and thinking about lessons to be learned for researchers, policy makers and translators:

8. Identifying the stakeholders.
   - Who will be affected by the science? who will feel the impacts?
   - How much power to influence policy or change does each stakeholder have? (Links to governance – local vs. central power)
9. Understanding possible stakeholder responses to the science.
   - How will each stakeholder respond to the science?
   - Can they respond to it?
   - Will they respond to it?
   - What will they do differently?
   - Why would they not change/respond?
   - Which are the priority stakeholders (audiences)? Easy wins? Most power?
10. Communication approaches for priority stakeholders?
    - What is likely to work best for each stakeholder in this context?

    In terms of case study questions:

    - What was chosen/used? How did each approach work? Why?
    - What was specifically not chosen/used? Why?
    - What could have been used? What different impact would it have and why?
    - What was the resulting policy influence?
    - What can that mainly be attributed to?

Annex 6. Questions to ask in interviews

The overall aim of the questions we suggest here is to understand more about the science-policy communication process and to identify and select communication activities that should be focused on and emphasized in our final report.

We have taken into account that the interview persons (IPs) will represent different perspectives. We suggest two alternatives; one addressing IPs with mainly a scientific background and one IPs with policy background

(Some of us will meet IPs with a mix of experiences and broader perspective - possibly including translators - perhaps the questions below are helpful support also under those circumstances)

Generally, the more the IPs understand about why we want to interview them the more help we can gain from them so give them a short background. Describe the interview process (based on the narrative that they have had opportunity to read, you would like to focus on and get information about their view on the communication process and help with selecting important communication aspects related to the issue). Also tell them how long you estimate the interview will take.

Alternative 1: IP represents a scientist perspective

1. IPs view upon and experiences of the **emerging issue/environmental problem (Main focus on the scientific background)**

    - How, why are you interested/involved in the subject? What is/has been your role? What is your science back ground?
    - Does the narrative (sent to you prior to this interview) describe the scientific background in a proper way?
        - *Is the description about how and when the environmental issue emerged, correct?*
        - *What should be added or changed? Activities and events, actors involved, time given?*

    - What kind of science and scientific results have in your opinion been most important for the development of scientific awareness and knowledge about the issue?
        - *E.g. natural and engineering science, social science including economy, humanities, inter- and transdisciplinary research.*

2. IPs view upon and experiences of **communication** of research and findings to policy (discussions related to the narrative)

- Does the narrative describe the science to policy process accurately?
- When and how did awareness of the environmental problem develop within the policy sphere?
  - *Were researchers involved in defining the policy needs for research? How?*
  - *Were policy makers involved in defining research areas/shaping the science? How?*

- How have the research findings been communicated to policy? (scientific journals and books, seminars, popular science publications, websites, via media (newspapers, TV and radio)
  - *Has the contact between researchers and policy makers been direct or indirect?*
  - *Were there i.e. 'intermediaries' (translators), NGOs or others involved in communicating the research to policy makers?*
  - *Have the research findings been available at a suitable time for policy use?*

- What has been the role of public opinion (and/or NGOs) in the development of the (research and) policy process?

- Please give examples of key communication events and/or long term communication processes that have been important drivers for the policy process? (and the research process, if applicable).

  - *Were there i.e. incentives provided to encourage researchers to talk to policy makers? i.e. forums for dialogues and joint learning, special funding programmes for research (MISTRA, RELU or alike)*
  - *For how long have different communication activities been going on? Regularly, irregularly over time?*
  - *Have any tools such as analytical models, environmental assessments, environmental quality objectives been used to process, analyse, simplify and communicate information by scientists, policy makers or others?*

3. Media and public opinion
   - If and how have research findings been communicated to media? (if necessary specify media) or directly to public?
   - Does the issue have a media profile? Why are media interested in the subject?

   There might be reason to dig deeper in to the media issue:

   - Where does the media get its information from?
   - Is the media consistent? Does it reflect scientific consensus? Are results provided by scientist debated by media?
   - Who is listening (responding) to the media?

4. Lessons learned by failures and success stories

   - Which of the communication activities were effective and which were not? Why? Please give examples of success stories and failures?

Alternative 2: IP represents a policy perspective

1. IPs view upon and experiences of the **emerging issue/environmental problem (Main focus on scientific background)**

   - How, why are you interested/involved in the subject? What is/has been your role? What is your policy back ground?

     Does the narrative (sent to you prior to this interview) describe the scientific background accurately? *Is the description about how and when the environmental issue emerged correct?*

     What should be added or changed? Activities and events, actors involved, time given?

   - What kind of information/knowledge has in your opinion been most important for the development of the policy related to this issue? Has that changed over time?
     Layman's knowledge, corporate knowledge, science? e.g. natural and engineering science, social science including economy, humanities, inter- and transdisciplinary research.

   - Were/are researchers involved in defining the policy needs of knowledge? How?

   - Were/are policy makers involved in defining research areas/shaping the science? How?

   - Have the contacts between researchers and policy makers been direct or indirect?

   - Have the research findings been available at the right time?

2. IPs view upon and experiences of **communication** of research and findings to policy (discussions related to the map?)

   - How have you been informed of the research findings? (via scientific journals and books, seminars, popular science publications, websites, via media (newspapers, TV and radio), media?

   - Were there i.e. incentives provided to encourage the researchers to talk to policy makers? i.e. forums for dialogues and joint learning, special funding programmes for research (MISTRA, RELU or alike)

   - Have any tools such as analytical models, environmental assessments, environmental quality objectives been used to process, analyse, simplify and communicate information by scientists, policy makers or others?

   - Please give examples of key communication events and/or long term communication processes that have been important drivers for the policy process? (have affected your way of looking upon and dealing with the problem)

- Who was involved in communicating? Were there i.e. 'intermediaries' (translators), NGOs or others that was involved in communicating the research to policy makers?

- For how long have different communication activities been going on? Regularly, irregularly over time?

- How much time and resources has your organization put into communication related to this issue? Nothing, a little, medium, a great deal, very much....(This Q is not always applicable)

3. Media and public opinion
   - If and how has policy makers need for new research by been communicated to media? (if necessary specify media)or directly to the public?
   - Does the issue have a media profile? Why are media interested in the subject?
   - How important have the public opinion been for the development of the policy process?

Eventually there might be reasons to dig deeper in to the media issue:

- Where do media get its information from?
- Is the media consistent? Does it reflect scientific consensus? Are results provided by scientist debated by media?
- Who is listening (responding) to the media?

4. Lessons learned by failures and success stories

   - What have been the effects/results/responses of the communication process?

   - Which of the communication activities were effective and which were not? Why? Please give examples of success stories and failures?

Other IPs

Possible topics of interest when interviewing other important stakeholders like NGOs, industry

- How have economic interests (corporate and societal costs and benefits) affected the science to policy process?
- Has your organisation's view about the environmental problem been influenced by public opinion? How?
- Have you been involved in the science-policy process? How? (funding research, organising communication events).

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