Knowledge Transferring in Science-Policy Process

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Abstract

Environmental policies often strongly depend on environmental monitoring data, yet these increasing datasets are not always used effectively in enacting and implementing public policy. We assumed that the collaboration of scientists and policy makers makes the science-policy process difficult. In the view of this, this paper addresses to clarify the mechanisms of knowledge transferring from scientists to policy makers. We discussed the roles of scientific information in terms of scientists' seeds and policy makers' needs. As a result, it reveals that the scientific information gives big efforts to the process of policy making. However, whether the information would transform into policy relevant knowledge or not depends on how policy makers perceive it. This transformation process can be expressed by 2x2 matrix to show the relation between scientists' seed and policy makers' need. If policy makers think the information provided by scientists is useful, the information successfully transferred into policy-relevant scientific knowledge. If it is not, it reveals the gap with causes: distance or direction.

Keywords: knowledge transferring, scence-policy process, direction-gap, distance-gap

1 Introduction

As policy quandaries, environmental problems are complex and difficult to deal with. They are complex because their casual chain has complicated interactions between biological, physical and social systems. They are difficult to deal with because their solution depends on the collaboration between scientists and policy makers. Implementing effective environmental policy requires not only the combined efforts of many disciplines to understand environmental problems, but also active interactions with stakeholders. To assist in this effort, interactive models of research are increasingly being adopted to understand complex environmental issues, their impact on human and natural systems, and the opportunities and constraints for policy making directed towards adaptation and mitigation [1]. Despite efforts to describe and characterize interactive research by many researchers, the existing literatures have yet to make explicit, theoretically informed generalizations about the conditions under which interaction achieves greater or less success.

Figure 1 shows the science-policy process which defines the conditions that facilitate the use of scientific data for policy [2]. The scientists convert raw data from monitoring networks into

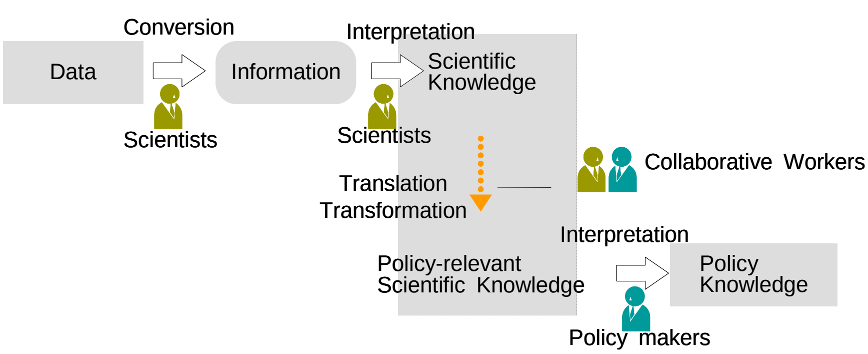

Figure 1 Process from data to policy makers' knowledge

information. They interpret this information into scientific knowledge. Then, scientific knowledge is transformed (or translated) into policy-relevant scientific knowledge by the collaborative works with scientists and policy makers. As the knowledge is provided to policy makers, they use it as one factor among many others in their decision making. It is important to note that scientific data is only one source of information that is a strong science-based component. This science-policy process represents a path from scientific data to the policy knowledge in a form that increases the likelihood that it will be used appropriately.

Table 1 Characteristics of scientists and policy makers

Scientists	**Policy makers**
Probability accepted	Certainty desired
Inequality is a fact	Equality desired
Anticipatory	Time ends at next term
Flexibility	Rigidity
Problem oriented	Service oriented
Discovery oriented	Mission oriented
Innovation prized	Innovation suspect
Replication essential	Belief are situational
Clientele diffuse, diverse, or not present	Clientele specific, immediate, and insistent

The difficulty in the collaboration stage comes not only from the limitation of their knowledge but also from the different characteristics between scientists and policy makers. As shown in Table 1 [3], the scientists and policy makers are generally marked by very distinct behaviors and attributes. These differences contribute to some of the difficulties associated with transferring scientific knowledge into policy-relevant scientific knowledge.

In the view of this, this paper addresses to clarify the mechanisms of knowledge transferring from scientists to policy makers.

2 Mechanism of Knowledge Transferring

Scientific knowledge changes the form to information based on policy makers' needs. This seeded information is transformed into policy-relevant scientific knowledge when policy makers perceive it useful. We use the term "seed" and "need" to discuss the relationship between scientific results as scientific knowledge and their use as policy-relevant scientific knowledge for several reasons. First, the analogy is simple. Decisions about science (i.e., science policy decisions) determine the composition and size of research portfolios that "seed" scientific results. People in various institutional and social settings who look to scientific information as an input to their decisions constitute a "need" function for scientific results. Of course, the need function can be complicated by many factors, e.g., sometimes a policy maker may not be aware of the existence of useful information or may misuse, or be prevented from using, potentially useful information. Our key point is that there is reasonable conceptual clarity in distinguishing between processes concerned with the seeds of science, and those concerned with its use. In a second reason for characterizing scientific knowledge in terms of seeds and needs, science seeds and needs are closely interrelated. Science policy decisions are made with some consideration or promise of societal requests and priorities [4]. Thus there is a feedback between the needs of science and the characteristics of seeds.

3 Relations between Seeds and Needs

We believe that policy makers can make decisions with better outcomes if they understand how seeded information relates to their needs. So we propose the matrix to show the relations between science seeds and policy makers' needs (see Fig.2). The matrix consists of a two-by-two grid, with one axis representing science seeds and the other representing policy makers' needs. The horizontal-axis of the grid, or the needs side, poses the question, "Are policy makers satisfied with information?" The vertical-axis asks, "Does the information match with the policy makers' needs?"

The matrix's top-left quadrant represent the case in which the science seeds match with policy makers' needs, that is, policy makers have access to the information they need from the science side. In this case, the information is successfully transformed to policy-relevant scientific knowledge which can be used for making decisions. On the bottom-left, despite the case in which information does not match with policy makers' need, the information is transformed to knowledge. The information is not directly related to policy makers' need however it helps policy makers to understand scientists' perspectives and their information. Therefore, the information can be used to support policy making as policy makers' knowledge. In those two left-sided cases, the information changes the form to policy makers' knowledge. On the other hand, the right-sided cases emerge the gap between scientists and policy makers. The top-right case indicates that policy makers are not satisfied with the information, even as it matches with policy makers' needs. It means that the information is not enough to make policy makers understood. This situation is called "distance-gap" explained in [2]. It is emerged when there is an inability of some policy makers to make use of highly technical advice, lack of public confidence in scientific information, the difficulty of obtaining high-quality science at short notice and a lack of universal support for scientific input into policy making due to both contradictory science and a lack of certainty surrounding the available results. The bottom-right case, which scientists' seeds do not match with policy makers' needs, emerges the "direction-gap" also defined in [2].

4 Information to Bridge the Distance-gap

One of the biggest aspects to make a gap is scientific uncertainty. As the uncertain information varies by users, the responsibility to provide this information also lies on different actors. The concept of uncertainty in providing information on environmental issues is closely linked to the concept of data and model quality. The appreciation of data quality on its turn is dependent on the final application and use of the data. The independent use is relevant for any analysis of this concept with respect to environmental data and models.

Common grounds of data between scientists and policy makers provide a structure to request and receive relevant, timely data from a trusted source. It provides the policy maker sufficient information to make comparisons and small changes, using the scientists as a means to process large amounts of data. The common grounds of data improve the scientific capability to study the environment and human impact.

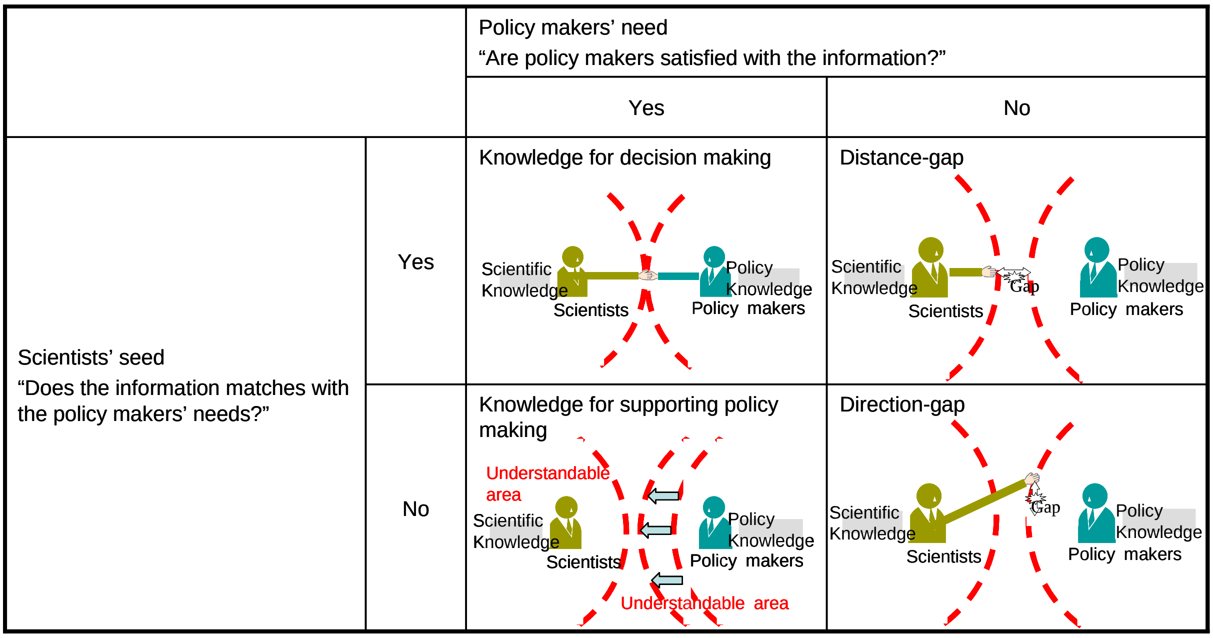

Figure 2 Two-two matrix showing the relation between scientists' seeds and policy makers' needs

Figure 3 shows the "distance-gap" as the difference in levels of confidence for a given scientific finding expressed by the scientists and policy makers. This relationship is portrayed as linear for the scientific community where the confidence level tracks the rate of confirmation. In contrast, the degree and rate at which social confidence and consensus develops for a given scientific finding may lag behind that of the scientists due to a complex of social factors. In reality, the shape of this function will vary with individual scientific findings. The level of confidence by the scientists increases with the level of scientific confirmation. As evidence accumulates to support the underlying hypotheses, confidence in its representations increases. In time, a model achieves greater standing as inferences concern ing its representations are disseminated and debated in scientific literature and other forums. At some threshold of accord with the scientists, consensus emerges. However, the emergence of the so-called scientific consensus does not necessarily guarantee the level of certainty demanded by most policy makers [5].

Although scientists are familiar with uncertainty and complexity, policy makers often seek certainty and deterministic results. There are two general approaches for bridging this distance-gap. These are: (1) increasing the rate of scientific confirmation; (2) providing information to help policy makers understand risk and uncertainty as scientists do. The information in the second approach will be categorized in bottom-left case shown in Fig.2.

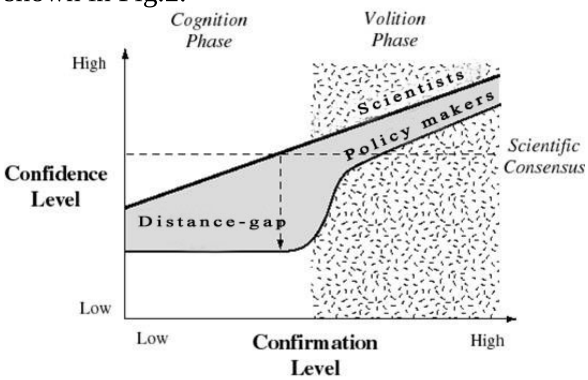

Figure 3 Example of Distance- gap defined as the difference in levels of confidence for a given scientific finding expressed by the scientists and policy makers (adapted from [4]).

As a concrete example, we introduce the view points for the applicability of satellite-derived data in oil spill monitoring [6] (see Fig.4).

For detection and real-time monitoring, a very important aspect of remote sensing is the production of data so that operations people can quickly and directly use it. An operational space-borne system for risk assessment, should guarantee the following aspects [7]: (1) the revisit-time (the maximum period between two consecutive acquisitions on a given site) should be compatible with the delay allowed for product generation in the case of an emergency, (2) the resolution and the coverage of images should be appropriate for the required application.

It also should use understandable scientific terms for policy makers.

5 Information to Bridge the Direction-gap

To bridge direction-gap, we clarify what policy makers need from scientists. We consider the case to transfer new technology in the policy.
The scientific and social issues represent a set of conflicting risks and uncertainties that have not been addressed by conventional analytical approaches. Managers involved in these issues require new approaches that can integrate existing models of planning, analysis, decision-making. This need arises at a time when there is a growth of new technologies to support the practices of risk management, risk assessment, and decision analysis. Yet given the availability and appropriateness of these technologies, there are many barriers to their adoption within risk management organizations. Decisions about adopting unfamiliar technologies are themselves complex risk management decisions that warrant a high level of procedural rationality, particularly in designing and evaluating trial applications. Successful applications are developed through a process of technology and knowledge transfer. Successful technology transfer often requires two complementary actions [8]: (1) the introduction of a new technology can be defined, and (2) the transfer of understanding or knowledge about the technology and its application. Both aspects of technology transfer are necessary.

Rogers [9] described fundamental barriers to the “diffusion of innovations” across a diverse set of governments, societies, and organizations. He listed five perceived attributes of innovations that dictate how they are received:

· *Relative advantage*: How much better is the innovation than that which it supersedes?

· *Compatibility*: How consistent is the innovation with the existing values, past experiences, and needs of potential adopters?

· *Complexity*: How difficult is the innovation to understand and use?

· *Trialability*: How easily can the innovation be experimented with on a limited basis?

· *Observability*: How visible are the advantage of the innovation to potential users elsewhere in the organization?

We believe that these attributes can be the formats to cover policy makers' needs, and the information is categorized in the top-left case shown in Fig.2.

		Policy makers' need "Are policy makers satisfied with the information?"	
		Yes	No
Scientists' seed "Does the information matches with the policy makers' needs?"	Yes	**Information to bridging the direction-gap** •Relative advantage: remote sensing offers "better" data, as it was previously defined. •Compatibility: fits easily into existing practice •Complexity: some aspects of remote sensing are technologically difficult •Trialability: there are some projects already started •Observability: easy to see	**Factors in distance-gap** •Presenting with jargon •Different behavior and attributes between scientists and policy makers •Different appreciation of scientific uncertainty
	No	**Information to bridge the distance-gap** •Re-visit time •Resolution and coverage of images	**Factors in direction-gap** •Unclear request from policy makers •Unfocused scientific information

Figure 4 Examples of effective information for knowledge transferring and factors in gaps in the case of the applicability of remote sensing technology in oil spill monitoring

As a concrete example, we give simple suggestions to answer the above five attributes in the field of remote sensing technology based on [2] (see Fig.4).

Space-based remote sensing provides a new source of information that cannot be easily obtained in other ways. To show this advantage will require a better understanding to realize potential useful applications. Until now, new applications of remote sensing data have been developed largely by individuals or organizations that already possessed both the necessary technical expertise and understandings of potential uses of the data. Remote sensing data can initially appear complicated and possibly even irrelevant to policy makers. They need easily understood knowledge that can be used to address environmental issues.

Relative advantage is the extent to which the innovation is perceived to be better than the current practice. The perceived positives must outweigh the negatives. Policy makers must be convinced that remote sensing offers "better" data, as it was previously defined, and this in turn can lead to better, more informed decision-making. This puts the responsibility on those developing remote sensing applications to educate policy makers about what remote sensing has to offer so that they will consider its application as an additional source of information to meet existing requirements. Remote sensing should be viewed as a supplement to or enhancement of existing information, not as a replacement. Even without improvements in decision making, remote sensing may be a more cost effective approach to assessment in some instances. For small-scale projects, remote sensing may be too costly at this time, but for large-scale projects, remote sensing techniques can offer significant cost savings compared to conventional on-site measurements.

Compatibility is the degree to which the innovation is perceived to be consistent with current values, past experiences, and priority of needs. Remote sensing should be perceived as very compatible with existing practices. Remote sensing is just another source of geospatial information used for environmental assessment upon which informed decisions are made.

Complexity is the degree to which the innovation is perceived to be difficult to understand. As is the case with any technical disciplines, there are associated vocabularies that are unfamiliar to the policy makers. Those in the remote sensing field need to be conscientious about using terminology that is unfamiliar to policy makers from other backgrounds so as not to give the false impression that remote sensing has difficulties for technical challenge. It should be agreed that some aspects of remote sensing are technologically difficult; a distinction should be made between the development of remote sensing application products and the interpretation of these products for policy purposes. Developing extraction techniques and application products is technologically demanding requiring a trained image analyst, but less skill and training are required to interpret these products in the context of policy.

Trialability is the extent to which an organization can try out one idea on a limited basis with the option of returning to previous practices. Because remote sensing requires a certain level of expertise and specialized computer software, trialability has been started in some organizations [7][10]. If the teams consist of scientists and policy makers to conduct demonstration projects, it allows teams an opportunity to learn more about remote sensing and gain greater familiarity with how it may impact traditional workflows.

Observability is the extent to which the results of an innovation are visible to others. An innovation with highly visible, beneficial results is more rapidly diffused. There are many web sites to distribute information and educational materials and communicate results of various projects (ex. [11][12]). Some organizations are also involved in communicating organizational activities at professional workshops and conferences and some of this information is presented in professional journals.

6 Conclusions

The scientific information gives big efforts to the process of policy making. However, it is not smooth to implement the scientific knowledge into policy. In this paper, we focused on clarifying the mechanism of knowledge transfer between scientists and policy makers in the science-policy process. In this stage, we assumed that the collaboration of two different types of actors makes the process difficult. We discussed the roles of scientific information in terms of scientists' seeds and policy makers' needs.

When scientists change the form of scientific knowledge to information, this information will be the "seed" and should be made useful for policy makers. However, whether the information would transform into policy relevant knowledge or not depends on how policy makers perceive it. This transformation process can be expressed by 2x2 matrix to show the relation between scientists' seed and policy makers' need. If policy makers think the information provided by scientists is useful (have benefit), the information successfully transferred into policy relevant scientific knowledge. If it is not, it reveals the gap with causes: distance or direction.

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