Chapter 12
From Science Communication to Knowledge Brokering: the Shift from 'Science Push' to 'Policy Pull'

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Abstract Traditional (*big C*) communications in large organizations usually serve to ensure consistent over-arching messaging internally, and to the public at large. To deliver on their public-good mandate, science-based governmental institutions must do more than broadcast the department's position. They must communicate not only broad policy directions, but also raw data, leading-edge science, general and informed layperson interpretations, and advice for action and behaviour change. Different sectors prefer to receive information and use knowledge in different ways. Science departments must engage with diverse audiences—for example, science users and decision makers, the scientific community, public organizations, and individual citizens—in ways tailored for each audience. This means paying greater attention to the changing contexts in which information is received and used, and consequently the mechanisms and relationships required to produce and transfer scientific information. For policy audiences in particular, the relevance of the science to the issues of the day, and the crucial importance of timing, underline the need for interactive knowledge brokering approaches that can deliver synergistic combinations of 'science push' and 'policy pull'. The authors draw on examples from Environment Canada, as well as from the UK Department for the Environment, Food and Rural Affairs, and Land & Water Australia, to show how dedicated (*little c*) science and technology communications and knowledge brokering activities are growing in importance. The need for investment in specialized approaches, mecha-

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nisms and skill sets for knowledge transfer at the interface of science and policy is also explored, particularly in relation to the field of environmental sustainability.

Keywords '*bic C*' and '*little c*' science communication, DEFRA, Environment Canada and Land & Water Australia, environmental sustainability, knowledge brokers and brokering, knowledge transfer and translation, science communication, science–policy linkages, science push and policy pull

12.1 Introduction

In the not too distant past, researchers toiled in ivory towers, presenting findings at meetings of learned societies and publishing in obscure journals, often entombing information. As the need for stakeholder and public accountability grew, public relations and '*big C*' communications departments flourished. They trumpeted the scientific discoveries of their institutions to demonstrate the excellence or relevance of their research and, of course, to generate more funding.

In government settings, in particular, their role evolved from broadcasting or 'pushing' the scientific advances of their parent organizations to creating and ensuring consistent, overarching messaging about those institutions—both internally and to the public at large. This resulted in 'closing down' the science communications process, effectively burying uncertainty and staving off debate. One result was a loss of trust in government science: a poll in the UK showed that, while levels of trust in science itself remained stable, government (and industry) scientists were less trusted than their university or not-for-profit sector counterparts (MORI 2004).

In this chapter, we argue that the emphasis on science communication as broadcasting and the drive for consistency and simplicity in messaging do not well serve the needs of either science-based governmental organizations, or the public at large, when dealing with messy, contested issues such as sustainability. These sorts of issues require not only new modes of conducting science, but also new modes of ('*little c*') science communication.

We have seen an increasing realization that complex, contested, contextual issues like sustainability can rarely be 'solved' by traditional, hard, empirical, reductionist, positivist ('Mode 1') science. In the sustainability domain, challenges to the traditional positivist epistemology such as those of Funtowicz and Ravetz (1993), Pretty and Chambers (1993) and Gibbons et al. (1994) have been influential. A new sort of science for tackling contemporary problems was popularized by Michael Gibbons and colleagues in their proposition of the need to move from Mode 1 to Mode 2 science, or 'science in the context of its application' (Gibbons et al. 1994).

It is no longer tenable to rely on the notion of a linear progression through an orderly research process driven by scientists, to a dissemination phase driven by communication specialists, to an adoption phase in which end users (whether in policy or management) presumably apply research findings directly in their everyday activities. Rather, science must be socially distributed, application-oriented,

transdisciplinary, and subject to multiple accountabilities. From a one-way linear process, science is evolving to a multi-party, recursive dialogue.

Coincident with the evolution in science, we are seeing an evolution in science communication. Traditional, *big C* broadcast models of 'pushing' science to undefined audiences are losing ground to more nuanced approaches. Typically, these recognize that different players prefer to receive science information in different ways. In fact, receptivity to new information may be more than a preference (Nisbitt and Mooney 2007)—given which, the framing, mode of communication and character of the communicator of the message have considerable influence on whether it gets through and is acted on.

Communicating science, therefore, has expanded to include *knowledge translation* in which science information is packaged to the preferences, channels and timescales of particular audiences, and *knowledge brokering* in which intermediaries (knowledge brokers) link the producers and users of knowledge to strengthen the generation, dissemination and eventual use of that knowledge. Effective science communication now includes the full spectrum of approaches from broadcast to iterative dialogue. In our contribution, we address the importance of dialogue—of linking producer and user—in ensuring that the right science gets done, that the science information gets out, and that it gets used.

The focus in this chapter is on dialogue with one particular user community—policymakers. Given the role of science in understanding environmental issues and in developing and evaluating possible solutions, policymakers constitute a key target audience for environmental science. A challenge for spanning the science–policy divide, however, is the fact that science provides one narrow window on the world, whereas policy must view the world through multiple lenses. Science is but one stream of evidence that policymakers must obtain and weigh in evaluating future courses of action. Those communicating the science need to be mindful of the crowded evidence and option space into which they are providing scientific information.

There is a vast literature in both agricultural and development extension on the adoption behaviour of farmers (see Gonsalves et al. 2005, Pannell et al. 2006). The literature on the diffusion of innovation is also well established (Rogers 2003). New work in action research and community-based health is building a base of knowledge on how health users interact with and use health evidence (Canadian Institute for Health Research, Canadian Health Services Research Foundation, and others). However, much less has been written about the adoption behaviour of policymakers—the 'demand' side of the science–policy interface—and how science can best inform policy.

Not only is the literature underdeveloped on theories about the interactions between science and policy and on the need to go beyond 'science push' to build 'policy pull', there are few descriptions of practical examples of that emergent theory put into practice. In this chapter, we showcase innovative approaches to bridging the science–policy divide in large institutional settings in Canada, the UK and Australia, based directly on the experiences of one or more of the authors:

- The examples from Canada's federal environment department focus on the development of a little c science communications model, questions about whom

to engage in strengthening links between science and policy, and some of the challenges inherent in changing roles and functions to move to Mode 2 science.
- A specific example of how to open up the policymaking process and engage a broader spectrum of participants is discussed in the context of the sustainable consumption and production goal of the UK Department for Environment, Food and Rural Affairs.
- Lessons learned on building organizational capacity to support 'knowledge adoption' to ensure that the right science is undertaken and used are presented for a research commissioning organization—Land & Water Australia.

Each of these three major sections provides a perspective on the context in which the initiatives arose, with the emphasis squarely placed on the challenges and benefits of practical implementation.

Based on our collective experience, we conclude by making the case for greater investment in knowledge transfer and brokering, and by proposing some future avenues for strengthening and consolidating the field.

12.2 The Beginnings of Knowledge Brokering in Canada

Canada's government has made strong commitments to science and technology (S&T); however, as with other countries, Canada has had its share of incidents in which, for various reasons, key policy issues have not been based on robust scientific evidence.

Crises such as the Atlantic cod fishery collapse (Hutchings 1996) and tainted blood scandal (Krever 1997) led to government-initiated dialogue on how science informs policy. For example, the Council of Science and Technology Advisors report *Science advice for government effectiveness* (CSTA 1999) outlined principles for the provision of effective science advice. The Government of Canada (2000) responded by developing the *Framework for science and technology advice,* and the *Creating common purpose* report (CCMD 2002) explored ways to improve the use of science in the development of federal policy.

A few broad initiatives were developed on the heels of these reports. For instance, a pilot course on the science–policy interface was developed by several federal departments but was not continued. In fact, few initiatives appear to have lasted, the Canadian Health Services Research Foundation[1] being a notable exception, perhaps due to its status as an arm's-length organization chartered specifically to address better use of evidence in the health sector.

The science–policy interface continues to be explored by groups within government (e.g. the 2006 Policy Research Initiative water conference[2]), related

[1] http://www.chsrf.ca

[2] Retrieved 13 October 2007 from http://policyresearch.gc.ca/page.asp?pagenm = rp_sd_water

to government (2007 PIPSC science–policy symposium[3]), and in the non-governmental (2007 *Pollution Probe* water report[4]) and academic (2007 Canadian Water Network knowledge translation planning tools[5]) communities. Strengthening the science–policy interface remains a concern for many in the federal government and those who interact with it.

Environment Canada is both a significant environmental science performer and the responsible federal authority for policy and regulation development, programme delivery, and enforcement in a range of environmental areas. This being so, the interface between science and policy is critically important in ensuring effective use of limited resources to deliver on an extensive mandate.

Environment Canada's *Science plan* (EC 2007) notes:

> Recognizing that transmitting new scientific knowledge to decision makers is a key role of government science, the [department's] S&T Branch will promote more effective communication between scientists and decision makers.

In this section, we highlight one successfully sustained Environment Canada initiative that developed into a broad departmental effort to strengthen the science–policy interface. The initiative focused on freshwater systems, but provided lessons for other science-based environmental issues.

Fresh water is an Environment Canada priority. A key federal role is providing scientific knowledge upon which decisions and sound policies and regulations for safe and secure water for Canadians and ecosystems can be based. A world leader in freshwater issues for over 30 years, Environment Canada's National Water Research Institute (NWRI) has led influential, multipartner, national scientific assessments of current and emerging threats to water quality, water quantity and aquatic ecosystem health. That scientific knowledge is used by water policymakers and decision makers at all levels of government.

12.2.1 The Evolution of 'Little c' Science Communication at the National Water Research Institute

Despite some worthy efforts in the 1990s, communicating the NWRI's considerable scientific output was until recently the responsibility of only one or two people. They engaged in routine internal reporting, with relatively little profile and no capacity for substantive science communication. In 2001, senior science managers recognized the increased importance of the Institute not only generating scientific

[3] Retrieved 13 October 2007 from www.hyper-media.ca/pipsc

[4] Retrieved 13 October 2007 from www.pollutionprobe.org/Reports/WPWS%20Final%20Report%202007.pdf

[5] Retrieved 13 October 2007 from http://cwn-rce.ca/pdfs/CWN%20KT%20Tool%20Kit%20for%20Web.pdf

knowledge, but translating and disseminating that knowledge to better inform the decision-making process, and thereby helping to resolve environmental issues of regional, national or international significance to Canada.

As a result, and in a first for Environment Canada, a new director position with equal status to NWRI research directors was filled and the science liaison function was augmented. An increased contingent of six to seven staff, most with a science background and with dedicated expertise in science writing and the links between water science and policy, was assigned to the unit. With this new profile and mandate, the Science Liaison Branch (SLB) initiated new activities targeted at better informing a multisector audience of water policy and programme practitioners. These included writing science summaries, developing internal and external newsletters, profiling national science assessments, redefining the web presence (www.nwri.ca), and undertaking selected science writing tasks in sector newsletters.

The SLB niche was carved out as one of *little c* science communication, rather than the traditional work of the far larger departmental Communications Branch. In addition, the SLB began to develop tools (mostly databases) allowing better organization of research activities and outputs so knowledge could be quickly accessed and packaged, both for routine reporting and as input to more significant programme or policy initiatives.

Quite intentionally, products and tools were developed collaboratively with NWRI researchers, resulting in raised awareness of the value of the SLB's function, greater efficiencies in responding to routine reporting requirements (yielding fewer requests and interruptions for scientists), and enhanced credibility for SLB-led products. A level of trust was built based on common goals, after which one further initiative helped in developing a more rounded knowledge-brokering unit.

12.2.2 The Science–Policy Workshop Series

In response to deaths in Walkerton, Ontario, in 2000 due to contaminated drinking water, and the resultant expectation of strengthened drinking water-related legislation and source-water protection rules, the Canadian Council of Ministers of the Environment (CCME)—composed of federal, provincial and territorial environment departments—asked the NWRI to broker a series of national workshops on water science and policy. The intent was to bring leading researchers together with policy and programme managers to provide recent science to practitioners (the policy and programme community, in all sectors), identify research needs and develop mechanisms for sustaining dialogue. The logic was that any new policy, regulatory or programme initiatives would be stronger if informed by the latest aquatic science knowledge. Because of its unique mandate, the SLB was well positioned to broker the meetings.

Five issue-specific, invitation-only science–policy workshops were originally held under the CCME 'banner' (for example, groundwater quality, water reuse and recycling). Subsequent meetings were organized under the lead of the NWRI.

In addition to supporting face-to-face discussions and networking opportunities, the SLB led development of various resource materials and workshop reports that were then more broadly disseminated to selected water research and resource managers, posted online, and presented at numerous meetings and events.

The anecdotal response was very positive; subsequently, workshop participants were surveyed to develop a metric of effectiveness for the better linking of water science with policy and programme initiatives. Ninety per cent of the policy/programme managers surveyed stated that the workshops and their products directly informed decision making about the development of a specific policy, programme, regulation, guideline, strategy or some other related management decision. Similarly, 90% of responding scientists and research managers reported that the workshops had been useful in refining their own organization's research priorities.

Although feedback suggests that the workshops were successful (Schaefer and Bielak 2006), participants viewed the sessions only as a first step. There was a clear sentiment that sustained dialogue and interaction would be essential in ensuring that science more routinely and significantly informs decision making. On this point, respondents preferred to stay networked through some form of regular electronic contact (web link and email lists), with occasional face-to-face meetings as the science developed.

These kinds of knowledge-brokering activities also received attention internally. In 2006, Environment Canada's Assistant Deputy Minister[6] of Science and Technology tasked the newly named S&T Liaison Division to broaden its mandate beyond its roots in water S&T to represent the full breadth of Environment Canada's S&T and enhance knowledge transfer within and beyond the S&T Branch.

Like many other major research organizations described in this chapter, the NWRI has made a concerted effort in the past few years to better communicate its science to targeted decision-making audiences. In some cases, bringing the science and policy communities together has been a direct and very positive experience. Nevertheless, the science–policy divide often remains, and greater effort needs to go into bridging it. One of the ways Environment Canada has sought to address the gap internally has been to understand where people actively work as intermediaries between science and policy, focusing particularly on policy analysts and their roles as translators or interpreters between the two worlds.

12.2.3 The In-between World of Policy Analysts

Until recently, considerations of the science–policy interface at Environment Canada focused largely on the role of scientists. Researchers were concerned that policy development did not make adequate use of relevant science, and often voiced

[6] See Environment Canada Organizational Chart; retrieved on 10 December 2007 from http//: www.ec.gc.ca/introec/org_chart_e.htm

frustration at the lack of feedback on how their science had been used to inform policy. Training in science communications (see, for example, STAB 2000, Bielak et al. 2002) and the science–policy interface was considered, developed and taken up positively in Environment Canada's science community. However, funding proved intermittent and insufficient: training the department's large science workforce to work more effectively at the science–policy interface is perhaps unrealistic, at least in the short term.

Over the longer term, Environment Canada and government departments around the world may find that new hires are better equipped to act at the science–policy interface as universities and professional societies react to the need, especially in environment-related fields, for graduate students skilled not only in research but also in collaboration, communications and negotiation. Initiatives such as the Aldo Leopold Leadership Program in the US are beginning to address the need for scientists to be better communicators and leaders.[7] However, they are currently doing so at the rate of 20 fellows per year. A recently introduced bill in the US House of Representatives[8] seeks to provide training in communications skills for US-trained scientists to ensure that they are better prepared to engage in dialogue on technical topics with policymakers and business leaders. However, it has yet to be approved and implemented.

At Environment Canada, we (AB, SP and KS) wondered if there was another point of influence that might allow improvements in the shorter term. At the other side of the science–policy interface are policymakers: if training scientists to better 'push' their research into the system is too slow, might training their policy counterparts be more effective? In the Canadian Government, at least, senior policy and other decision makers (such as politicians) generally do not have scientific backgrounds, and science is but one of myriad streams of evidence and opinion they must weigh in making decisions. Thus, it might be even more challenging to train policymakers and other decision makers to be good clients for science[9] than to train scientists to be better communicators.[10]

How is it, then, that *any* science crosses the great divide into policy in Environment Canada? At an internal workshop on the science–policy interface in

[7] http://www.leopoldleadership.org

[8] See the bill to create the Scientific Communications Act of 2007 (introduced in US House of Representatives) [H.R.1453.IH]). Retrieved on 11 December 2007 from http://thomas.loc.gov/cgi-bin/bdquery/z?d110:h1453

[9] An interesting initiative in this regard is the EXTRA programme run by the Canadian Health Services Research Foundation (http://www.chsrf.ca/extra/index_e.php). EXTRA trains 24 health care managers each year to be better users of research evidence. However, the programme's target population includes nurse, physician and other health administration executives, who may have higher scientific literacy than senior policymakers and decision makers in the Canadian Government.

[10] Because of the ever-increasing S&T component in modern decision-making, it may be valuable for scientists to develop expertise in the policy domain and move directly into decision-making roles.

March 2005, staff suggested an important but, they felt, unacknowledged role for policy analysts as 'bridgers' between the two 'solitudes' of science and policy in the department. An international workshop was convened in December 2005 to consider whether 'policy analysts' might be the missing link between science and policy. Experts from a wide range of disciplines (including environmental science, science communication, public management, planning, knowledge management, public understanding of science, and science policy) endorsed the assessment that by bridging the 'two solitudes' policy analysts and other intermediaries performed a critical but under-studied role in the science–policy interface.

An attempt was initiated to better understand who carries out these intermediary roles within Environment Canada, and their background, work, challenges and place in the department. In 2007, narrative interviews were commissioned with 65 science and policy staff who were thought to perform linking or bridging functions within Environment Canada. Two workshops to analyse and validate the results from the interviews were subsequently held with other science and policy staff who were thought to be functioning in brokering roles. Participants confirmed that, despite some good practices throughout the department, the science–policy interface could still be considerably strengthened to better support environmental decision-making.

A key finding from this research was that a set of people in Environment Canada clearly identify themselves as working in the intermediary role. Although their official job titles rarely acknowledge that function, they see a core role for themselves as operating at the boundary between science and policy. One of the significant outcomes from the workshops was the formation of a nascent community of practice of intermediaries within Environment Canada.

In addition to clearly identifying this role as important to Environment Canada, participants flagged key factors affecting their ability to carry out the role. From the vantage point of the science or policy unit in which they were housed, they stressed that information on the activities and priorities of the other side was difficult to obtain. Those intermediaries based in science units reiterated frustrations expressed previously by the science community that there is little feedback about how science input to the policy process is used. Those in the policy domain struggled to know where, among Environment Canada's 4,000 or so S&T staff, to direct a particular science question. Given the stated preference of participants and interviewees—and, according to the literature, their counterparts in other organizations—for consulting an expert over consulting published sources, the capacity to find the right expert is critical.

All noted that good working relationships are key for an effective interface. Policy analysis involves working with people as well as with information and so requires both relational and informational work. However, competencies such as facilitation and relationship building, both critical for creating trust, are important skills not often emphasized when training or hiring policy analysts.

In Environment Canada, relationships across the science–policy divide are sometimes deliberately fostered through bridging or brokering groups within science units that cultivate good 'client' relations. Sometimes, they result from serendipity

—chance encounters at workshops, exchanges at bus stops.[11] Often, tenure in the department is a good measure of people's networks. This factor favours intermediaries and brokers rising up through Environment Canada's science units, where tenure has typically been quite stable. In contrast, the policymaking community within the Canadian Government—like government departmental staff elsewhere—are highly mobile. Turnover in the policy ranks remains a significant challenge to strengthening the science–policy interface at Environment Canada.

In responding to the issues raised through the interviews and workshops, it is important to be mindful of the need to address both systems and people issues. Knowledge of current Environment Canada priorities and activities, and of where expertise lies, can be improved through better information systems (such as expertise inventories, databases of plain-language research summaries, and maps that align research activities with desired departmental outcomes).

Building brokering capacity will require Environment Canada to make work placements, training and mentoring available to budding intermediaries to strengthen their skills (for example, in communications, facilitation and negotiation) and to help them build effective networks on which they can draw. It might also require changing the hiring profiles of policy analysts to bring in people who already have such skills and the right mix of technical and policy backgrounds.

To drive such a shift in hiring would require increased recognition that brokering is an important role in a department, such as Environment Canada, that works in the highly complex and contested world of environmental policy. This brings us full circle to the *cri de coeur* of policy analysts at the March 2005 workshop: that their work was not acknowledged or valued.

Building recognition that brokering is a required function for Environment Canada is going to take more than exhortations and academic treatises on its value. A demonstration project to track and evaluate specific contributions of brokering to its success is currently under consideration. It will build on the learning from the narrative interviews and subsequent workshops and will use the experience and expertise of the nascent community of practice of intermediaries across the department. The evaluation component will not only document the value of brokering to the advancement of a particular issue, but also support the transfer of brokering approaches to other environmental issues that the department manages.

Environment Canada has focused over the past few years on identifying who needs to be better involved in the effort to improve dialogue between science and policy. Although the capacity of both policymakers and scientists to engage each other directly needs to be bolstered, progress is being achieved in the short term by focusing on intermediaries—those who work in between science and policy, whether individuals (such as policy analysts) or dedicated *little c* translation and brokering units (such as the S&T Liaison Division).

[11] In fact, the authors of this chapter developed their (interagency) relationships through a series of chance encounters.

12.3 Communicating into Policy Via the Evidence Base in the UK

In the UK, a small team at the Department for Environment, Food and Rural Affairs (DEFRA) experimented with novel ways to create a science–policy dialogue, designing a technique to open up the policymaking process not only to scientific evidence, but to an altogether broader array of evidence. This allowed policy teams to work as knowledge brokers and improve the dialogue at the science–policy interface. The technique focused on drawing science into policy rather than communicating it outwards, ensuring that the policy teams developed a better understanding of science's contribution to their policy goals.

Many people have attempted to describe the policy process, using analogies ranging from 'a constantly shifting jigsaw' (Levitt 2003: 14) to 'painting a water colour picture' (Kathryn Packer, then an independent consultant to DEFRA, pers. comm., October 2007). The image explored in this section comes from Parsons' (2002) critique, *From muddling through to muddling up: Evidence-based policy-making and the modernisation of British Government,* particularly the idea that Parsons draws from Schön (1983: 2), that modern evidence-based policymaking is predicated on the existence of a 'firm high ground' in the 'swamp' of policymaking; and that the task for policy is to 'map it out and occupy it' (Parsons 2002). Is this a better representation of the policy process? Does a high ground really exist? If it does, is it stable and can we map it? Do such maps have any utility in policymaking? If they do, what tools should policymakers use to create them, and how should the maps be read?[12]

Policymakers have limited opportunities to present the fullness of their work to parliamentary ministers. Their work is complicated by changes in interests and priorities brought about by the arrival of new ministers, which often have a profound impact on the work of policy teams.[13] Can policymakers produce maps that bring sufficient breadth of evidence to ministerial discussions of the policy landscape and encourage rigorous analysis of alternative interpretations, when the reality is that severe time pressures drive them towards narrow channels of problem-specific questions?

We explore these issues using a UK case study, in which 'lines of argument' were developed to help formulate the evidence strategy for sustainable consumption and production (SCP) policy. The study shows why policy's 'firm high ground' is

[12] The focus is on Parsons' description of Schön's analysis because of the strength of the imagery, but the critique holds for other models of the policy process that assume the existence of stable areas where the supply of evidence and the demand for it are reconciled (see, for example, McNie 2007, Sarewitz and Pielke 2007).

[13] Over the period of this case study (2005 to 2007), three different people occupied the position of Secretary of State for the Environment in the UK. Each brought a different set of policy priorities, as did the new occupants of the junior ministerial positions, most of whom changed with each reshuffle.

an illusion: a snapshot map of the policy environment will fail to reflect its constantly changing nature. If more effort can be put into developing tools that reflect this mutability and can handle contradictions and multiple interpretations, the evidence base can be used to communicate complex messages from a wide variety of stakeholders *into* the policy process.

12.3.1 The Work of the Sustainable Consumption and Production Evidence Base Team

SCP is one of the four priority areas for action set out in the UK's strategy for sustainable development, *Securing the future* (DEFRA 2005) and is one of DEFRA's five strategic priorities. Central to its delivery is the vision of more effective and innovative products that respect environmental limits and leave natural resources unimpaired for future generations. This requires a major shift to deliver new products and services with lower environmental impacts across their life cycles, new business models that meet this challenge while boosting competitiveness, and new approaches to encouraging consumer behaviour change.

This presents policymakers with particular challenges in developing an evidence base for SCP. First, the long-term goals of SCP policy (a 'one planet' economy, decoupling economic growth from environmental degradation via better products, production processes and consumer behaviour change) may be far in the future and thus unclear. Second, there is very little certainty about the scale of the global impact of UK policies, the environmental limits within which we are working, or the time horizon over which policy outcomes are delivered. SCP is largely an influencing rather than a delivery programme; an important aspect of evidence development is to assess whether the current range of government policies really delivers the full SCP agenda or whether a wider range of policy instruments is needed.

The SCP team's task was to design an evidence base that reflected four key issues:

- Long-term policy goals that were—and remain—nebulous and contestable, with different interest groups lobbying for different interpretations of 'sustainability'
- The poor understanding of government's role in fostering and supporting innovation (Smith and Stirling 2006), particularly innovations that are changing the framing of environmental policy (carbon footprinting, life-cycle analysis) or its focus (wind energy, nanotechnology)
- A pan-government focus on the need to maintain analytical rigour to ensure that policy options were based on robust evidence
- A desire to open up the policy process to a wide variety of external stakeholders rather than close it down (see Rayner 2003, Jasanoff 2005, Stirling 2005)

The evidence-based policymaking movement may still be a peculiarly British concept (see Solesbury 2001), but it has matured over the past two decades and outgrown its original home in the world of medicine, moving into the social sciences and—after

the BSE and foot-and-mouth disease crises in Britain in the early 1990s—into environment science and S&T studies (see DEFRA 2006, Sorrell 2007). In this process, our understanding of the relationship between evidence and policymaking has moved on from the Schönian perspective: it has adopted the idea that knowledge production, particularly in the sciences, is more distributed (see Gibbons et al. 1994).

The SCP team started with the idea that evidence for policy emerges from three types of information: data, analytical evidence, and stakeholders' views and opinions. By engaging with stakeholders in a structured way, which brings rigour to the data and to analysis, we can establish a 'line of argument' between the particular goal definition of a stakeholder group, the values inherent in that definition, and the evidence that stakeholders believe will validate their conviction that this is the path policy should take.

Different stakeholders present different lines of argument, often because they favour different approaches to the delivery of the same goals (for example, technological solutions, green taxes or cultural change), and may be selective in their use of analysis and data to support their case. In addition, stakeholders such as lobby groups, who have firm views based on a particular value set (and often strong media skills), need to have their views and the evidence on which they are based set in the context of the real breadth of evidence that surrounds every policy question. By encouraging this diversity and presenting stakeholder opinions in a structured fashion, we begin to map out the existing framings of the potential paths policy could take. The process of constructing those frames—as lines of argument—allows a mix of policymakers and external stakeholders to jointly explore the diversity of values, goals and innovation needs that permeate the complex issue of sustainability, while ensuring that discussions are based on the best available knowledge.

Lines of argument workshops (held in 2006) drew on the Cynefin knowledge management framework (Kurtz & Snowden 2003) and the 'five whys' problem interrogation technique.[14] Backcasting was used to help participants focus on the SCP policy goal of a 'one planet economy' by 2020: they were then asked to think about what would need to have happened for this goal to be achieved. This helped draw out the potential richness of the SCP policy goal, allowed alternative views to emerge, and encouraged participants to think as freely as they could about the different business and policy pathways that were being constructed.

Participants were then allowed to self-organize in small groups on the issues they deemed important, and asked to discuss and write down answers to five questions, capturing disagreements and alternative opinions in their answers to allow different lines of argument to emerge as discussion progressed. The questions were asked in strict order:

1. 'Why is this issue important?'
2. 'Why is change happening?'
3. 'Why do we need to intervene to change the impact of this change?'

[14] See http://www.tda.gov.uk/upload/resources/pdf/f/five_whys_analysis.pdf

4. ‘Why should government intervene?’

Participants summarized the answers into a line of argument that addressed the overarching question:

5. ‘Why does (or doesn’t) government need a policy on this issue?’

This was then used as the basis for answering the question the team would use to formulate the evidence base for each potential policy path: ‘What evidence do we need to develop this policy?’[15]

Although lines of argument are very simple precursors to potential policy formulations, they allow a real two-way dialogue between the knowledge base and the policy goals, and help us to focus on the future, look for innovation gaps and explore changing values. Wind energy is a simple, hypothetical example of this: the development of cost-effective wind turbines and the rise of the green movement have contributed to wind energy’s move from being a niche issue 20 years ago to being well embedded in government policy today.

What might have happened to energy policy in the UK had a broad variety of stakeholders been involved in this sort of interactive and forward-looking policy development process 20 years ago? Might different choices have been made along the way? It is impossible to answer this in retrospect, but the SCP team worked on the principle that an open approach to developing and presenting lines of argument responded to the four issues outlined at the beginning of this section. First, it allowed multiple and often competing definitions of sustainability to coexist, valuing dissent and alternative interpretation (see Shaxson 2005). Second, the technique broadened thinking about the full range of innovations that might emerge or be needed. Third, well-defined processes were used to ensure analytical rigour, piloting workshop techniques and seeking expert advice on the robustness of the lines of argument. Fourth, the process opened up the ‘black box’ of policymaking, making it clear both to policy teams and to external stakeholders that the role of policymakers is to structure choice for decision makers based on robust evidence and analysis.

An internal evaluation of the technique concluded that it is a cost-effective yet powerful method of scoping an evidence base for policy, and for communicating *policy* questions—rather than *research* questions—to a wide variety of stakeholders. For the sustainable food agenda, the lines of argument worked effectively, moving the policy question from a narrow concentration on biodiversity to a far broader focus on life-cycle analysis, which allowed a challenge to the prevalent assumptions about the energy component of food miles (see AEA Technology 2005). Similarly, the team assessed whether the contested concept of ecofootprinting, on which the One Planet Living agenda is based,[16] should be used to underpin DEFRA’s sustainable development policy. A report commissioned after the lines of argument work (RPA Ltd 2007), used

[15] Throughout, it was stressed that evidence fulfils five functions in the policy process: it *challenges* received wisdom, *enriches* our understanding, *explains* complex issues, *confirms* what we think we know, and *scopes* opportunities for change (see DEFRA, 2005).

[16] See http://www.wwflearning.org.uk/ecological-budget

a breadth of evidence to help the SCP team conclude that 'the ecological footprint should not, as yet, be used as a headline sustainable development indicator'.[17]

Lines of argument have real value in new policy areas where there is little evidence or where policymakers need to examine how well available evidence aligns with new policy goals. They can also be used to check the coverage of the existing evidence base: even in aspects of SCP policy that had existed for several years, the team found areas where the evidence was surprisingly sparse. The method can also be used where there is a need to think more strategically about policies, where there is a need to engage with stakeholders more effectively and earlier in the policy process, or where there is uncertainty in the policy environment and the evidence is contested or open to alternative interpretations. Opening up stakeholder dialogue in this structured way helps policymakers see that challenge and alternative interpretation are inherent parts of the process of generating evidence and analysis: it ensures that participation in the policymaking process is not 'closed down' by encouraging consensus where none exists. In doing so, it ensures a real two-way communication between policy and external stakeholders.

Parsons (2002) makes the point that policymaking needs to be a process of organizational and public learning, which means understanding the reason for an alternative interpretation of the evidence: that is, is it because of uncertainty in the evidence, differing levels of knowledge, or opposing values? While the maps do not provide answers, they move us away from the situation of 'knowledge fights' (van Buuren and Edelenbos 2004). Even using simple lines of argument to structure choice for decision makers allows for a good shared understanding to develop about all the current framings that policy could take and the reasons for the differences between stakeholder groups, and clarity in the choice of policy options when the decision is made. The maps serve other purposes—they allow a deeper interrogation of the values underlying the different paths, promote a more forward-thinking approach than government might often take (Bochel and Shaxson 2007), and provide a robust analytical framework against which we can identify evidence needs to help decision takers make valid judgements.

At any one time there may be multiple 'high grounds' that represent 'better' choices for decision makers. With issues such as sustainability there will always be conflicting understandings of what constitutes 'better'—and it is for politicians, in their roles as decision makers, to judge exactly which version of 'better' to pursue. In addition, any innovation or change in values will change the topography in ways that cannot be precisely anticipated: it may raise new 'high grounds', lower existing ones, drain swamps or reveal paths that were hidden.

Though admittedly in its infancy, the lines of argument technique is able to allow for all this. It has the potential to bring rigour and sophistication to our maps, forcing us to think in more detail about the relationship between evidence, policy and the democratic process.

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[17] See http://www2.defra.gov.uk/research/project_data/More.asp?I = SD0415&M = KWS&V = footprinting&SCOPE = 0#Docs

12.4 Fomenting Synergy between Science and Policy in Australia

The Canadian and UK case studies describe various methods for improving the demand-pull on science from policy by using intermediaries and structured dialogue. The Australian case study shows how it is possible to take these further still. Improving organizational capacity and allocating resources to knowledge activities, not just knowledge products, is central to building a robust and reflexive relationship between science and policy. We need to focus less on 'communicating science' and more on creating a robust and durable relationship between the two communities, leading to better uptake and greater impact of knowledge more generally.

Over the past decade or so, Australia has seen an evolution in approaches to science communication that parallels developments in Canada and the UK. This has been accompanied and stimulated by changes in how the research process itself is funded, organized and managed.

The focus here is on applied research to inform more sustainable management of natural resources in Australia. In particular, this section focuses on practical measures that can be implemented to deliver more effective linkages and interactions between science and policy for complex contemporary issues, such as sustainability. The section draws on experience over the past 15 years within Land & Water Australia (LWA), an Australian Government research funding authority, in trying to organize research investments so that they deliver useful and influential outcomes for policymakers and managers of natural resources.

12.4.1 Science and Policy Down Under

LWA funded dedicated research programmes exploring the adoption of sustainability measures by landholders from the early 1990s. Yet, despite the all-pervasive influence of policy settings in determining the relative attractiveness of sustainability measures across all sectors of the economy (for example, in shaping property rights or trying to influence behaviour by offering juicier carrots or wielding smarter sticks), by 2000 LWA had not funded a single research project on the adoption behaviour of policymakers.

Like most science organizations and research funding bodies, LWA had corporate and programme-level 'communication strategies' overseen by a communication manager supported by a 'communication team' made up of 'communication officers'. Until 2000, this effort was modest (around 3% of total expenditure) and consisted primarily of corporate public relations and publishing research results in a traditional 'science-push' effort.

From 2000, with a new CEO, LWA took a new strategic direction. The 2000–2005 strategic plan set five corporate objectives: leadership, influence, relevance, return on investment and accountability. All these implied a close, interactive

relationship with the corporation's principal shareholder and main sponsor—the Australian Government. Given the importance of policy innovation in pursuing sustainability, the government is also a key client, just as much as the on-ground managers of natural resources.

Having set such objectives, and having identified policymakers as an adoption target in the same way that it had previously characterized farmers, it was clear that LWA also needed a communication strategy for this client group, just as it was accustomed to preparing for water authorities and farmers. It was equally clear that this strategy needed to be based on an interactive, knowledge-brokering model, rather than a traditional science-push communication effort.

12.4.2 From 'Communication' to Knowledge and Adoption

In the early 2000s, LWA became uneasy with the terminology used in the 'communications' field. Despite its interactive connotations in popular everyday usage, in the science/extension domain 'communications' is associated primarily with one-way dissemination and promotion of research outputs. Yet in order to demonstrate leadership, to be influential and relevant, LWA had to be funding good science on the big important issues. To deliver a good return on investment, knowledge generated by research had to be adopted by intended users in policy and management spheres. No matter how elegant or insightful the research project, LWA's interest, as an applied research investor, was in its uptake and eventual impact.

LWA realized that it was essentially in the business of investing in *knowledge* and its *adoption*, so it dropped 'communication' and recruited a new Knowledge and Adoption Manager. It developed a Knowledge and Adoption Strategy[18] and a new team of professionals to implement the strategy, with commitment from the corporation's board to quadruple the previous communication budget to around 18% of total expenditure by 2006.

The Knowledge and Adoption Strategy drove LWA's corporate Evaluation Strategy, because it distilled the three key questions to answer in judging overall performance:

- What knowledge assets have we generated?
- What do we know about the uptake and application of that knowledge among target client groups?
- What are we assuming or do we know about the impact of the application of that knowledge?

The second and third of these questions are more complicated and expensive to answer than the ones that precede them, with increasing attribution difficulties.

[18] See http://www.lwa.gov.au/Practice/index.aspx

Nevertheless, there is much value in being as explicit as possible on assumptions about how an investment in science will make a difference, and then to follow through to track that application.

The changes at LWA went far deeper than just changing job titles and position descriptions. With support from Dave Snowden from the then IBM Institute for Knowledge at Cambridge University and his colleagues, LWA overhauled its whole approach to managing and evaluating its portfolio of research investments (1,600 projects back to 1990). Some of the manifestations of this work included the following.

- Instead of considering research projects as 'completed' when the last research payment has been acquitted and then archiving the project files, all projects are now considered to be 'live' investments and their knowledge assets to have potential value regardless of their age, consistent with Snowden's (2002) notion of knowledge as a 'flow' rather than a 'thing'. Projects are likely to be evaluated every several years on an ongoing basis, because as much or more is learned from evaluating the adoption and impact of 10–15-year-old research projects as from very recent projects.
- Different knowledge domains (for example, local knowledge, Indigenous knowledge and strategic knowledge) are considered more explicitly in addition to formal scientific knowledge, and funding is targeted to modes of inquiry that recognize them and understand their characteristics; for example, Community Fellowships to help experienced amateurs share their hard-won lessons more widely (LWA 2006).
- The diverse ways in which knowledge is expressed (Snowden 2004a) are also recognized, and LWA has experimented with different ways of drawing out and sharing tacit, experiential knowledge among scientists, its own staff and end users of research, including techniques such as story circles (Snowden 2004b).

The lessons from this experience are discussed in more detail in Campbell (2006), Campbell and Schofield (2007), and Schofield (2005); however, some key points relevant to policy audiences are distilled very briefly here.

12.4.3 The Knowledge-Seeking Behaviour of Policymakers

When LWA started to treat policymakers as an adoption target—analogous to but different from farmers—it realized a need to know more about their knowledge-seeking behaviour. Several broad findings emerged from reviewing the knowledge-seeking behaviour of policy professionals in natural resource management agencies:

- They only know what they need to know when they need to know it, and so are generally poor at defining knowledge needs or research questions.
- They tend to be time-poor, information-overloaded people who do not read anything unless they have to.

- They have a very short term perspective driven by a reactive political context and are very responsive to parliamentary ministers' needs (which, in turn, can also be influenced by science).
- They know they need to be able to summarize information in less than a page for the minister or the minister's office, and hence tend to be averse to anything that seems too complicated.
- They default to trusted sources, often in-house, even when they know those sources are out-of-date or incomplete.
- They are rarely as skilled in using web-based tools or formal, refereed scientific sources as amateur community volunteers and non-government organizations; they tend to simply ring up the departmental library and ask 'What have we got on this?'
- They often have a jaundiced opinion of science, research, or both, believing that they are too slow and too expensive, and invariably answer questions that no one has asked, usually accompanied by requests for more funding.

Against that background, LWA developed a specific engagement strategy for policy audiences.

12.4.4 Techniques to Engage Policymakers More Productively with Science

Word limits preclude a comprehensive explanation of LWA's approaches, but some of the most successful tools included:

- Working out preferred times and places for discussing technical matters (for example, senior executives favour breakfast briefings for face-to-face interaction, and they are more likely to read emails with carefully distilled science information on Sunday night at home)
- Careful scoping of research questions with policy people at a very early stage in the research process
- 'Over the horizon' issues scanning, with a quarterly analysis presented in distilled form
- Development of specific knowledge management tools targeted to the policy-maker's daily operating environment (one click on their Windows desktop)[19]
- Targeting talent ('fast-track individuals' in middle management as well as 'key influencers') with special face-to-face briefings, invitations to events and distilled information
- Finding out who is in the minister's 'kitchen cabinet' and targeting them as key influencers (LWA keeps a register of its 100 most important key influencers constantly updated)

[19] Such as the NRM natural resource management toolbar: http://www.lwa.gov.au/regionalknowledge_e-news

- Never breaking the 'no surprises' rule (while not being party to censorship)—where research findings are potentially contentious or embarrassing for the government, key senior executives or political staffers are briefed in advance, so that they can be better prepared before issues hit the media

The most important aspect in organizing policy-useful research is to get the research question right. This means investing in specific measures in close consultation with end users to elicit and articulate knowledge needs. Done well, this process develops understanding of the adoption context and consequently the design of the research process from the outset. Knowledge and adoption activities should be hard-wired into the research process throughout.

12.5 Investing in Knowledge Brokering

Knowledge brokering is typically used to refer to processes used by intermediaries (knowledge brokers) in mediating between sources of knowledge (usually in research) and users of knowledge. Knowledge brokering is usually applied in an attempt to help knowledge exchange work better for the benefit of all parties. It involves bringing people together, helping to build links, identifying gaps and needs, and sharing ideas. It also includes assisting groups to understand each other's abilities and needs, and guiding people to sources of knowledge. This may include summarizing and synthesizing research and policy into easily understood formats and translating policy problems into researchable questions.

Knowledge brokers help to ensure relevance; that is, that research is answering the right questions and that policy stakeholders are engaged in the inquiry process and have some ownership of its outputs. They can also influence the research process by providing opportunities for stakeholders to get involved in a meaningful way. Dedicated (*little c*) science communications and targeted knowledge-brokering activities are growing in importance; we are now seeing the genesis of specialized knowledge-brokering units and job descriptions.

Such groups and individuals must be comfortable in initiating dialogue and operating in the worlds both of the scientists and of science users, be able to fashion research outputs into language that can be understood by the users, and help develop researchable questions from articulated knowledge needs and deliver the information in timely fashion. They should be trusted, valued and respected by both communities. The information they provide must be based on robust evidence, obviating attempts to blindly navigate the science and policy swamps, and thus reducing transaction costs at the science–policy interface.

To design, develop and deliver these sorts of tools, LWA invested deliberately in various forms of knowledge brokering. In fact, it now considers knowledge management and brokering to be one of its three lines of core business. The evident success of this strategy for the organization (the non-core budget of which has increased as a result, to the point that around 60% of its total expenditure is third-party

funds[20]) should be a powerful incentive for others to understand the importance of an appropriate balance between science-push and policy-pull and the need to invest in dedicated mechanisms and people accordingly.

12.6 Conclusions

This chapter describes applications of an emerging model of science communications on three continents. The model goes beyond the prevalent, traditional science-push to consider the 'pull' for information from those who need it. It is clear from the literature and from our experiences that there are both a need for and clear advantages to this new mode of science communication: instead of simply getting messages across, we provide information that can readily be used in policy. It is also evident that practical application of the model is far from widespread. We need to move from theory into practice.

Timing is everything. The Canadian, UK and Australian case studies were developed separately, but all have been informed to some extent by the work on knowledge management by Dave Snowden, who frequently makes the point that knowledge is most useful *when* it is needed. For the policy environment, in particular, this means that robust, interactive, ongoing relationships between science and policy, supported by good knowledge management systems, will be more effective than traditional science communication approaches in ensuring that policy is based on the best available knowledge.

The examples we have provided are all from the environmental sustainability domain—one we have simplistically characterized as 'messy' from a policy perspective, and one where traditional science communications approaches do not work particularly well because science has no monopoly of sustainability knowledge.

In a metaphor often used at LWA, we propose that organizations 'fund the arrows, not just the boxes'. Typical organizational charts are composed of boxes connected by lines and arrows, but budgets typically allocate all funds to the boxes. Good knowledge and adoption activities do not just happen—they have to be resourced. In other words, money has to be allocated to the arrows as well as to the boxes. And the arrows should be two-way.

Resilient systems to support knowledge brokering must be put in place to make such brokering activities possible, while existing staff and new hires with the specialized skills to act as brokers will make them happen.[21] This will allow a shift from a

[20] See LWA 2005–06 annual report, retrieved on 14 October 2007 from http://downloads.lwa2.com/downloads/publications_pdf/PR061205.pdf

[21] The UK's Chief Science Adviser wrote in a recent article in *Nature* that 'for scientific advice to underpin government action, communications skills must be a much bigger part of scientific training and culture' (King and Thomas 2007).

'products' model, to a marketplace of products tailored to specific audiences, to iterative knowledge brokering based on ongoing, durable relations (working with the users of information on custom designs, and incorporating domains other than science).

Finally, given the interest in the emerging field of knowledge brokering for environmental sustainability, and our experience that this is a diffuse domain where the players are often working with little support, publishing in a multiplicity of forums, perhaps with few contacts in the field, we consider that it would be very beneficial to see a broader community of practice established to help bring people together. We propose the creation of a regular forum dedicated to knowledge brokering, where the community can meet and exchange information and experiences.

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