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Policy Relevant Scientific Information: The Co-Production of Objectivity and Relevance in the IPCC

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# **Policy Relevant Scientific Information**

## **The Co-Production of Objectivity and Relevance in the IPCC**

Alison Shaw

### **SCIENCE IN DECISION-MAKING**

This paper will briefly explore a prominent understanding of objectivity in the socio-political sphere and the failures of the scientization of policy. Using constructivist social studies of science and science policy literatures, a framework is proposed that operationalizes the understanding that in areas of mandated science, hybrid discourses are produced that are neither science nor policy. It will be argued that traditional efforts to 'purify' the domains between science and policy may not only be impossible but may also be undesirable. Instead, an interactionist approach that considers the flexibility and interpenetrating relations between these communities can more adequately provide insight into the socio-technical nature of increasingly technical public policy problems (i.e. environmental problems). The last section of the paper proposes a framework that is used to examine the IPCC process.

### **Truth Speaks to Power or Power Speaks to Truth?**

The role that science has played in society has been influential and dominant in social and institutional decision-making structures (Geiryn 1999; Jasanoff 1990, 1991, 1996; Jasanoff and Wynne 1998), due to the prevalence of what might be called a "truth speaks to power" (Price 1965) view of the science-policy relationship. The perceived apolitical status of science has resulted in a great cultural presence within society. The precise, reductionist and rational quality associated with the products of science is seen to provide

information that is useful for the policy sphere, but that is not tainted with political interests or biases. Policy analysts use scientific research and studies to decipher the causes, effects, mitigation and remediation associated with public environmental policy decisions. Scientific information is seen to be objective, discrete, and value-neutral. As such, policymakers and other 'users' commonly view it as an indispensable political resource that provides important information required for the fuzzy arena of public policy and decision-making. Public issues regarded as controversial or problematic in politics are often put into what is perceived as the objective, value neutral and rational hands of scientists and scientific inquiry.

Over the last several decades, the attitude toward science and policy has shifted from this steadfast faith in democratic institutions and essentialist constructions of knowledge to an increased public scepticism of the role and use of science in the public and policy domain. The result is that it is common in the policy relevant environmental sciences to find controversies over the sufficiency and adequacy of information and its requirements. Where science is presented as unified and robust, counter-experts can be mobilized to highlight uncertainties and assumptions in the science. Counter experts can either highlight uncertainty and the need for more robust research or they can mobilize contrary evidence using information from the other side of an unsettled scientific controversy or from different disciplinary vantage point (Salter 1988; Campbell 1988; MacKenzie 1990; Brunk et al. 1991; Jasanoff 1990, 1995, 2003). When the 'battle of the experts' begins over the use of science in the socio-political sphere it causes confusion over legitimate courses of action. These controversies often end in deadlock, and when a decision is imminent the authority of the policy decisions becomes embroiled in a power politics (Sarewitz and Pielke 2000). Even in situations where consensus-based science is provided to inform the policy sphere, this information can often be overridden by other political and social concerns.<sup>1T</sup>

Robinson (1982) goes further to suggest that in the public domain, ethical and normative arguments are often framed as scientific and technical questions. Any values that underlie a particular policy can be represented in technical terms with

questions of value framed as questions of fact. In this way scientific information can be used to support a variety of ideological and value perspectives both within the policy and the scientific sphere. In other words, in practice scientific information is not transferred to the policy sphere but is instead carried along social networks that negotiate the value of scientific information for a particular problem and context.

In the policy sphere, the politicization of science and scientization of politics are thus two faces of the same coin. Political rationality puts science into the precarious situation of being labelled either 'good' or 'bad', objective or advocacy-based, robust or uncertain. Policy officials downplay underlying uncertainties and assumptions when and if scientific information supports their particular policy decisions. In contrast, where information does not support particular policy goals officials or interest groups can highlight the uncertain areas inherent in scientific research in order to delay policy action. What this exposes is that cognitive authority does not entirely reside in the arena of science. Instead the legitimacy and value of the science is a negotiation that takes place at the science policy interface (Jasanoff 1990, 1996).

### **Policy Relevant or Mandated Science**

The perceived advantage of science operating on behalf of the public sphere is that agreement among scientists has the effect of removing areas of discourse from ethical and political contestation (Jasanoff 1996a, 174). The origin of this use of science in policy is linked to a political agenda that attempted to ensure that adequate distance existed between policy and politics (Jamieson and Elzinga 1997). In this perspective, the objectivity and accuracy of scientific methods used to calibrate the truth existing in the natural world are also used in the policy sphere to inform rational policies in the social sphere. The disadvantage of this scientization of politics is the way that it is assumed that scientific information is inoculated from ethical, moral and democratic understandings. Decades of the social studies of science have brought the status of scientific knowledge under critical scrutiny. What is found in this literature are the ways that social processes and cultural commitments determine which questions are asked, what methods are chosen

and which interpretations are made. Despite these tacit values, scientific information is used as objective, rational and neutral in the socio-political sphere. Litfin highlights the paradox of the scientization of policy, “[s]ince science is modernity’s preeminent instrument of legitimation, all participants can be expected to claim that their positions are mandated by science, even if science alone can never mandate anything” (1994, 6). What Litfin highlights are the ways that the use of science can be and is often used to legitimize different even contradictory policy decisions.

### **Problems with Translation**

Science used for policymaking has more recently been referred to as an arena of ‘mandated science’ (Salter 1988). Mandated science can be identified when a scientific panel or advisory body has, as its primary audience, a governmental or regulatory body that seeks recommendations from it (Salter 1988). Scientific work, either in the form of individual studies, scientific testimonials or scientific assessment, becomes “mandated” when it is evaluated in terms of the conclusions it can offer to policy makers about the merit of particular regulations (Salter 1988).

Using four empirical case studies on standard setting, Salter (1988) identifies four defining characteristics of mandated science. First this type of science has a governmental audience waiting for recommendations from it whether in the form of an individual scientific study, a testimonial, an advisory body or an assessment forum. Second, despite the connection to the socio-political sphere, science, scientists and scientific evidence tend to be idealized when used either in the political and/or legal domains. Third, mandated science straddles the boundaries of the scientific and policy worlds and therefore embodies a unique form of discourse that is neither solely scientific nor political. The fourth characteristic is described as the moral dilemma in mandated science, attributed to the extension of values and particular cultural and moral commitments of scientists as they extrapolate studies and research into the broader socio-political domain (Salter 1988). In mandated science, scientists must align themselves with the policy community and grapple with the fact that science “is directed toward closure, towards the production of conclusions that would support decisions taken in another sphere of activity, government or

economic relations" (Salter 1988, 189). Mandated science is a unique area where scientific expertise has direct implications on normative questions of fairness, democratic rights and moral issues in the consideration of scientific outcomes.

In the situation where information on a particular topic is to be integrated into a single scientific report, scientific interpretations are transposed from a complex, contested and uncertain setting to a setting that demands concise, simple and consensual knowledge. Due to the burden of proof, the scientific canon of hypothesis testing rests on the doctrine of "theory until proven fact" as a fundamental component of the truth-seeking process. In scientific disputes "a fundamental dichotomy (exists) between the potential dispute resolution objectives of 'truth' and 'justice'" (Salter, 1988). This method makes it difficult to connect science to the often strongly normative decisions required in a policy context. The moral dilemma identified in mandated science is that experts, based on their scientific credentials, are asked to inform particular policy processes precisely due to their idealized insulation from the socio-political sphere, yet they must concurrently assume the role of advising on regulatory or social issues beyond their areas of expertise (Salter 1988; Jasanoff 1990).

By having scientists select and interpret policy relevant information, scientists implicitly transfer underlying commitments and values and present information as though it is objective and value-neutral. To provide a hypothetical example, climate scientists know that banning CO<sub>2</sub> emissions could result in extreme economic costs, but they also know that not banning emissions will increase the rate and magnitude of climate change. If asked to advise on such an issue, underlying ideological, political and moral judgments are implicitly made about the appropriate response. This is the paradox of science operating in the policy sphere; to be considered good science, scientific information must be constructed and presented without regard for its social or political implications. Yet, for the scientist to provide convincing evidence to both political and regulatory bodies, they must anticipate the policy situation and legal constraints under which it will be interpreted.<sup>1</sup>

## **Value Frameworks in Mandated Science**

In public policy issues, different interest groups can use incontestable scientific evidence to argue from opposing sides of an issue and are able to use varied disciplinary affiliations to justify their arguments and claims (Yearley 1996, Social Learning Project 2000a,b). This problem is often attributed to different disciplinary goals, methods and objectives. For instance, an economist will examine a problem in different ways than an ecologist who will examine problems in different ways than a chemist, and so on. In principle, disciplinary differences in method and goals can be dealt with through issues of cooperation, communication and translation.<sup>2</sup> In practice, it is argued here that these differences are often the result of more complex issues where implicit in the selection and interpretation of materials, the assessor(s) also transfer deeply embedded assumptions, judgments and commitments into the social and cultural context.

Robinson's (1982) investigation of 'hard' (business as usual) and 'soft' (alternative energy) forecasts about future supply and demand of energy demonstrated each argument was equipped with incontrovertible evidence about the merits their approach. Therefore, decisions regarding their approach were less about getting the 'facts' right and more about the underlying commitments and value-frameworks that are used to the select and interpret. He summarizes the issue succinctly:

With respect to the specific calculations used, the important point is usually not the accuracy of those calculations but their interpretation and relevance. In turn, the interpretation and relevance also depend upon the premises subscribed to, literature read, and methods used (1982, 32).

What information is selected and how it is interpreted therefore lies with the prior commitments and value frameworks of the analyst. Robinson (1982, 32) argues that what is perceived to be a scientific process, is often based on prevailing patterns of belief and assumption about the world and how it operates. He posits that the interpretation and use of data is based on a, "process [that] works at the level of premises not of "factual" data and it thus tends to be invisible and not subject to falsification" (Robinson 1982, 32).

In another study, Robinson and Hooker (1987) find that the Canadian National Energy Board's use of forecasts became "both cause and consequence of policy decisions". They argue that forecasts base present decisions on the prediction of future events using current assumptions to determine the future and do not consider possible changes in behaviour or more varied supply of energy sources. Without considering the role of present choice, these forecasts give the appearance of inevitability to future energy paths and lessen the potential for creative policy options to present problems. They argue that this use of forecasts allows decision-making institutions to assume "a false cloak of objectivity" (Robinson and Hooker 1987). Brunk et al. (1991) present similar propositions in their analysis of risk assessments and in the deregistration of the Monsanto Corp. herbicide, Alachlor, in Canada. They find that questions of risk depend on normative conditions that, depending on how normative questions of what is fair, equitable and reasonable are answered, will influence the way risk assessment is interpreted.

In short, risk assessors who strive in the face of mild uncertainty to be strictly neutral and to attend only to the facts, cannot attain the neutrality to which they aspire. Whether they recognize it or not, any decision they reach will depend for its reasonableness on the relative worth of the various values that their ostensibly value-free approach puts at risk (Brunk et al. 1991, 37).

That normative issues pervade what is perceived as the quantitative, objective and value-neutral territory of scientific estimations of risk becomes significant. It undermines the intended role of science in policy – to present objective and value-neutral information that will lead to better policy decisions. Where non-scientific and non-technical judgments are tacitly made, scientific risk assessment oversteps the boundaries of the technical and moves into the territory of normative judgment or premises (considered to be the territory of risk managers). The underlying assumptions of the risk assessor prescribes specific conditions or make implicit assumptions about what is considered to be fair, equitable, and reasonable having implications for the policy sphere. This contestation and controversy, causes confusion over which scientists are more reliable and which information is correct and



which is not, making policy decisions even more complex. Policymakers are forced to make decisions about which experts have authority rather than decisions about the issue at hand (Wynne 1989, Pielke Jr. 2000).

### **Scientific Process versus Scientific Content**

Stabilizing scientific information in the policy arena becomes less about the credibility of the content (each side may have incontestable evidence) but instead becomes more about who has the trust and credibility to select and interpret scientific information. Wynne (1996) finds that analyzing 'sides' in science policy issues is a simplistic approach to complex problems. He asserts that in the public policy sphere there are multivalent interpretations of any one particular context. In his seminal case study, the Windscale-Sellafield inquiry, he finds that the legitimacy of the information produced was based less on realist concerns about the bio-physical science and shifted more to social realist concerns based on the trust of experts and authorities in the inquiry process (Wynne 1989). Wynne comments,

Abstract scientific knowledge may seem universal, but in the real world, it is always integrated with supplementary assumptions that render it culture-bound and parochial. The validity of this supplementary knowledge crucially affects the overall credibility of 'science' or 'experts' (1989, 12).

Similar to Robinson (1982) and Salter (1988), Wynne (1989) argues that scientific content is less of a determinant in the decision-making process. Instead its validity is assessed through a parochial lens where issues of the competency of officials and experts, adequate decision-making processes and transparency become criteria that determine the validity of scientific claims.

Guston (2001) refers to social criteria as metonyms between principal and agent whereby the principal does not have the accreditation to assess the credibility of the science but instead uses other benchmarks to determine the credibility and legitimacy of the information produced such as timeliness and professionalism. He uses the concept of boundary organizations that integrate conflict into the confines of the organization, as a way to stabilize the boundary between science and policy. Gieryn (1983, 1999) argues

that definitions of good science and bad science are ambiguous, flexible, historically changing, context-dependent and generally accompanied by considerable contestation. Through what he calls 'boundary work' (1995, 1999), scientists or actors employ rhetoric to construct boundaries between different types of science and scientists, and between science and non-science. This rhetoric varies and is contingent on the context and the audience, which it is trying to convince of its social value.<sup>3</sup> Empirical studies in the social studies of science and science policy argue that what science is and what is non-science is not, is not discovered in the world 'out there' but is negotiated where science interfaces with the non-scientific community. In her empirical research on standard setting for pollutants, Jasanoff (1990) finds that in the arena of mandated science the domains of scientists and policymakers are not predetermined, but rather their respective boundaries are negotiated *in situ* at the science policy interface. These negotiations are agreements about the role and authority of each community over particular concepts.

Process design has been identified as a way to manage the boundaries between science and policy. For instance the design of global environmental assessment processes that consider elements such as participation, geographical representation of actors, and iterative assessment are viewed as factors that influence the credibility, legitimacy and relevance of scientific information (GEAP 1997, Cash et al. 2001, Farrell et al. 2001).<sup>4</sup> However little research has been done on deriving processes of science policy interaction (Farrell et al. 2001). If boundaries are negotiated at the interface it may be more reasonable to derive processes that encourage and manage this science policy interaction.

In conjunction with the validity of experts, officials and the processes is also science policy interaction that occurs at the interface whether it is managed or not. This is where abstract and universal constructions are negotiated for their 'fit' within underlying value frameworks and where supplementary assumptions are interrogated. It is at this interface that boundaries between science and policy are negotiated. Constructivist studies that examine the role and use of science at the policy interface have argued that any effort to analyze policy requires the simultaneous analysis of science and vice versa.<sup>5</sup> Policymakers and risk

managers negotiate the value of the science for the particular and local context in which it is being used. In other words, scientific information does not float freely but instead determinations of what is objective and sufficient information for a particular context and/or problem requires the certification of social networks or user communities to legitimate scientific authority. Consequently, in order for scientific information to be influential, its value for the social and policy environment is negotiated and interpreted by a user community.

It follows that if the user community negotiates the 'fit' of scientific representations and interpretations at the science policy interface, than this community also has a considerable hand in stabilizing scientific claims. The constructs of policy and science are not "structural necessity or faceless rationality" (Gieryn 1999, 89) as represented through the 'truth speaks to power' or 'power speaks to truth'. Instead in practice the boundaries at the science policy interface undergo continual negotiation between and within both communities at the science policy interface (Litfin 1994, Jasanoff 1995). Exploring the contingent understanding of both policy and science as constructed by discursive and rhetorical strategies within a particular context forces a reconceptualization and reanalysis of the science policy interface.

### **Boundaries at the International Sphere**

Applied to the international sphere, the negotiation of science policy boundaries becomes far more complex with scientists from various socio-political and cultural contexts aggregating and interpreting scientific information based on different disciplinary goals and values and different cultural frameworks and values and where the diversity of international governments and stakeholders becomes ever more heterogeneous. Once science moves into the policy sphere, interests, power relations, reputations and scientific uncertainties become resources used to persuade decisions one way or another (Wynne 1989). Trust among diverse actors is required and can only be established by stabilizing the boundary at the interface through social processes of inclusion rather than exclusion (as revealed through the concept of boundary organizations) (Wynne 1989, Jasanoff 1990, Jasanoff and Wynne 1998). Yet it is not enough to focus on getting the science 'right', especially in the

international sphere where the multitude of different value frameworks can ensure that the concept of the 'right' scientific information remains under critical scrutiny and negotiation.

Science studies reveal the ways scientific institutions and communities are not discrete social worlds acting independently from society, culture or politics. Instead, the seemingly discrete institution of science has implicit social and cultural commitments that act to produce and reproduce social power in mutually reinforcing ways (Jasanoff and Wynne 1998; Shackley and Wynne 1996). Science is not devoid of political values nor is politics (of rationality) devoid of some form of scientific legitimation.<sup>6</sup> Instead they are a reflection of one another where through norms and practices, mutual arrangements between knowledge and power are created and recreated.<sup>7</sup> Jasanoff and Wynne (1998) argue that bureaucratic and scientific cultures cooperate in the simultaneous production of knowledge and social order leading to the systemic co-production of information.<sup>8</sup> Guston (1999, 89) asserts that, "By clearly portraying science as it is practiced, constructivism can recover the human face beneath science's rationalist mask". Constructivist approaches in the social studies of science break down essentialist representations of science to reveal the contingent, flexible and multivalent commitments involved in scientific practices and the production of scientific claims.

The understanding that information is negotiated and co-produced at the science-policy interface and is the result of a social process rather than unitary and universal scientific content provides some major insights into the ways that science in international regimes can be investigated. Borrowing from the concept of the socio-technical hybrid where the subject and object are interpenetrating forces (Latour 1987), Jasanoff (2003) adopts an idiom to describe the ongoing interaction between science and policy. She describes this as co-production where the natural order and the social order recreate one another in mutually reinforcing arrangements.

The idiom of co-production has been used to account for the mutual ordering between science and policy. In the book *States of Knowledge: The co-production of science and social order*, Jasanoff (2004) highlights co-production as a way of interpreting and accounting for complex phenomena so as to avoid the strategic deletions and

omissions of most other approaches in the social sciences (Jasanoff 2004). Co-production is shorthand for “the proposition that the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it” (Jasanoff 2004). What is highlighted here is the need to design processes that manage the intersection between social worlds that include a broader peer community in negotiating relevant and appropriate scientific information.

The concept of boundary objects offers a nuanced way of designing processes that manage the exchange and negotiation of materials between different social worlds. Boundary objects are shared representations that have considerable purpose and meaning for two or more social worlds. A boundary object involves a process of stabilizing representations by maximizing both the autonomy and communication of divergent social worlds (Star and Griesemer 1989). Each world draws on repositories of information, ambiguous symbols and inscriptions that are used as “good enough” roadmaps, that rely on a level of abstraction taken from both concrete and theoretical data but delete local contingencies (Star and Griesemer 1989). Boundary objects are “both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites” (Star and Griesemer 1989, 393). In the negotiation of boundary objects there are no transcendent boundaries for cognitive authority – each side draws a different map to create science as a distinct ontological preserve and to claim legitimate and authoritative representation (Gieryn 1989, 341). In other words, boundary objects are standardized representations that are collectively negotiated and that translate across divergent social worlds and satisfy the informational requirements of each. What becomes critical in producing boundary objects are the underlying processes that encourage the interaction, exchange and negotiation across divergent social worlds in order to achieve this common representation while also preserving the role and professional identity of each community involved.

A defining aspect of mandated science is the recognition that the decisions and/or the documents that result are neither entirely scientific nor entirely political. It is the proposition here that because institutional arrangements are socially constructed

(Skodvin 1999), as are categories of what constitutes science and non-science (Gieryn 1985, 1993), there may be more fruitful ways of constructing and designing science policy processes that recognize the sociality and situatedness of scientific practices. Processes are needed that not only manage science policy interaction but also manage it in a way that recognizes the interpenetrating and inseparable forces of these two social worlds while remaining credible to the scientific community and legitimate to the policy community. Science policy communities interact whether they are managed or not. Therefore a process that manages and facilitates science policy interaction and interpenetration may be more successful at producing policy relevant scientific information. A set of processes that lead the production of boundary objects that includes diverse and divergent social worlds in determining what is authentic and relevant information becomes critical.

## **DEVELOPING THE IMBUED MEANING FRAMEWORK**

Without global systems of governance or entrenched science policy relationships, the international sphere and in particular, environmental regimes, provide an ideal opportunity to investigate and experiment with possibilities for increased science policy interaction at the global scale. The Imbued Meaning framework derived below is used as a lens to examine the Intergovernmental Panel on Climate Change (IPCC) at this scale of analysis.

While both science and policy communities have their own discourses, values, goals, and knowledges which are necessary to maintain as credible and accountable to each set of practices and processes, it is critical in matters of environmental policy, to understand that both are interacting simultaneously in framing and describing problems. With the advent of global environmental change it is not enough to say that science is too uncertain, nor is it sufficient for nations to maintain old forms of diplomacy where interest realization and pursuit of uncoordinated goals and objectives ends in deadlock, disagreement and non-compliance. Both communities are required for the simultaneously normative and technical dimensions of global environmental change.

The Imbued Meaning framework is a pragmatic attempt to use the scholarship of the social studies of science and science policy

**Weak Co-production (Points 1-3)**

1. A managed interface that creates space for formal science policy interaction
2. A bi-directional exchange of discourses and materials occurs across the boundary.
3. A formal negotiation of the final representation of the information.

**Strong Co-production (Points 1-5)**

4. Including the 'user' community in problem framing.
5. Information is reappraised at some time in the future.

Box 1: The Five Elements of the Imbued Meaning Framework

research to respond to some of the problems about the status and role of scientific information in the policy sphere. This framework suggests that unidirectional model of science is not a useful way to think about the science policy relationship. Instead an interactionist model is articulated that focuses on pragmatic (and credible and legitimate) ways of constructing policy relevant information. The main insight of this framework is that the science policy interface includes both knowledge producers and knowledge users in a structured process of interaction and negotiation to co-produce policy relevant scientific information. Five process-related elements are proposed in the Imbued Meaning framework. These are highlighted in Box 1.

**The IPCC as Mandated Science**

The IPCC is the scientific assessment body that was initiated in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) to compile, assess, and interpret scientific information pertaining to climate science in a comprehensive manner. For this reason three working groups were set-up; working group I (WGI) assesses the climate sciences, working group II (WGII) assesses the biophysical and social impacts and vulnerabilities and working group III (WGIII) assesses the possibilities for mitigation. This process has established the scientific basis and understanding of climate change over particular periods in time.<sup>9</sup>

The IPCC was established as an intergovernmental process in order to bridge the distrust and skepticism that had developed between the US (among others) and the UNEP in the ozone assessment and was intended to ensure transparency in the process where governments were included in the review of the scientific information. Recollecting this process, the IPCC Secretary recalls,

[The US] actually said... that they needed a government mechanism except they used the word ad-hoc because they didn't know how long it should be or how long it should last and various questions and what exactly should be the terms of reference (Interview 2001).

The requirement of an intergovernmental process satisfied sceptical governments' needs to be involved in reviewing the information and the process in which it was constructed.<sup>10</sup> By including governmental representatives in the scientific assessment process, two objectives were fulfilled: i) scientists coordinated or enrolled a governmental audience to which to transfer their climate findings and ii) participating national governments had the ability to review the materials and authorize the legitimacy of the process; thereby granting governments access to the arena of knowledge production. The ability to review and evaluate knowledge created a space for the maintenance of sovereign authority in the process. This was necessary in order to derive and develop the political legitimacy in the scientific process and to increase the possibility for stabilizing knowledge in the international policy sphere.<sup>11</sup> More importantly the derivation of the intergovernmental mechanism established a working relationship between scientists and the 'big players' (thus the 'big emitters') in the international policy community.

The IPCC was created as an intergovernmental scientific assessment that has, through various adaptations in the process, evolved into a body made up of its own practices and form of inquiry. Procedural management by the IPCC's Bureau<sup>12</sup> attempts to simultaneously ensure the efficacy of the IPCC, the credibility of the scientific information produced and the legitimacy and relevance of the scientific messages diffused to governments. To accomplish these objectives the IPCC has had to be adaptable not only to emerging and increasingly international climate science



literature but also to the diverse needs of the international policy sphere. The IPCC has reflexively adapted, modified and evolved its formal procedures to more effectively mediate between the worlds of science and policy (see Table 1). The end result has been a process that, over its three iterations, increasingly included governments within its structure, and simultaneously increased policy relevance through the SPM and SYR in efforts to produce “policy relevant but not policy prescriptive” information. These mechanisms were initiated in the Second Assessment Report (SAR). The SPM was formally described as a way to extract information that may be politically important from the supporting material of the underlying Working Group reports (Bolin 1994). In the SAR, a WMO executive council decision to make more explicit links between the findings of the underlying WG reports and the objectives of the UNFCCC, with specific focus on Article 2 resulted in a Synthesis Report (IPCC, web). The SPM is defined as a “component of a Report, such as an Assessment, Special or Synthesis Report, which provides a *policy relevant but policy neutral* summary of that Report” (IPCC 1999) [emphasis added]. The SYR is defined as a report “that synthesize and integrates materials contained within the Assessment Reports and Special Reports and are to be written in a non-technical style suitable for policymakers and address a broad range of *policy relevant but policy neutral questions*” (IPCC 1999) [emphasis added]. The policy relevant scientific questions (PRSQ) were introduced in the TAR SYR to increase the connection between the IPCC process and the parallel policy process in the Conference of the Parties (COP).

### **The Underlying Processes of the SPM and SYR Through This Lens**

The processes underlying the SPM and SYR are formally conceived of as more effective ways to translate scientific information into the policy sphere. Yet in practice, the SPM and SYR have generated an explicit science policy interface. The procedural innovations of 1) the review, 2) line-by-line approval (in the case of the SPM) or the section-by-section adoption processes (in the case of the SYR) and the 3) policy relevant scientific questions (PRSQ) have been developed to manage this interface and to expedite the transfer of information into the international policy sphere. These procedural

Table 1: A Historical and Causal Typology for the Increased Science Policy Interface in the IPCC

<i>Phase of the IPCC</i>	<i>Science Policy Interface</i>	<i>Reason for Increased Political Presence</i>	<i>Result</i>
<b>FAR</b>			
a) Intergovernmental mechanism	Includes governments in nomination of scientists and in the review.	Scientists negotiate with WMO, UNEP and governments for a global assessment with the aim of a Convention.	To increase political saliency of the climate issue and international cooperation.
b) Comprehensive assessments	Extending the borders of science to create a more policy relevant knowledge continuum.	To ensure comprehensive assessment especially regarding the costs benefits of mitigation in WGIII.	Increased relevance to the policy sphere through WGIII in particular.
<b>SAR</b>			
a) Extensive two stage review	Involves 1) external experts and 2) experts and governments in the formal review of WG material.	To ensure the selection of relevant information is unbiased and complete.	Increased scientific credibility of the information and legitimacy of governments
b) Formalized SPM and SYR process	Distinguish between the scientific product and the product for governments.	Communicating concise 'take home messages' for approved by international governments.	A separation and demarcation of the boundaries between the underlying reports and the SPM's. SYR minimizes WG siloes to provide an interdisciplinary overview of key findings that are more closely aligned with the COP process and further removed from the underlying report.
<b>TAR</b>			
a) Inclusion of review editors	Select governments included in revision process.	Concern in the SAR about the biased selection of material.	Further inclusion of governments in order to foster legitimacy of the underlying selection process.
b) Policy Relevant Scientific Questions (PRSQ) in the TAR Synthesis Report (SYR)	Integrates governments in framing scientific questions.	The Chairman's attempt to develop a closer relationship to the UNFCCC.	Inclusion of the user community in a front-end framing of relevant scientific questions. Further connect the IPCC to the needs of the COP process.

innovations become boundary processes are defined here as processes that manage science policy interaction. What is of interest in the complex practices of the SPM and SYR are the ways that these processes contribute to the seemingly paradoxical requirement of being policy relevant while remaining policy neutral.

1. *A Managed Interface.* The elements of the Imbued Meaning framework considered together are viewed as a pragmatic way of co-producing policy relevant scientific information. Each element individually offers a path to generate scientific information that is credible, legitimate and policy relevant. In particular the ability to integrate the user in problem framing and to reappraise information at some future date contributes to greater science policy interaction and a basis for stronger co-production. Relating to the first element of the Imbued Meaning framework, there is a need to stabilize the credibility and validity at the interface. In order to retain the credibility of the scientific assessment process each community must be perceived as pursuing its own objectives, norms and the practices. The identities of each community must be perceived as discrete. This is particularly important for ensuring the credibility of the scientific process (Gieryn 1999, Guston 2001). Any infiltration by the policy sphere can be perceived as partial, thereby reducing the legitimacy of the documents or recommendations in the policy sphere.

In the IPCC the rigid distinction between the underlying assessment reports and the policy relevant SPM and SYR products was made in order to separate the science from the non-science (see Figure 1). This was necessary in order to 1) attract reputable scientists to the participate in the underlying assessment, 2) to ensure that the scientific and policy communities recognize the autonomy and thus credibility of the scientific assessment process and 3) to ensure that the scientific information is accessible to policymakers through a summary of policy relevant findings. However deriving policy relevant scientific information requires science policy interaction at the interface.

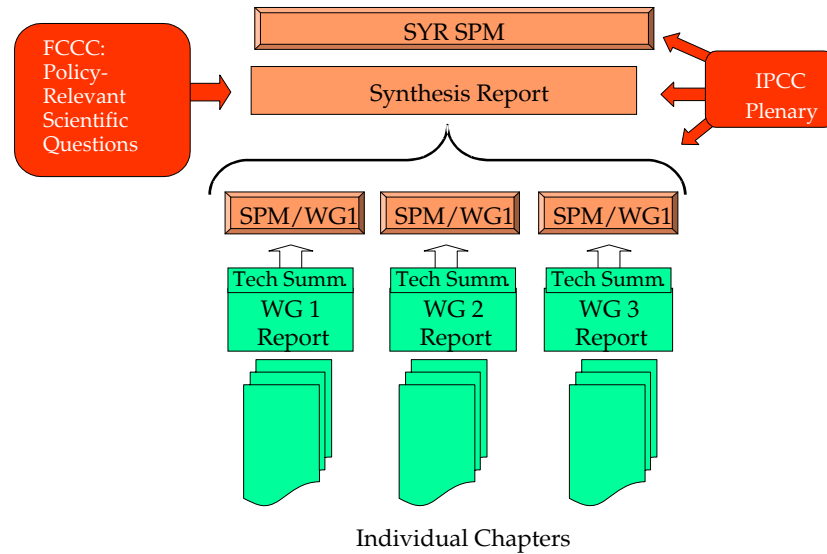


Figure 1: The Structure of the IPCC Reports. Orange represents documents of governments while green represents scientific documents.

Although discrete boundaries between science and policy contribute to the perceived impartiality and credibility of the scientific information produced, discrete boundaries do not contribute to legitimate, relevant or appropriate scientific information. Therefore what is required instead is a formal interface where the two communities converge. Managed and agreed to processes and protocols are required in order to facilitate discursive interaction between these two communities. An interface is necessary to ensure that key and critical findings are translated into the policy sphere in ways considered acceptable and appropriate to the international policy community.

2. *The Exchange of Materials, Discourses and Values.* Second in the Imbued Meaning framework, the unidirectional model of science for policy is viewed as illusory. It leads either to the policization of science or the tacit transfer of values and assumptions in the scientization of policy (Jasanoff 1990, 1995, Jasanoff and Wynne 1998, Pielke Jr. 2000). There has been a mobilizing literature on the status of scientific knowledge itself. What has been an increasing recognized is that science has associated underlying assumptions,

social and cultural commitments and uncertainties that contribute to claim-making (Latour 1987, 1993). It becomes increasingly clear that once these tacit aspects move beyond the goals and interests of the scientific profession into the non-scientific sphere scientific information decision-makers and interest groups interrogate them. Interrogation of the sufficiency, adequacy and appropriateness of information is not only the work of scientists and experts; the user community negotiates the values of scientific information at the interface. In order to derive policy relevant scientific information, this interface must ensure that the mutual exchange and negotiation of discourses, values, knowledges and interests is encouraged between communities.

In the SPM and SYR, the inclusion of the broader expert and governmental community in an extended review encourages the exchange of materials, discourses and values across the science policy interface. Governments (and international NGO's) review the information selected and interpreted as policy relevant and policy neutral by lead authors (LA). There are a number of things that occur through the review process 1) governments use particular frameworks to interpret and modify information in the SPM, and 2) these governmental review comments sensitize authors to the values and interests of different governments. In the government comments there are tacit attempts to simultaneously exchange language with values. A simple example of this is provided in the statement, "Development paths that focus on the social, economic and environmental elements of sustainable development may result in lower GHG emissions" (IPCC doc p.2 line 3). One nation suggested that the word "will" replace "may" with the ending "in all countries" (WGIII Comment 86 p.22). Another nation recommended inserting "or may not" after "may" to indicate the trade-offs associated between economic, environmental and social justice concerns (WGIII Comment 87 p.22). In many cases what at first glance appears to be an editorial comment can at second glance be identified as a recommended change that emphasizes or de-emphasizes a particular message. The former comment emphasizes the role that development paths play in reducing greenhouse gas reductions while the latter emphasizes an ambiguity in the message that some governments argue is less prescriptive. The review ensures the exchange of

materials, discourses and values occur among lead authors and governmental delegations in the first draft of the SPM and SYR.<sup>13</sup> This becomes particularly important for the line-by-line approval process in the SPM (and section-by-section adoption process in the SYR).

3. *The Development of Formal Negotiation.* Third, it may be valuable to exchange materials and discourses and facilitate and manage interaction between the two communities, yet the problems identified in the mandated science framework reveal that conflicting value-frameworks lead to contestation and disagreement over appropriate selections and interpretations of information (Robinson 1987). Final representations of policy relevant scientific information cannot merely be transferred or 'translated'. Policymakers do not have the accreditation to determine what is and is not credible scientific information nor do scientists have the authority to determine what is policy relevant. In order to produce policy relevant scientific information that is credible and legitimate, a formal negotiation is required with inputs from both communities. Scientific information and its value are negotiated at the science policy interface whether this interface is managed or not. Based on this understanding from the science policy literature, the third element of the Imbued Meaning framework requires that a managed negotiation be set-up at the interface where science policy interaction is encouraged and where formal procedures for conflict resolution are made available. The negotiation toward a common representation that is agreeable and agreed to offers a formal and credible way for science and policy communities to cooperate and to co-produce policy relevant scientific information.

The line-by-line approval process in the SPM enables differing governmental interpretations to be made transparent in the larger Plenary. The ways information is represented becomes critical to governments able to represent information in multiple ways while remaining within the confines of remaining technically correct. This is illustrated in the negotiation of the ways the costs of stabilization of greenhouse gas concentrations in the atmosphere at 550ppmv should be represented. Like words, the way metrics are represented can have a significant influence on the emphasis of a message. In the WGIII LA plenary there were strategic discussions

about the best way to communicate the costs of stabilization. Authors agreed to express this message as a proportion of the global economy 0.06% to signify the relatively low cost of mitigating greenhouse gas emissions. However this representation came under fire in the approval process. The US argued that 0.06% of the global economy did not provide an adequate picture of the costs and purposely made them appear inconsequential. They argued instead that the nominal cost quantities would provide a better reflection of the costs of stabilization (i.e. trillions of US dollars). The negotiation began when other nations argued that the metric in trillions made numbers look very large and emphasized the costs of mitigation. This example is less about negotiating the technical information and is more about the strength of the message that is represented. Both representations are consistent with the underlying science. Not without considerable contestation, a compromise was finally approved where 2% GDP losses were represented, a small but considerable fraction of GDP (June 22 [9] Figure 7.2 Stabilization Costs). This example illustrates that the emphasis of the underlying message can change while remaining technically accurate. It also highlights favored ways to emphasize the information both among authors and among governments. These favored messages or particular value-frameworks become transparently scrutinized in the approval process. Yet what is identified is that IPCC authors select and interpret the scientific messages considered policy relevant.

4. *Including the Users in the Framing.* Fourth, for strong co-production to occur, the user community needs to be included in the framing of the public policy problem and the information required to address it. Scientific research can be misguided with regard to real-world problems. In the social studies of science research the framing of scientific problems is in part guided by contextual factors such as funding availability and societal need. Rather than having scientists assume what those needs are, in areas of mandated science it may be more advantageous to develop a process where a range of users' interests are included in framing the problem and the informational requirements to respond. For instance, in the seminal case of the Windscale-Sellafield Inquiry it was found that if sheep farmers had been included in the framing of scientific questions about location and impacts of radioactive

fallout, the scientific process would not only have been more legitimate but more efficient and relevant (Wynne 1989). This provides an opportunity for knowledge producers and users to interface and to determine the informational requirements to address.

The addition of the policy relevant scientific questions (PRSQ) in the Third Assessment Report (TAR) represents an innovative attempt for the IPCC to increase its policy relevance in the international policy community. Whereas the WG SPM's encouraged the transfer of key scientific findings and the negotiation of their representation, the PRSQ's are an effort to integrate the user community in framing questions considered to be policy relevant for authors to address based on the underlying IPCC Climate Change Reports and Special Reports. Rather than having authors anticipate the needs of policymakers, the SYR encourages governments to explore and negotiate the critical areas of policy relevance in the climate issue. This transforms the material from that which is scientifically interesting to that which is policy relevant and becomes critical for co-producing policy relevant scientific information. In the IPCC these questions were intended to guide authors' selection of information to address these relevant questions.

However these questions were not entirely effective at generating strong co-production of the SYR texts. First of all, the PRSQ's arose from the IPCC Bureau. Rather than having a serious negotiation in the international policy community about which questions were pressing and which required scientific information to address, the IPCC "got the American government, Small Island States, the European Union all to think about it and [to send questions] to [the IPCC] through the SUBSTA process" (Interview, IPCC Chairman). This ad hoc way of determining ten policy relevant questions (condensed to nine) bypassed considerable debate and negotiation that may have increased the relevance. Moreover, the questions did not contribute to framing the problem but were instead ways to integrate the user at the end of the scientific assessment process. For strong co-production to occur, this integration needs to happen before the scientific assessment reports are drafted.



Second, efforts were made to reduce the workload on participating authors as much as possible. Authors used procedural strategy to bypass political controversy. Part of the strategy was based on the 'simple rule' used in the IPCC.<sup>14</sup> The simple rule states that previously approved information cannot be reopened for negotiation. A Bureau member makes this strategic point; "It's almost better from the SPM because it's been agreed to by policymakers" (part. obs. June 19, 2001). In the SYR and SYR SPM there were a number of times, where a delegate took issue with particular text only to find that it was directly taken from an approved WG SPM and was thereby not considered for revision. In practice, the level of interdisciplinary synthesis that took place across the WG's in the SYR was minimal with the majority of the writing process based on cutting and pasting previously approved information. A Bureau member notes that, "In reality it's all going to be out of WGI and II. We're just cutting and pasting as you can tell, but a bit more than that, a bit of synthesis but I wouldn't spend time on it" (Interview [44]). WGI and WGII information was preferred due to the fact that probabilities were attached to the scientific claims. WGIII information experienced considerable contestation in the processes for being 'policy prescriptive' and 'less scientific' due to its proximity to policy.

5) *The Timely Reappraisal of Information.* Fifth, these institutional arrangements must not be viewed as static instead they must be constructed as dynamic and ongoing. Policy relevant scientific information must be reviewed and revised in light of new scientific information and new policy concerns. In this way the provisionality of science is highlighted, and the paths forward are neither technocratic nor static but may change over time. Moreover, Eckley (2001) finds in her research on policy negotiation that policymakers are more predisposed to agreement when they know that the information will come up for reappraisal at some point in the future. Including the user in the framing, interrogation and negotiation of information may be more palatable if the information can be changed at some predetermined point in the future.

In the IPCC assessments, the most contemporary peer-reviewed research is reviewed, assessed and compiled every five years.<sup>15</sup> However as demonstrated in Table 1 (above) much more is

occurring in the assessment process. The process itself was able to adapt different strategies and innovations to more effectively manage the credibility, legitimacy and relevance of the climate change science in the international policy sphere. The reappraisal of information contributes to experimental process required to find more nuanced ways for science and policy to interact and to derive policy relevant scientific information. The adaptive management of global environmental problems will be required in order to maximize adaptation and mitigation benefits while simultaneously minimizing costs.

## CONCLUDING REMARKS

Science and policy have boundaries that are negotiated *in situ* on individual topics and domains (Jasanoff 1990). In other words, negotiations are constantly taking place at the interface whether they are managed or not. Yet it is important to note, unless one maintains a positivistic and unidirectional understanding of science, the identification of social processes does not undermine the usefulness of scientific products. Shaw and Robinson (in press) examine the ways that positivist accounts of science as objective, rational and neutral in the policy sphere have the paradoxical effect of derailing scientific authority. With regard to potentially urgent and irreversible problems if scientists are unable to provide details about technical problems until uncertainties have been sufficiently reduced, such as those posed in environmental policy problems, sufficient scientific information may take decades. Scientific information with considerable uncertainties can be used as a political resource to legitimize policy inaction. Yet the epistemological shift to a constructivist understanding of science, offers a new way of thinking about and approaching problems of credibility, legitimacy, and relevance of science in the policy sphere. The understanding that science is negotiated at the policy interface identifies differences between the theory and the practice of science in the policy process. Rather than directing attentions to the theoretical understanding of science as monovalent and objective, the imbued meaning framework critically examines the status of science using the social studies of science and the role of science using contemporary science policy literature. Each of these

literatures suggests that science in principle is much different than science in practice. Rather than focussing on theory, which suggests a unidirectional transfer of science to policy, it may be more desirable and pragmatic to design assessment processes that attend to empirical studies of science in practice.

By viewing science from a constructivist approach the science policy negotiation that occurs in practice at the interface does not necessarily suggest a politicization of science. Instead it accounts for what occurs in practice as science moves into the policy sphere. The constructivist approach does not seek to undermine the value of scientific activities or to posit that science is equivalent to other forms of knowledge making. Instead it provides a more realistic understanding of what science can and cannot provide in the policy sphere. It does not idealize science but examines the social processes and interactions that contribute to the dominance of a claim in scientific studies and a particular representation in the policy sphere. In this way a constructivist account of science offers greater flexibility to the understanding of science and in particular its use in the policy sphere.<sup>16</sup>

The five elements of the Imbued Meaning framework were used as a lens to examine the innovative processes of the IPCC. This framework emerged from the social studies of science literature that challenges scientific concepts of discovery and verification and instead focuses on empirical accounts of the social processes involved in constructing scientific claims. This literature highlights the need to examine the underlying social processes and commitments in science in order to more effectively understand scientific representations (Bloor 1991, Latour 1987, 1993, Knorr-Cetina 1992, Hacking 1992). Once these representations move into the policy sphere, they become modified due to the need to meet non-scientific objectives (as noted in mandated science) (Salter 1988). The negotiation of scientific value at the interface contributes to the negotiation of different selections and interpretations and the negotiation of different value-frameworks. The Imbued Meaning approach considers this science policy interaction as occurring whether managed or not and suggests that processes can be designed to manage this interaction for increased policy legitimacy and relevance.

Interestingly, the review and approval processes and the policy relevant scientific questions derived in the IPCC (through rather ad hoc means) were generated as ways to connect science with policy and in theory are innovative ways to 'translate' science into the international policy sphere. In practice, however, these boundary processes both manage and encourage science policy interaction at the interface. In the IPCC there is 1) a stabilization of the science policy boundaries external to the assessment process. Internal to the IPCC, the boundary processes that generate the SPM and SYR encourage 2) the bi-directional exchange of materials, discourses and values, 3) a formal negotiation (with conflict resolution mechanisms) between lead authors and governments, 5) and the reappraisal of information at agreed to points in the future. In this way the adaptations in the IPCC has contributed to the weak co-production of policy relevant scientific information through the SPM and SYR. In the TAR there was an attempt 4) to include 'users' in the framing of what is policy relevant. This is the next step for encouraging strong co-production. However the user community must be included to determine what is policy relevant before the commencement of the assessment process.

It is uncanny that over the iterations of the IPCC's efforts to derive policy relevant and policy neutral scientific information, the ad hoc process that has emerged significantly aligns with contemporary understandings in the social studies of science and science policy literatures. Managing for global environmental problems minimizes possibilities for verification and scientific robustness. These problems are not only scientific problems but also reflect normative choices to be made by decision-makers and society about ways to live in the future. What these aspects of global environmental problems, such as climate change, illustrate is that decisions about how to manage these problems are not entirely scientific nor are they entirely political but instead require some combination of both. Therefore ways to manage science policy interactions become critical in order to 1) generate policy relevant scientific material and 2) to derive a collective and cooperative basis from which to assess and manage the problem.

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## NOTES

<sup>1</sup> An example of this in the legal context is illustrated in Salter's (1988) example of the health and ecological consequences of lead particulate in the municipality of Toronto in Ontario (The Toronto Lead Controversy Chapter Five). The inability to derive "objective" or sufficient evidence pointing to the Toronto Refiners and Smelters Company in the community as the absolute cause of the documented health outcomes meant the judge ruled in favour of the defendant and called for more 'objective' research.

<sup>2</sup> Integrated assessment is an example of multi-disciplinary cooperation.

<sup>3</sup> For instance, Gieryn (1999) reveals how in the late 19<sup>th</sup> century, Tyndall used different rhetorical devices to carve a role for science between religion and mechanics. The rhetorical strategies used to separate science from religion focused on empiricism, observable facts and practical utility rather than on mere religious or poetic understandings of the natural world. However the rhetoric shifted when differentiating science from the mechanical and technical trades. The virtues of science then focused on the theoretical and abstract, moving beyond material facts into invisible laws and reason. Science was seen also as a noble and cultured tradition distinct and quite separate from the brute guild of mechanics. Tyndall's efforts to separate the boundaries of the scientific from the religious and mechanical reveals the "interpretive flexibility" in the rhetorical strategies of science to remain distinct and separate from non-science. Gieryn argues that the characterization of science is relational to the characterization of non-science.

<sup>4</sup> Global environmental assessments are the entire social process by which expert knowledge related to a policy problem is organized, evaluated, integrated and presented in documents and otherwise to inform decision-making (Farrell et al. 2001, 312). In this definition assessments are

seen as areas of mandated science that embody hybrid forms of activity that require credible and legitimate processes for transferring relevant science to the policy arena.

<sup>5</sup> See Jasanoff 2003, 1990, 1995, 1997, 2004; Wynne 1996, 1990; Lidskog and Sundquist 2003.

<sup>6</sup> See Gieryn 1982, 1999; Guston 2001.

<sup>7</sup> See Jasanoff 1990, 1996, 2003; Latour 1987, 1990.

<sup>8</sup> See Latour 1987; Jasanoff 1996, 2004; Guston 2001[0].

<sup>9</sup> The first assessment report (FAR) took place from 1988 to 1990, the second assessment report (SAR) from 1992 to 1996, and the third assessment report (TAR) from 1996 to 2001.

<sup>10</sup> Without knowing how to develop an intergovernmental process, the WMO secretary general, Obassi, invited governments participating in either the WMO or UNEP to discuss climate change. The first IPCC meeting was held in May 1988 where an international community of scientists was brought together and where 32-33 delegations attended “to collect technical information relating to climate change” (Interview [38], 2001). The timeline for the completion of the first assessment report (FAR) was intended to allow completion in time for the Second World Climate Conference (1990) (the first was held in 1979).

<sup>11</sup> Cognitive authority is achieved through “access to knowledge and the ability to evaluate it” (Nowotny 1992).

<sup>12</sup> The Bureau is made up of the Chairman, the Secretary, six Co-Chairs (one developed nation co-chair and one developing nation co-chair for each working group), and seven elected members.

<sup>13</sup> Observing non-governmental organizations (NGO) from industry and environmental sectors are able to participate in the exchange of materials and discourses as well.

<sup>14</sup> The description of ‘the simple rule’ was used informally among participants in the process to describe the aspect of the process where previously approved information cannot be re-opened.

<sup>15</sup> There has been current discussion about lengthening the iterations to seven years instead of five.

<sup>16</sup> It needs to be reiterated that science is recognized, as an important social project comprised of standardized and rigorous methods. In the arena of mandated science its usefulness (rather than its authority) is about offering well-analyzed materials that have been collectively reviewed by

specialists that are then negotiated for their value in the policy sphere. The Imbued Meaning framework encourages both of these critical processes of validation to be managed through an explicitly constructed assessment process.

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