INSTITUT DE RECHERCHE SUR LA SCIENCE, LA SOCIÉTÉ ET LA POLITIQUE PUBLIQUE
INSTITUTE FOR SCIENCE, SOCIETY AND POLICY

Policy Brief Series
Science/Policy Interface
2
May 2014

From Many to One:
Integration of Knowledge and Values in Decision-making

Matthew Gaudreau and Marc Saner
University of Ottawa

uOttawa

issp.uottawa.ca

Note from the Series Editor

This policy brief, part of a series by the Institute for Science, Society and Policy (ISSP) at the University of Ottawa, is supported by a SSHRC Public Outreach grant (#604-2011-0007). The goal of the series is to mobilize academic research beyond the walls of universities. The series is directed at public servants operating at the science/policy interface in Canada and abroad. It has been designed to bring forth some themes and findings in academic studies for the purpose of synthesis, knowledge transfer and discussion. This brief is the second in the series. The ISSP also carries out adjacent activities on the topics covered in these briefs. We hope they will be well received and are looking forward to any feedback you may have. You may reach me directly at msaner@uottawa.ca.

Marc Saner

Director, ISSP

Titles in this Series

(1) (Policy Brief) Researchers are from Mars; Policymakers are from Venus: *Collaboration across the System* – by Matthew Gaudreau and Marc Saner
(2) (Policy Brief) From Many to One: *Integration of Knowledge and Values in Decision Making* – by Matthew Gaudreau and Marc Saner
(3) (Policy Brief) Dealing with Not Knowing: *Evaluating and Communicating Uncertainty at the Science/Policy Interface* – by Matthew Gaudreau, Michael Bordt and Marc Saner
(4) (Workshop Backgrounder) Making it Work: *Improving the Interface Between Scientists and Policy Makers: Management Incentives* – by Sasha Kebo and Marc Saner
(5) (Workshop Report) The Top Five Management Incentives for Improving the Interface Between Scientists and Policy Makers – by Michael Bordt and Marc Saner
(6) (Policy Brief) A Map of the Interface between Science and Policy by Marc Saner (update of a Staff Paper, Council of Canadian Academies, 2007)
(7) (Policy Brief) The Role And Responsibilities Of The Scientist In Public Policy by Bill Jarvis (republication of a Discussion Paper, Public Policy Forum, 1998; with permission of the Public Policy Forum and the Author)
(8) (Policy Brief) A Question of Balance: *New Approaches for Science Based Regulations* (republication of a Policy Brief, Public Policy Forum, 1998; with permission of the Public Policy Forum and the Author)

Please visit www.issp.uottawa.ca for PDF versions of these documents.

ISSP

About the Authors

Matthew Gaudreau

Holds an MA in Globalization and International Development from the University of Ottawa. His interdisciplinary academic training includes economics, political studies, and human geography, with exposure to environmental science. His MA research focused on the sharing of ecological information between environmental actors in civil society, particularly in the context of China. In addition, he has strong research interests in the concept and application of interdisciplinary research within the social sciences and between the social and natural sciences. He is a Research Consultant with the Institute for Science, Society and Policy and a PhD student at the Balsillie School of International Affairs, in the Faculty of Environment at the University of Waterloo.

Marc Saner

Dr. Marc Saner is the inaugural Director of the Institute for Science, Society and Policy, and an Associate Professor in the University of Ottawa, Department of Geography. Prior to this appointment, he served as Executive Director, Regulatory Governance Initiative, School of Public Policy and Administration, at Carleton University, and Director of Assessments and Executive Vice-President of the Council of Canadian Academies. Previously, Dr. Saner was a Director at the Institute on Governance where he built the Ethics and Risk Management Sector and co-managed the Technology and Governance Program. His primary interest has been multi-disciplinary work at the intersection of science, ethics and governance. He holds a PhD in applied ecology from the University of Basel, Switzerland (1991) as well as an MA in applied ethics from Carleton University (1999). Dr. Saner publishes in peer-reviewed journals in the areas of technology ethics, bioethics, risk management, biotechnology and ecology and has been invited to speak at seminars, workshops and international conferences around the world.

Acknowledgments

This work was funded under SSHRC grant #604 2011 007. Without this support, the series would not have been possible.

We thank Geoff Munro, former co-chair of the Assistant Deputy Minister Integration Board of the Government of Canada and Gary Corbett, President of the Professional Institute of the Public Service of Canada (the union representing scientists and other professionals) for providing letters of support for this project.

We thank our reviewers, Heather Douglas, An Ngo, Patrick Fafard, and Jeff Kinder for their valuable and constructive comments.

We are also grateful for comments by students in the course “GEG5105: Decision-making on the interface of science and policy” (Kevin Depault, Nicholas Gosselin, Cam Nelson and Jacob Sammon).

Finally, we would like to thank Michael Bordt for many improvements to the text.

Any errors and omissions are solely those of the authors.

From Many to One:
Integration of Knowledge and Values in Decision-Making

Introduction

Policy- and decision-making are consultative processes that often include not only multiple levels of government, but also multiple sources and forms of knowledge. For example, evidence on degrees of physical risks and benefits, socio-economic risk and benefits, long-term forecasts, local knowledge, values and ethics, and legal and political assessments all may enter a decision-making process. The question arises, are there any key insights and recommended practices that help in the design and management of such a complex system?

This is the second entry in a series by the Institute for Science, Society and Policy that seeks to summarize academic knowledge on an important question at the interface of science and policy. This second brief will review selected academic analyses and explore research on these questions:

- *What* are the key sources of knowledge and values used in decision-making?
- *How* are these sources of knowledge and values integrated into a decision?

Good decisions are the holy grail of any governance system—we will only provide an introduction here since policy and decision-making processes are multi-faceted in their inclusion of varying sources of information, and their occurrence at multiple levels of actors (Forbes, 2011).

It is important to recognize that we are dealing with a variety of science/policy interfaces within and between organizations (See Brief #6 in this series). For example, it is not realistic to describe a single interface between research scientists and the minister of a given government department. In fact, there exist a series of interfaces between researchers and policy analysts, as well as interfaces between disciplines (for example, between a biologist and a statistician). Implicit in this is that the qualitative dimension of any given interface is contextual, which means that there are different knowledge forms and types of values that play into decision making. In short, every interface will have its own makeup. However, the general themes remain the same.

Approach and Method

This “state of knowledge” review is the result of an examination of 77 articles and books that relate to science/policy interfaces and organization theory. Of these academic works, this policy brief cites 26 papers that are relevant to issues surrounding knowledge integration at the science/policy interface.

While this review has attempted to discuss as many works as possible, it is certain that there are other groups of literature that discuss knowledge integration and the science/policy interface. For the purpose of coherence, we have selected those works that deal more directly with knowledge forms in the science/policy context.

One Decision – Four Components

One approach to answering a difficult question is to evaluate and clarify each concept contained in that question. In this section we will introduce pertinent literature that addresses the meaning of the four concepts in the title of our brief: 'integration', 'knowledge' (or 'evidence'), 'values' and 'decision-making'.

Integration

Luukkonen & Nedeva (2010) note that 'integration' has different meanings depending on who uses it, but at a general level can be understood as "referring to the process of forming a new entity from different parts where the result is something 'composite' or 'integral'" operating on a continuum from "fragmentation to uniformity". As such, the process of integration is a social phenomenon in which multiple forms of knowledge interact with values and constraints in the process of decision-making.

Knowledge and Evidence

The sources of knowledge and evidence that are often involved in decision-making are multidisciplinary, including understanding risks and benefits from the perspectives of the natural sciences, the social sciences, as well as local knowledge (Irvine, 2009). Each of these knowledge forms brings with it differing views on degrees of uncertainty. To achieve an understanding of the policy issue as a whole, this demands the capacity to integrate compartmentalized knowledge among disciplines (Kenney & Gudergan, 2006).

Statistics Canada (2012) defines the natural sciences as "disciplines concerned with understanding, exploring, developing or utilizing the natural world. Included are the engineering, mathematical, life and physical sciences." In the case of the **natural sciences**, knowledge is technical and narrowly defined, typically created through a methodology that includes experimentation, observation and falsification (Greenhalgh & Russell, 2009; Renn, 2008). Knowledge has grown over time from taking into account the magnitude of single risks, to multiple studies of multiple risks at varying exposures and over increasingly long timeframes (for example, lifecycle approaches) (Abt, Rodricks, Levy, Zeise, & Burke, 2010). In addition, the acceleration of science, technology and commercial production methods makes it more difficult to achieve a full understanding of the degree of risk related to constantly-emerging sources (Williams, Kulinowski, White, & Louis, 2010). Nevertheless, the knowledge provided by research in the natural sciences is a recognized primary source of overall knowledge produced for use in many decision-making processes (Marburger, 2010).

Policy and regulatory decisions do not occur in a 'social vacuum', and as such, knowledge from **social sciences** must also be brought into play (Irvine, 2009). Again referring to Statistics Canada's (2012) definition, the social sciences involve "the study of human actions and conditions and the social, economic and institutional mechanisms affecting humans." This includes anthropology, economics, geography, political studies, psychology, and sociology, among others. These disciplines are particularly pertinent as scientists have been increasingly encouraged to justify the policy relevance of their research findings in terms that are economically quantifiable or understood in terms of social importance (Watson, 2004). Many policy and regulatory decisions will be made with input from the social sciences in determining social acceptability and attitudes (Renn, 2008). However, there are also drawbacks in the use of social science knowledge, as advice can vary with 'world view', and due to a lack of a "common denominator for measuring cultural or social acceptability" (Renn, 2008:43). This raises a long-standing debate about the role of the researcher which applies not only to the social sciences, but the natural sciences as well (Popper 1963; Kuhn 1970; Latour & Woolgar 1986). We should note that in a number of contexts, for example, economics and demographics, social sciences are the sole providers of the key evidence.

Over the last decade, the concept of **local knowledge** has become more accepted as an important source of context-specific information (Berkes, Folke, & Colding, 2000; Berkes, Colding, & Folke, 2003; Irvine, 2009). Incorporating local knowledge can serve to acquire grounded data from people who have interacted with an ecosystem for a prolonged period of time, to incorporate their economic and social needs, and also to gain an appreciation for their concerns (Fischer, 2000; Guldin, 2003). Further, local knowledge can help to better position the other knowledge forms by contextualizing the way that evidence will affect stakeholders (Irvine, 2009).

In practice, the methods and debates between these three sources of evidence (and the divisions within them) overlap and differentiate in different contexts. Nevertheless, having noted these three general knowledge forms (natural, social and local) that may serve as inputs to policy discussion, (McEwen, Crawshaw, Liversedge, & Bradley, 2008) indicate that agreement exists neither on what kinds of evidence should count, nor on what counts as evidence. In terms of the science/policy interface, it is here that we begin to see the influence of values in the process of weighing evidence and priorities for policy decision-making, where varying priority (or preference) is given to each of these three knowledge forms.

Values

In the integration of knowledge and decision-making processes at the science/policy interface, discussion includes two general levels of values. First are values related to the actual **sharing** (communication) of scientific knowledge (Douglas, 2009; Douglas, 2008), and second are the values that are present in the **evaluation** of various sources of evidence for policy purposes (Pielke, 2007).

Douglas (2008) indicates that there is a dual problem in the role of 'values' from the point of view of **sharing** expert knowledge: (1) limiting the authority of experts to their disciplinary boundaries, and (2) the potential politicization of expertise undermining the authority of experts. She argues that values play an important role for experts in that scientists must weigh their disciplinary knowledge in terms of wider social importance (and the possibility that their judgment is wrong) to judge the manner in which their expert opinion should be shared. In this context, values are an integral factor in deciding which form of knowledge to pursue or integrate, and in deciding what level of knowledge is sufficient in making a decision. This point is echoed by Watson (2004), who takes a slightly different perspective in not necessarily portraying disciplinary knowledge as a constraint, but in encouraging disciplinary *knowledges* to be weighed against each other and stakeholders. Sarewitz (2004) further suggests that conflicting evidence in various fields can serve to exacerbate controversies rather than resolve them, and that pursuing knowledge endlessly can in fact fuel controversy and hinder decision-making.

In terms of the **evaluation** of evidence, Engels (2005) discusses the role of values in the use of scientific knowledge, noting that it is often the case that in addressing a policy question, some expertise is used while other expertise is not. Likewise, policy advocates from different perspectives often use the same evidence to promote different policy decisions. Like Pielke (2007), Engels shows that there is a spectrum of decision making scenarios with varying degrees of values consensus and uncertainty, which in turn affects the way that scientific knowledge is treated.

An important theme in regulatory science is that the 'facts' from the natural sciences themselves are value-laden. That is to say, the results of the natural sciences in this context embed the standards of the legal framework, assumptions made by the scientists and evaluators and judgments about what is relevant and what is not (Brunk, Haworth, & Lee, 1995; Sarewitz, 2004).

Pielke (2007) discusses the role of values and uncertainty in his classification of the role of the scientist (see also Brief #1 in this series). In situations where values consensus is high and uncertainty is low, it is easier to weigh evidence objectively as interests are more uniform. However when there are conflicting values and high uncertainty, it becomes much more difficult to weigh evidence in a way that is not contentious. Further, both values-conflict and uncertainty can be better understood as a spectrum rather than binary, where there is greater or lesser conflict and uncertainty.

Decision-Making

One of the primary concepts driving recent attempts to rationalize the science/policy interface through basing decisions in existing scientific knowledge is the concept of **evidence based decision-making** (Brownson, Gurney, & Land, 1999; Guldin, 2003; McEwen et al., 2008). This concept has been criticized for this expectation of a linear relationship between evidence, narrowly defined as being generated from natural science, and policy outcome (Bowen & Zwi, 2005; Monaghan, 2008). Howlett (2009) points to the importance of a government's ability to access and analyze information as well to understand how this information relates to public opinion and the policy environment. While at times the use of evidence may be constrained by existing laws and institutions, an important factor is policy analytic capacity. Howlett and others see this concept as central to decision-making in the context of multiple sources of knowledge.

> **Key concept:** Policy analytic capacity "*refers to the amount of basic research a government can conduct or access, its ability to apply statistical methods, applied research methods, and advanced modelling techniques to this data and employ analytical techniques such as environmental scanning, trends analysis, and forecasting methods in order to gauge broad public opinion and attitudes, as well as those of interest groups and other major policy players, and to anticipate future policy impacts*" (Howlett & Joshi-Koop, 2011).

To this end, scholars in North America, Europe and Australasia have conducted empirical studies assessing the ability of countries at the national and sub-national level to integrate multiple sources of knowledge for the purpose of informing policy decisions. In the Canadian context, Oliphant & Howlett (2010), for example, found empirical evidence that while researchers at Environment Canada possess analytic capacity, they are not sufficiently linked to policymakers in the Federal Cabinet to be able to transmit their evidence. At the provincial level the BC Ministry of Environment was found to not have access to all the data necessary to inform policy analysis (Oliphant & Howlett, 2010). In a follow-up study, surveying policy analysts at the provincial level across Canada, Howlett & Joshi-Koop (2011) found that the self-reported departmental capacity related to environment was very low, with research evidence seldom used compared to analysts from the health and education sectors.

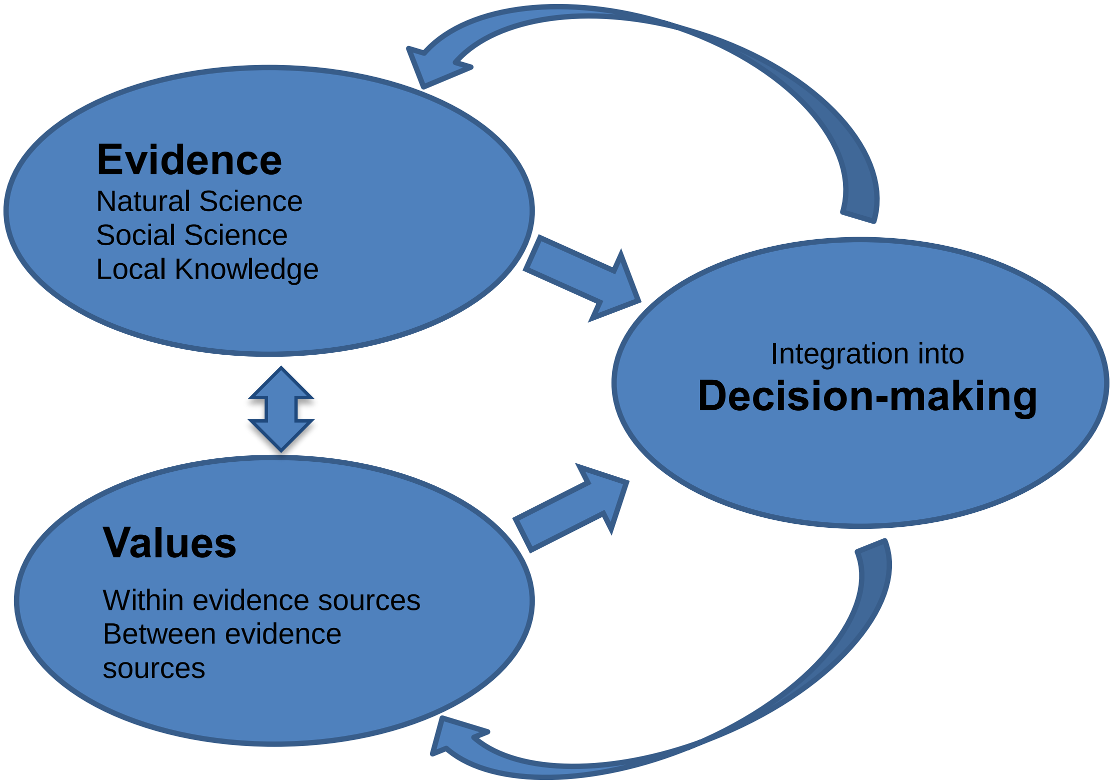
The lack of ability for many governmental organizations to access data, perform rigorous analysis, and transmit evidence to decision-makers has led several scholars to conclude that the existence of evidence alone does not necessarily translate to the best policy (Elgin, Pattison, & Weible, 2012; Howlett & Joshi-Koop, 2011). In essence, the concept of evidence-based policy making does not account for the political process, which serves to manage conflicts related to values and knowledge (French 2012).

Therefore, it remains important to move beyond the linear model to better understand the opportunities for the values of different actors to weigh the varying information available (from natural and social sciences, and also from local knowledge). To this end, the term **evidence informed decision-making** has been adopted, leaving room for the values-gap at the interface (Bowen & Zwi, 2005; Monaghan, 2008; Pielke, 2007). Thus the literature comes back to the issue of values in weighing evidence.

Heuristic Model and Examples

Figure 1 visualizes some of the issues discussed in the review of academic literature related to knowledge sources and decision-making. The components of this heuristic model identify the types of knowledge and evidence, the sources of values, their relationship to decision-making, and the interaction between these components. While most of the components in the diagram are clearly addressed in the literature, the important addition here is the interaction factor that makes the model non-linear. It is subject to feedback loops where evidence and values both interact and are included in decision-making, but decisions outcomes also have effects on the creation of new evidence and values. This is in contrast to a linear model as described above, where evidence is neatly transmitted to form policy.

Figure 1: Evidence, Values and Decision-making: A Non-linear Process



Example 1: We want to elaborate on the case mentioned in Brief #1 in this series ("Successful Collaboration Between Scientist and Policymakers") of the dismissal of the former Chair of the UK's *Advisory Council on the Misuse of Drugs*, David Nutt, who had publicly stated that the classification of some narcotics as dangerous did not correspond to the data reported in scientific studies (Davies, 2010). This example highlighted the potential pitfalls for individual scientists in commenting on policy within specific institutional roles, but also serves to illustrate the more abstract evidence/values dynamic at the science/policy interface.

While the intent here is not to take a stance on the content of his comments, it can be seen that in making his observations, Nutt was speaking in the capacity of a natural scientist. In a linear, evidence based policy model that includes research from natural sciences as the primary input, Nutt's comments may not have been considered controversial. However, the decision-making process clearly involves more factors than the linear model suggests. While evidence from natural science is important, so is social evidence (for example. economic, public health and legal), social and political values and institutional setting (Monaghan, 2008).

Nutt's decision to speak on this issue, which he knew to be politically sensitive (Davies, 2010), drew upon his values as a disciplinary expert, as described by Douglas (2008). While some observers call for scientists to voice their opinions in this manner

(Marburger, 2010), Pielke's (2007) conception of the interaction of values and uncertainty is useful in viewing how an individual's knowledge may be received under different circumstances. Nutt was commenting on a topic for which there was little values consensus, and ambiguous uncertainty. Further, the evidence he was discussing was only a single source among a broader spectrum of knowledge on the issue. Because of the lack of values consensus, the weighing of evidence becomes prone to politicization – the linear model cannot apply (Marburger, 2010; Pielke, 2007). In addition, there was very little collaborative interaction on the issue between scientists (not only Nutt, but those from other disciplines) and policy-makers.

Example 2: Each situation will apply the evidence-based decision-making model differently. As discussed in the literature, there are approaches to dealing with multiple sources of knowledge that implicitly address values. Irvine's (2009) case example on Wild Salmon Fisheries Policy in Canada draws out the interaction between different forms of evidence, differing values, and a collaborative policy making effort. The situation described had a relatively high level of certainty (the salmon populations were threatened), but a lower level of values consensus (fishers needed to earn income and conservationists feared the negative environmental effects of fishing). This case is important as it focuses on the process of identifying and integrating knowledge, while simultaneously constructing values consensus through the integration process.

In his study, Irvine (2009) discusses several points at which different knowledge forms and values conflicts were handled. While the policy initiative first depended on studies by natural scientists in the wake of a fisheries crisis, the process quickly began by including stakeholders from the public with local knowledge and engagement with the fisheries. This gradually resulted in the inclusion of natural scientists, social scientists, and the public (non-scientists) in both the assessment and management of risk. In this case, despite initial values conflict, the early collaboration between different stakeholders and producers of knowledge led to a more desirable outcome.

Practical Implications

Irvine (2009) develops a set of principles that assist in effectively integrating knowledge and constructing shared values. Among others, these principles include:

- the need for decision makers to *want* policy change,
- the need to acknowledge the resources and expertise available,
- the need to have checks on the expertise to ensure legitimacy,
- the need to include knowledge from outside natural sciences,
- the need to understand risks and uncertainties, and
- the need to communicate with the public.

Pohl (2008) describes this type of activity as an attempt to *co-produce knowledge*, where interaction through early dialogue, and the inclusion of various knowledge forms, assists in constructing shared values. The idea of **collaborative modelling** is increasingly being presented as such an alternative (Cockerill, Daniel, Malczynski, & Tidwell, 2009; Selin & Chevez, 1995).

Collaborative modelling calls for a participatory process in policy analysis where the interdisciplinary sources of knowledge that go into decision-making are incorporated (Cockerill et al., 2009). Such an approach allows researchers and analysts to incorporate scientific knowledge, socio-economic and political factors, as well as local knowledge into the process. This results in a more comprehensive integration of knowledge forms and values for supporting decision-making (Selin & Chevez, 1995). Nevertheless, as Irvine points out, there is an initial need for decision makers to *want* policy change for these processes to be effective.

Conclusion

While it can't be expected that the insights illustrated above can be applied to every circumstance, they draw on concepts commonly faced when integrating knowledge in practice. This is done through the inclusion of different knowledge forms, and the identification of competing values that affect the manner in which these knowledge forms are weighed. The empirical studies also illustrate how the process of knowledge integration is not necessarily a linear technocratic endeavour, but is actually a process that takes place between and among actors. Thus, the discussion of concepts such as knowledge forms, competing values, and decision-making is illustrated in the everyday activities of and interactions between scientists and policy makers. As well, this knowledge integration can be facilitated by the factors identified in the first brief: communication and leadership from the early stages of science/policy development (Gaudreau & Saner, 2014).

However, as pointed out by Irvine (2009), given the range of knowledge inputs to decision-making, there is a key challenge in understanding the certainty of the evidence. Because the different knowledge forms, each coming from unique disciplines and personal backgrounds, must be weighed against each other to come to a decision, the issue of "just how certain" evidence might be is of paramount importance. As such, the following brief in this series will delve deeper into how uncertainty is evaluated at this interface, and how it is communicated (Gaudreau, Bordt, & Saner, 2014).

References

Abt, E., Rodricks, J. V., Levy, J. I., Zeise, L., & Burke, T. A. (2010). Science and decisions: Advancing risk assessment. *Risk Analysis, 30*(7), 1028-1036.

Berkes, F., Colding, J., & Folke, C. (2003). *Navigating social-ecological systems: Building resilience for complexity and change.* Cambridge: Cambridge University Press.

Berkes, F., Folke, C., & Colding, J. (2000). *Linking social and ecological systems: Management practices and social mechanisms for building resilience.* Cambridge: Cambridge University Press.

Bowen, S., & Zwi, A. B. (2005). Pathways to "evidence-informed" policy and practice: A framework for action. *PLoS Medicine, 2*(7), e166.

Brownson, R. C., Gurney, J. G., & Land, G. H. (1999). Evidence-based decision making in public health. *Journal of Public Health Management and Practice, 5*(5), 86-97.

Brunk, C. G., Haworth, L., & Lee, B. (1995). *Value assumptions in risk assessment: A case study of the alachlor controversy*. Waterloo, Ontario, Canada: Wilfrid Laurier Univ. Press.

Cockerill, K., Daniel, L., Malczynski, L., & Tidwell, V. (2009). A fresh look at a policy sciences methodology: Collaborative modeling for more effective policy. *Political Science, 42*, 211-225.

Davies, J. (2010). Exploring the science-policy interface. *Cell, 141*, 390-391.

Douglas, H. E. (2009). *Science, policy, and the value-free ideal.* Pittsburgh: University of Pittsburgh Press.

Douglas, H. E. (2008). The role of values in expert reasoning. *Public Affairs Quarterly, 22*(1), 1-18.

Elgin, D. J., Pattison, A., & Weible, C. M. (2012). Policy analytical capacity inside and outside of government: A case study of Colorado climate and energy issues. *Canadian Political Science Review, 6*(1), 101-116.

Engels, A. (2005). The science-policy interface. *The Integrated Assessment Journal, 5*(1), 7-26.

Fischer, F. (2000). *Citizens, experts, and the environment: The politics of local knowledge.* Durham, NC: Duke University Press.

Forbes, S. (2011). Science and policy: Valuing framing, language and listening. *Botanical Journal of the Linnean Society, 166*, 217-226.

Gaudreau, M., Bordt, M., & Saner, M. (2014). *Dealing with not knowing: Evaluating and communicating uncertainty at the science/policy interface .* (Policy Brief ISSP

Science/Policy Interface Series No. 3). Ottawa: Institute for Science, Society and Policy, University of Ottawa.

Gaudreau, M., & Saner, M. (2014). *Researchers are from mars; policymakers are from venus: Collaboration across the system .* (Policy Brief ISSP Science/Policy Interface Series No. 1). Ottawa: Institute for Science, Society and Policy, University of Ottawa.

Greenhalgh, T., & Russell, J. (2009). Evidence-based policymaking: A critique. *Perspectives in Biology and Medicine, 52*(2), 304-318.

Guldin, R. W. (2003). Forest science and forest policy in the Americas: Building bridges to a sustainable future. *Forest Policy and Economics, 5*(4), 329-337. doi:10.1016/S1389-9341(03)00042-X

Howlett, M., & Joshi-Koop, S. (2011). Transnational learning, policy analytical capacity, and environmental policy convergence: Survey results from Canada. *Global Environmental Change, 21*(1), 85-92.

Howlett, M. (2009). Policy analytical capacity and evidence-based policy-making: Lessons from Canada. *Canadian Public Administration, 52*(2), 153-175.

Irvine, J. R. (2009). The successful completion of scientific public policy: Lessons learned while developing Canada's wild salmon policy. *Environmental Science & Policy, 12*, 140-148.

Kenney, J. L., & Gudergan, S. P. (2006). Knowledge integration in organizations: An empirical assessment. *Journal of Knowledge Management, 10*(4), 43-58.

Luukkonen, T., & Nedeva, M. (2010). Towards understanding integration in research and research policy. *Research Policy, 39*(5), 674-686.

Marburger, J. (2010). Science's uncertain authority in policy. *Perspectives, Summer*, 17-20.

McEwen, J., Crawshaw, M., Liversedge, A., & Bradley, G. (2008). Promoting change through research and evidence-informed practice: A knowledge transfer partnership project between a university and a local authority. *Evidence and Policy, 4*(4), 391-403.

Monaghan, M. (2008). Appreciating cannabis: The paradox of evidence in evidence-based policy making. *Evidence & Policy: A Journal of Research, Debate and Practice, 4*(2), 209-231.

Oliphant, S., & Howlett, M. (2010). Assessing policy analytical capacity: Comparative insights from a study of the Canadian environmental policy advice system. *Journal of Comparative Policy Analysis, 12*(4), 439-445.

Pielke, R. A. (2007). *The honest broker: Making sense of science in policy and politics.* New York, USA: Cambridge University Press.

Pohl, C. (2008). From science to policy through transdisciplinary research. *Environmental Science and Policy, 11*, 46-53.

Renn, O. (2008). *Risk governance: Coping with uncertainty in a complex world.* Earthscan.

Sarewitz, D. (2004). How science makes environmental controversies worse. *Environmental Science and Policy, 7*, 385-403.

Selin, S., & Chevez, D. (1995). Developing a collaborative model for environmental planning and management. *Environmental Management, 19*(2), 189-195.

Statistics Canada. (2012). *Data quality, concepts and methodology: Methodology.* ([online] http://www.statcan.gc.ca/pub/88-001-x/2010002/technote-notetech1-eng.htm; No. 88-001-X). Ottawa: Government of Canada.

Watson, R. T. (2004). Turning science into policy: Challenges and experiences from the science-policy interface. *Philosophical Transactions of the Royal Society B, 360*, 471-477.

Williams, R. A., Kulinowski, K. M., White, R., & Louis, G. (2010). Risk characterization for nanotechnology. *Risk Analysis, 30*(11), 1671-1679.

The Institute for Science, Society and Policy

The Institute for Science, Society and Policy offers a unique, holistic approach to understanding the social implications of science and technology. We're interested in how to use these different perspectives to inform science and technology policy.

Centered at the University of Ottawa, the ISSP carries out research, teaching and public outreach on the relationship between society and science, innovation and technology.

Institute for Science, Society and Policy
Desmarais Building
55 Laurier Ave. East, 10th Floor
Ottawa, Ontario, Canada
K1N 6N5

Address inquiries and comments to:
issp@uottawa.ca

uOttawa

issp.uottawa.ca