From Climate Change to Social Change

Perspectives on Science-Policy Interactions

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6 LOST IN TRANSLATION?

Boundary Work in Making Climate Change Governable

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6.1 *Boundary Work*

Introduction

This book's central question is: What kind of science-policy and science-society interactions do we need in order to translate climate change issues into long term processes of successful societal and political change? This chapter introduces a boundary work perspective and demonstrates its usefulness for answering that question. I will show how boundary work operates in climate change policy, that is, how it makes climate change governable on the levels of political cultures, policy politics, organizational arrangements and single projects. The boundary work concept firstly has descriptive value, in that it accurately pictures what is going on in the interaction between politics, policy and science. In addition, one may attribute some explanatory value to the concept, especially in the sense of mutual transgression of boundaries by experts and policy workers. Finally, in the sections below on boundary arrangements and projects, the concept will be shown to have considerable prescriptive-heuristic use.

Climate change knowledge is routinely portrayed in the media as embodied in scientific models, measurements, projections and forecasts. It is scarcely realized that the production, dissemination and utilization of climate change knowledge deviates from the standard academic model. The institutions in which these processes occur and acquire legitimacy are hybrids where science and politics not only meet, but also intertwine. Look for example at the reports by the International Panel on Climate Change (IPCC). One kind of input is the lengthy discussions among scientists of very different disciplinary backgrounds. From these different, sometimes conflicting, angles they formulate 'robust' conclusions that supposedly hold "under a variety of approaches, methods, models and assumptions"(IPCC, 2001, p. 19). Another sort of input is the sometimes tortuous diplomatic negotiations; after all, country representatives have political agendas and a large say in the exact wording of conclusions in chapter summaries. In view of the interests at stake and the political

importance of international consensus on climate change knowledge and policy, this intertwinement is a sensible practice. The choice of who gets to write the results, the presentation of its contents, and the way it is summarized, are the result of a double set of scientific and political constraints, blended in ways that are difficult to disentangle (Petersen, 2006, pp. 158-160; Yearley, 2009, pp. 392).

In advisory relationships such as in the IPCC, experts and policy makers are at work together. Detailed empirical studies of expertise for public policy have shown that expertise that is mailed to the policy maker in reports, articles or books rarely leads to any kind of policy uptake (Nutley et al., 2003). Experts may be very sensitive to immediate demands of policy, and effective use of new scientific information relies on mutual face-to-face interaction, on working together. From a macro-perspective, science/politics interactions are ongoing dialogues that portray the dialectics between the scientization of society and politics and the politicization of science. Of course this does not mean a complete blurring of the boundaries between science and politics as in a seamless web. Rather, it should be conceptualized as *boundary work*.

Work implies meaningful and purposeful activity, directed at the creation of a collective product. Experts do not work on policy reports by blindly and thoughtlessly following algorithms, but through an understanding of the problem at hand, a meaningful comprehension of the knowledge available, the context in which this knowledge is to be used, as well as what kinds of statements are tenable, given professional standards and values and the targeted audience (Wenger, 1998). Working *together* means policy makers and experts have to negotiate tensions and barriers between their academic-professional and political-administrative worlds. Their concerns and projects never quite coincide, no matter how policy-oriented the expert or how evidence-oriented the policy maker. Working together implies negotiation of work across boundaries between social worlds and mutual adjustment, and dealing with new, unknown problems as they emerge. Advising policy is complex, professional work, where not all eventualities have been resolved and not all role conflicts have been settled. Inversely, policymaking civil servants negotiate complex streams of puzzling and powering, in which expert advice is but one parameter in a fuzzy set of undefined equations.

Definition and Multilevel Framework

Because this work occurs across the boundaries of policy and expert worlds, it is called *boundary work*. Boundary work can more formally be understood as the attempts by actors to define practices in contrast to each other through demarcation, as well as their attempts to find productive cooperation across these boundaries through a division of labour that is more or less accepted by relevant actors (Star & Griesemer, 1989; Gieryn, 1995; Halffman, 2003; Hoppe, 2005). Boundary work portrays a fluid and dynamic picture of science-policy interactions that is very different from the idea of an essentialist definition of science as, for example, demarcated from other forms of knowledge by the falsifiability of its statements. It also refutes the corresponding ideas of a 'gap' to be 'bridged' or a unilinear process of 'knowledge transfer' from science to politics.

The ongoing process of negotiating a division of labour between science and politics can be discerned by looking at texts, objects and people (Halffman, 2003). 'Boundary texts' (discourse, language, concepts) are about linguistic repertoires in which both parties speak and define their different roles – the IPCC reports provide a good example. 'Boundary objects' refer to tangible tools which actors use in producing knowledge and advice in policy settings, like testing procedures, standardization methods, computer models, measurement devices, or indicator systems. 'Boundary people' are the different players in boundary arenas – either scientists or policy workers, or those who combine or frequently oscillate between these two roles (Hoppe, 2008). Together, boundary texts, objects and people shape boundary configurations.

Such boundary configurations are most clearly visible in concrete research-and-policy projects around particular topics. However, projects are carried out by organizations or organizations-of-organizations which (sometimes explicitly) mediate the boundary between professional-academic networks and public sector or policy organizations. Such organizations usually cluster around the typical problems in a specific issue or policy network. These problem-and-network structures in turn are permeated by a political-cultural sphere, the characteristics of which influence science-policy interfaces on all levels. To describe a comprehensive picture of the science-policy interface, then, means to understand multilevel science-policy interactions and the ways these levels interact (see Figure 6.1).

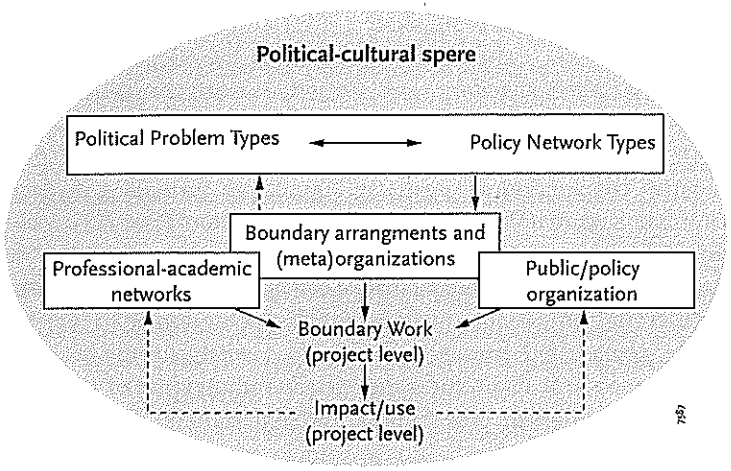

Figure 6.1 Multilevel conceptual framework for understanding science-policy interactions

In this chapter I will use this four-level model to describe and analyze salient features of science-policy interactions in the climate change issue. I will use examples of productive and less productive boundary work to argue three major points:

- In climate change issues, problem framing is plagued by *scale asymmetries* that inevitably trigger *puzzling/powering dynamics* that are difficult to control.
- *Both* the science and the politics of climate change consist of the creation and maintenance of productive power/knowledge structures through *boundary work.*
- The boundary work of science/politics interactions is never about knowledge transfer (in either direction); it is about the *co-creation of knowledge and expertise* in collaborative knowledge pursuits.

6.2 *Scale Asymmetries: Scientific Puzzling and Political Powering in Problem Framing*

Policy Analysts and Policy Entrepreneurs 'Lost in Translation'

After George Bush stymied Al Gore's bid for president, Gore came "to believe that even a US president is powerless to act on climate change unless public opinion has moved, that acting as a teacher and advocate can have a greater political impact."(Freedland, 2007). Gore became a brilliant policy entrepreneur for the climate change issue.

His documentary movie, 'An Inconvenient Truth', won him the movie world's Oscar and the international political world's Nobel Peace Prize, and set off avalanches of media events. The global warming issue, and thus climate change policy, raced to the top of government agendas all over the globe. Businesses soon jumped on the bandwagon and marketed their products as 'green' or 'climate friendly', in an endless shower of self-congratulatory semantic creativity, which made one wonder why there was a sustainability and climate problem in the first place.

Yet, did Gore get what he intended? The answer is ambivalent, maybe even negative. It looks as though policymakers are at a loss about what to do exactly about climate change. 'Think globally, act locally' and 'glocal solutions' are good rhetoric. Yet, 'lost in translation' better describes the real situation. Policy analysts and policy entrepreneurs deal with a global warming and climate change issue, yet they appear to be at a loss as to how to translate this into action in their own territorially circumscribed jurisdictions. As a global policy problem, climate change requires scaling-down to formulate appropriate policy responses. Yet, instead of straightforwardly descending a ladder of logically nested scales, finding national, regional and local answers requires a continuous back-and-forth process between scaling-down and scaling-up, a dialectic between global framings of the problem and its local manifestations and policy implications (Jasanoff & Martello, 2004).

Cross-scale Asymmetries, Puzzling and Powering, Boundary Work

Powering for mobilizing political support

The above conclusion is especially true if national or local 'reserves' are declared unavailable for human use for the sake of global goals. For example, setting aside more space for rivers to anticipate increased peak discharges in densely populated countries like The Netherlands and Indonesia inevitably conflicts with local economic or housing development plans. The same applies when parts of the rainforest are declared taboo for commercial logging in the interest of biodiversity in countries like Brazil.

From a political 'powering' angle, issues that concentrate costs locally to achieve globally dispersed benefits require a fiercely entrepreneurial style of politics (Wilson, 1989). Policy entrepreneurs like Gore must forcefully sell their policy solutions e.g. by stretching normal political time frames to include future generations of humans among the beneficiaries, or

by expanding the beneficiaries by including animals, plants or 'nature' itself. Yet, such arguments are not usually convincing. Given the causal link between fossil fuel consumption and economic growth, is a climate policy that focuses on the reduction of greenhouse gas emissions not eroding governments' major claim to legitimacy as guarantor of economic wealth and prosperity? Is it not 'ecological imperialism' to impose a low-carbon economy on developing states in the South? The functional authority of science is abundantly manifest in the IPCC and, mediating between science and politics, its policy-analytic boundary organization, the Subsidiary Body for Scientific and Technological Advice (SBSTA). However, given that a complex phenomenon such as the global climate system will never be scientifically understood completely, is this functional authority not overtaxed when it is used to represent future generations and non-human species? It would seem that in this case scientific authority threatens normal democracy as a process of ascertaining the views of a majority of the presently living humans in making equitable and fair policy decisions.

Boundary work as 'puzzling + powering' for appropriate problem scale

The scale asymmetry problem does not only relate to the mobilization of political support for unpopular measures to achieve global goals. It has a cognitive side too, as it involves 'puzzling' as well as 'powering'. The question of how scientists, stakeholders, policy workers or politicians arrive at 'closure' about the space-time boundaries to be drawn around 'problematic' systems is a combined one of puzzling and powering. How do they frame the scientific and policy problem? Especially, how do they decide on its scope, i.e. the levels or scales and the cross-level and cross-scale interactions to be taken into account in thinking about the problem and designing potential solutions? Scientific modellers frequently distinguish between analytical-physical scale levels like global-continental-fluvial-regional-landscape-patches. Politicians and policy analysts will think in terms of existing multilevel governance on the intergovernmental-national-provincial-local continuum, or in terms of levels of governance practice like constitutions-laws-policies-programmes-operational rules-implementation routines. The world of corporate management and business has its own ways of thinking about scales and levels: world markets, regional international markets, multinational firms, or national franchises, each with their own strategies and tactics. In effective governance regimes all these different ways of ordering the world in scales and levels have to be somehow aligned.

The analytic problem of framing the scales/levels is primarily influenced by the existing scale/level distribution in the real-world institutional environments. Yet, sometimes the reverse is true. Innovative ideas and problem definitions can lead to re-thinking and re-building the politico-administrative institutional environment according to physical boundaries, one that promises to be more functional for effective problem solving. The emergence of a worldwide, international climate change policy regime over the last decades is a case in point. At a regional scale, nation-states around the North Sea established international policy forums for regulating activities like offshore drilling, wind farms, fishing, shipping and pollution control. In so doing they have created a *transnational* political arena focused on the North Sea as ecosystem. Another example of a successful practice of multilevel, intergovernmental collaborative forums that match scientifically relevant scales for ecosystem-based decision making, is the integrated catchment-coastal zone management regimes established in many European countries by the June 2000 EU Water Framework Directive: " ...the directive introduces both new goals and new means of achieving them (i.e., new organizational framework and new measures). ... Organisationally, measures to achieve new goals will be co-ordinated at the level of river basin districts, i.e. *hydrological units and not political boundaries* (italics, RH). ...an important innovation of the Directive is to widen participation in water policy-making, river basin management plans...involve extensive consultation and public access to information"(Ledoux, 2005, p. 206).

Cross-scale asymmetry problems therefore invite, even demand, boundary work. It is unproductive to look at them as matters for political powering alone, or as just problems of intelligent puzzling. Dealing with scale issues inevitably involves both intellectual and political struggles on how to draw boundaries around problems. This is inherent in the substance of all scientific questions and political issues with a multilevel character, especially if the problem's scope stretches the entire globe. Unfortunately, all too frequently scientists and policymakers find themselves under-prepared to deal with boundary work situations, without a compass, or guidelines on how to productively engage in it. The sections below on boundary arrangements and boundary work projects show this to be unnecessary.

6.3 *A Multilevel Framework for Understanding Science-Policy*

Figure 6.1 above set out a multilevel framework for understanding boundary work. The next subsections will elaborate this concept on each of the four levels, with special reference to the climate change issue.

Level 1: Boundary Work is (Trans-)Nationally Culture-bound

Competing ideas on the vulnerability of nature to human exploitation (Holling, 1986), societal fairness, and the trustworthiness of expert or lay knowledge infuse climate change debates from the dinner table to the Kyoto process. Attitudes to risk, equity and science/politics interaction are embedded within political cultures and reflected in institutional frameworks (Thompson & Rayner, 1998). There is overwhelming evidence that public policy responses to new scientific or technological developments like, for example, biotechnology, are determined by *national* political cultures and regulatory styles (Halffman, 2005). Hence, it is not surprising that the allegedly same and universal knowledge about global climate problems leads to divergent policy responses in different countries (recent overview in Compston, 2009). There is also emerging evidence for the existence of different global or transnational cultures (Strassheim, 2007), leading to divergent ideas about shaping a transnational governance regime for climate change.

National culture

As an example, consider how German politics and its culture-bound boundary work (re)frames the global climate change issue (Beck, 2004). Environmental politics in Germany arises from local resistance against environmental degradation of landscapes and livelihoods. To make such local resistance politically effective, the problem is processed in a broader national political system. Germany's political system may be characterized as a mix of ingredients, such as: legal positivism, strong judicial and administrative review, federalism and vertical, intergovernmental relations (*Politikverflechtung*), the high status of the state bureaucracy, a historically well-organized civil society and a tradition of delegating state tasks or corporatism. Such a political system tends to frame global climate change as an impending 'catastrophe'; more than an issue of quick technical fixes, it is a fundamentally moral and ethical issue. The policy response is to embrace the precautionary principle and order drastic cuts in carbon dioxide emissions, and possibly decentralize decision-making to the *Länder* and local grassroots level. One easily recognizes a green political philosophy that could influence policymaking because of

proportional representation, which gave the German Greens relatively easy access to seats in parliament. Greens were denied this opportunity in first-past-the-post and winner-take-all systems in the United States and the United Kingdom. In the growing awareness of the global nature of the climate change problem in the 1980s and early 1990s this led to a national policy response in which Germany claimed a 'front-runner' status in preparing global precautionary measures for mitigating climate change through strict greenhouse gas emission reduction targets.

Transnational cultures?

The Kyoto Protocol itself provides an example of one type of transnational multilevel governance culture. Kyoto was constructed by borrowing from past treaties e.g. on ozone depletion and nuclear arms. The designers thought the problem ought to be tackled through global emission controls, "treating tonnes of carbon dioxide like stockpiles of nuclear weapons to be reduced by mutually agreed and verifiable targets and timetables" (Prins & Rayner, 2007). Testimony to effective EU-dominance, it is the product of a statist top-down conception of international treaties as legal instruments for creating multilevel governance regimes. In this European model governance levels are nested within higher general purpose administrative and political units (single states as treaty partners) and there is a centralized legal authority (the treaty itself). The framework is system-wide (global) and institutionally durable (set dates for renewing and widening the treaty), and appropriate targets and instruments are in place (an emission trading system, joint implementation, clean development mechanism).

According to its critics, this approach denies the multilevel and multi-actor complexity of global climate change. Kyoto has not achieved demonstrable emission reductions and, in view of predicted growth rates, does not hold out the promise of decreasing emission levels in the future. In spite of this, the need for strategies of local adaptation to climate changes draws only symbolic attention. This is understandable only when one realizes that in order to change the present strategy of more of the same – more stringent targets and more timetables, underwritten by more countries – requires a culture transition from a Russian doll model to a marble cake model of global multilevel governance.

In this alternative mode, transnational regulatory regimes are set up specifically for a narrow purpose; they are territorially different and have overlapping membership. Authority is dispersed, jurisdictions

are task-specific, partly overlapping and competing; moreover, they are impermanent and polycentric. Marble cake multilevel governance finds its cultural roots in the American federalist experience. It finds expression in the US-led idea of a pact to combat global warming, with Japan, China, Korea, India and Australia. This more flexible approach could allow early mitigation efforts to serve as policy experiments from which can be learned what works, where, when and how (Prins & Rayner, 2007). One of its claimed advantages is to focus on what governments, households and firms actually do, in contrast to abstract, directive target setting, characteristic of the Kyoto approach. Its potential weakness, of course, is that it requires high levels of mutual trust between national and transnational 'partners in governance'.

Level 2: Boundary Work as Policy Politics in Policy Domains

Policy politics

The second level of boundary work is best defined as the *sectoral* or *policy domain* such as emission trade policy, energy transition policy, or biodiversity policy. A political system at large may be viewed as a 'federation of domains' where each domain has a distinct style of *policy politics*. Policy politics is the combination of the types of cognitive processes and the styles of competitive interaction that are characteristic for problem processing in a specific domain. Policy politics describes a particular governance space, which coordinates the production, dissemination and acceptability of knowledges for political decisions. 'Knowledges' is used in the plural because normally political decisions have to align different types of knowledge from different actors: citizens, professionals, bureaucrats, experts. The policy politics of a certain domain acquires its special character precisely because it implicitly or explicitly constructs a particular public epistemology, i.e. the taken-for-granted expectations about the legitimacy and validity of these knowledges. Thus, policy politics involves contests about the availability of knowledge, about powers and competencies to frame and define problems and about the legitimacy of knowledge claims. Policy politics, then, deals with the borders between science and other actors' modes of knowing.

Theorists tend to bypass this policy-domain level and consider (trans) national styles only as explanation of the variations in science/politics interactions. Yet, as variations between domains may be greater than between national styles or cultures, distinguishing policy domains as a distinct level is important. For example, the policy politics of water

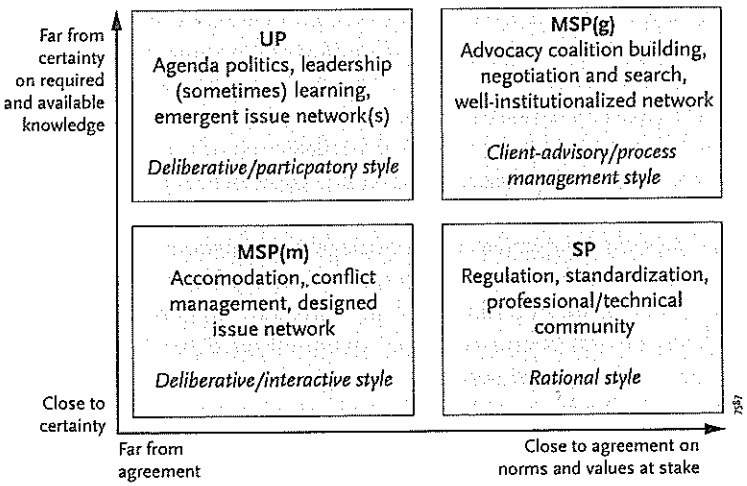

Figure 6.2 Problem-network types (bold) and styles of analysis for and in policy (italics)

management in India, say, may look more like the policy politics of water management in The Netherlands than the general national political cultures would suggest. In addition, changes in regulatory regimes at policy domain level cannot be explained only by national path dependencies. Where issues are of a global nature, global-local boundary work dynamics in policy domains may be more important than national styles and cultures (Jasanoff & Martello, 2004; Strassheim, 2007). In turn the policy politics of a network of actors in a particular policy domain strongly affects the boundary arrangements at the next analytic level.

Problem types

The science-policy interface is arranged differently in practice because not all problems have the same characteristics. A well-known typology is presented in Figure 6.2. Depending on the degree of certainty in available (and relevant) knowledge, and the degree of (dis)agreement on norms and values at stake, one may distinguish between structured (SP, lower right), moderately structured (MSPg with goal consent and MSPm with means consent, upper right and lower left) and unstructured problems (UP, upper left). Each of these types is associated with different political styles (policy politics) and 'public epistemologies' (Ezrahi, 1980; Hisschemöller et al., 2001, pp. 437-470; Hoppe, 2010). Different policy politics and public epistemologies in expert advice result in the path-

dependent institutionalization of combinations of a dominant problem definition and hegemonic problem solution alternatives.

As pictured in the media, global climate change is the paradigmatic case of an unstructured, 'messy' or wicked' web of problems. However, taking a closer look reveals political and scientific efforts to redefine the problem as more structured. This is normal because politicians and policy advisors generally feel uncomfortable about the value-loaded ambiguities and evidentiary uncertainties and complexities involved in (as yet) unstructured problems. They therefore support efforts to move problems out of the unstructured quadrant in Figure 6.2, for which scientific authority can provide a strong back-up (Ezrahi, 1990). Experts support this process because in their turn they are used to 'domesticating' the 'wicked' overall problem through disciplinary problem structuring, i.e. by fitting the problematic situation to their models and by deconstructing the problem into smaller, relatively independent sub-problems to be solved separately or sequentially.

Problem structuring through problem decomposition
Looked at through this lens of problem structuring, the IPCC and the SBSTA have already managed to transform global climate change from an unstructured problem into a range of moderately structured policy problems with goal consensus (MSPg). There is a fair amount of convergence about the goals of climate change policies, about effective and efficient instruments, their side effects or risks, and about the way these have to be distributed among countries participating in the Kyoto process. Now that it was made into a knowledge problem, the IPCC could mobilize different sciences in a complex inter- and transdisciplinary endeavour to break down the overall problem by 'imposing' different disciplinary paradigms, methodologies and models:

"The IPCC stood out from many other 'science for policy' organizations through its commitment to include in its core activities the economic, social scientific and policy aspects of its scientific theme. Though, according to the self-understanding of the IPCC, these disciplines could not have the precision and exactitude to which the physical sciences aspired, it was clear that global climate change could not be studied in the absence of societal analyses...(T)he things that worry us about climate change are chiefly the implications for people, commerce, cities and to some extent wildlife. The actual impacts that will arise clearly depend on how people respond. Without expert advice on these policy matters, there

could be no sensible modelling of the 'output' side of the climatologists' work. ...(P)olicy responses to climate change again depend on people's willingness to accept the policy prescriptions – to forgo air travel or to put up with climate risks and so on. *The IPCC handled this issue by dividing its procedures into three parallel tracks dealing with the physical sciences, the socioeconomic impacts and possible policy responses.* (italics, RH) ... The institutional assumption of the IPCC is that the most relevant social science is economics..."(Yearly, 2009, pp. 400-401).

Level 3: Boundary Arrangements
The third level in boundary work is a subsidiary part of the policy-domain level and focuses on the *boundary arrangements* and *organizations* that institutionally facilitate the science-politics interactions and knowledge-power structures in a given policy domain. The concept of boundary arrangements tries to capture the sheer variety of boundary-crossing science/politics hybrids that have flourished and proliferated during these last decades (Strassheim, 2007, p. 283). In the Netherlands alone, the array of hybrid institutional forms runs from legally established, highly institutionalized, boundary organizations like the Center for Economic Policy Analysis (CPB) or the Scientific Council for Government Policy (WRR), to merged organizations or organizations-of-organizations like Alterra (for agriculture and environment) and Deltares (for coastal and river management), sectoral councils (like RMNO, for Spatial Planning, Nature and Environment) and research 'centres of excellence' (like NICIS, for urban research and practice), all the way to informal hybrid virtual forums where academics, professionals, businessmen and government officials meet around shared problems (like the website of the 'coalition' of CO_2-neutral cities). In other words, explicitly established and institutionalized boundary organizations are but one manifestation of a much broader twilight zone of hybrid arrangements (Halffman & Hoppe, 2005).

Not surprisingly, this makes for a variety of arrangements about boundary work. In an empirical study of Dutch boundary work discourse no less than seven distinct types were observed (Hoppe, 2008). Although there is no one-to-one correspondence between problem type and type of boundary arrangement, the dominant or average type of problem exerts considerable influence on the nature of boundary arrangements in which boundary workers are embedded politically and institutionally. For example, boundary work at the international, strategic IPCC level (where climate change is a moderately structured problem with some

goal consensus) differs from boundary work at the level of, say, a detailed technical and specialist project in river-basin management (in which the climate change aspects of the problem are considered almost domesticated). In the former case, this leads to complex negotiations between scientists, policy analysts and diplomats on problem definition and alternative routes to a solution; in the latter case, the focus is on technical problem-solving alone, and the process is largely delegated to a professional community of specialists, with relatively little interference from politics and policy. Of course, there are many in-between positions that are not discussed here for reasons of space (but see Figure 6.2).

Attributes of ideal-typical boundary arrangements

For simplicity's sake, therefore, this level is described here through a shortlist of characteristic attributes of ideal-typical boundary organizations (see e.g. Guston, 2001; Miller, 2001; Cash et al., 2002). Readers should realize that not all of these attributes occur in each boundary organization, and that each may be present in stronger or weaker form.

Double participation: People from both the political/policy and the scientific world are represented and take part in the activities of the boundary organization. This first ingredient of boundary organizations is clearly visible in e.g. the production and consultation processes preceding the publication of the Dutch government's 2007 White Paper and the Delta Commission's 2008 advice on 'Living with Water'. The 'blue ribbon' commission was chaired by a former minister of agriculture and consisted of people with high political, administrative or scientific status.

Dual accountability: The leadership or management of the boundary organization is accountable to relevant representatives of science and politics. In discursive balancing acts they have to define a stable and acceptable mission for their boundary organization. In any political system with representative democracy this is a difficult task. Decisionism, or political primacy, is the sacred norm: 'Politics on top, scientists on tap'. Yet, worldly reality will more or less deviate from this norm. For example, science/policy interactions in water management clearly show that Dutch policymakers will respect expert input, yet see expert advice as a way of fighting over policy by packaging political opposition in technical questions about indicators, model parameters, risk levels, etcetera (Wesselink et al., 2009). This also applies to most other policy domains (Hoppe 2008).

Boundary objects: The above example explains why expert reports or advice are usually excellent (textual, conceptual, graphical) boundary objects: they are "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. They may have different meanings in social worlds but their structure is common enough to more than one world to make them recognisable, a means of translation. The creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds"(Star & Griesemer, 1989, p. 393). Examples of suitable boundary objects are indicator systems (Turnhout et al., 2007), econometric or climate models, bi-annual audits, report series, etcetera. Textual boundary objects that immediately support budget decisions appear to be the best guarantee for successful boundary work. Their production contributes significantly to the next item:

Co-production of social and cognitive order, using *negotiation, confrontation* and *mediation* to resolve conflicts. Experience shows that premature consensus-seeking and compromise-building are serious dangers in productive boundary work. They can be avoided through deconstruction and reflexive analysis of key assumptions such as established policy concepts or promising scientific or technological developments (Hisschemöller et al., 2009). This requires steps that neither politicians nor scientists are necessarily comfortable with: the identification of critical scientists, counter-experts, visionaries, and even dissenters, and sometimes confrontation with local knowledge. For example, experts' model building for integrated assessment of site-specific climate change options can be supplemented by parallel participatory integrated assessments involving local inhabitants (Siebenhüner & Barth, 2005).

Metagovernance and *capacity building* implies cross-jurisdictional, cross-level and cross-scale orchestration of distributed knowledge production. This task deserves special attention to avoid the incrementalist seduction in national or local climate adaptation policy. Part of the seduction is the almost irresistible urge among politicians and administrators for cherry-picking and venue shopping. Their political motives drive them to claim and assert problem ownership of projects with visible, easily deliverable, short-term results ('cherries'). To achieve this, they steer such projects towards decision arenas and procedures ('venues'), which will most likely realize the politically desired results without necessarily producing any real change. They steer clear of decision areas and procedures that

may produce politically 'adverse' outcomes. In terms of intelligent trial-and-error learning, these political strategies lead into the three pitfalls of incrementalist policy change: misguided policy trials may produce costly outcomes, policy moves prematurely declared successful retain too little flexibility to correct errors, and learning about errors may be very slow. Against such tendencies, the effective boundary organization needs to engage in 'metagovernance'. Metagovernance resists the bias inherent in cherry picking by keeping alive a holistic picture of the problem. It counters venue shopping through the careful design of procedures of deliberation and participation and by monitoring of progress along the designed lines. Sufficient attention to capacity building in all relevant boundary organizations and projects is another important element of metagovernance.

Level 4: Boundary Work in Projects

Finally, a *micro-level* of actual boundary work practices in *projects* may be distinguished. This is where the boundary is at its most fuzzy and sometimes even 'up for grabs', as it has to be negotiated and renegotiated in the smallest details. For example, in the production of authoritative texts by the IPCC the political and scientific practices of dealing with uncertainty depend on the characteristics of the policy and knowledge workers involved, as well as on the design of the projects they engage in (Petersen, 2006). Other aspects of boundary work in projects are: dealing with values (is it a political or scientific responsibility, or shared?), dealing with conflicting knowledges, the impacts of the project design on the participants' ability and willingness to learn, and on the building, maintenance or erosion of mutual trust and the organizational flexibility of the project itself.

It is at the project level that the considerable body of knowledge of project design ingredients becomes relevant. Research on knowledge on project design and its impacts is evolving into an interdisciplinary field of its own. It goes under different labels: from-knowing-to-doing (Nutley et al., 2003), integrated assessment (Van Asselt, 2000), participatory and deliberative policy analysis (Kasimir et al., 2003; Loeber, 2005), collaborative knowledge production or joint fact-finding (Van Buuren & Edelenbos, 2004), reflective practitionership (Schön, 1983), communities of practice (Wenger, 1998), transition management (see Grin, chapter 5 in this book), design rules for inter- and transdisciplinary projects (Scholz, chapter 4) or adaptive management (see Pahl-Wostl, chapter 7), and many more.

In spite of all these budding communities of learning and practice, the project-level of boundary work still hosts many perplexities and dilemmas. All scholars who have reflected on the limitations of the human mind have concluded that boundary work is inevitable in reaching aggregate political decisions for collective action, if anything because our inability to know (everything) forces us to at some point stop the cognitive process if we want to make decisions and take actions. Hence, any form of learning in political task fields should not be limited to scientific analysis-and-instruction; it necessarily takes the shape of pragmatic trial-and-error learning by variation-and-selection. Perhaps, then, the most important question for boundary work at project level is how to arrange projects as field experiments in intelligent trial-and-error learning processes. Important questions to ask are then: How is it possible to specify project arrangements, procedures, and strategies to make errors less damaging and to accelerate learning? Under what conditions do (sets of) politically and scientifically partisan players manage their mutual interactions to deal better than usual with uncertainty, value ambiguities, limited time, and so forth? Under what conditions do they do worse than normal?

We still need much better knowledge about truly intelligent and politically acceptable trial-and-error learning. In theory, we may formulate key principles for boundary work projects (Woodhouse & Nieusma, 2001). They include: early debates involving many divergent perspectives, building flexibility into projects so as to facilitate a change of course in case of negative feedback, taboo- and back-up systems and other precautionary steps to cope with initial, sometimes huge uncertainties, gradual scale-up of activities (again with a view to flexibility), and designed, accelerated feedback through advanced testing and intensive monitoring. Yet we know from experience how difficult it is to design these desirable features into actual projects, and, once designed, to faithfully adhere to them.

6.4 *Co-Production of New Expertise*

In this chapter I have introduced and discussed some descriptive, explanatory and prescriptive functions of a boundary work perspective in science-policy interactions on the climate change issue. I have stressed three interrelated key observations:

- Science is not a separate institutional sphere for independent production of warranted and salient knowledge.

- Long-term science/policy interactions are about mutual knowledge exchange, hardly about unilinear transfer.
- Both science and politics work to develop new expertise for dealing with new problems through the creation and maintenance of productive knowledge/power structures.

Thus, *co-production of new expertise* is the glue that joins the efforts of science and policy. In the application of insights on boundary work to climate change, the following main hypotheses have been advanced:

- Cross-scale asymmetries in the global climate change problem lead to endemic difficulties in delineating boundaries around 'problematic' systems; these can only be dealt with through productive boundary work.
- Transformations in the interface between science and politics, the dialectics of scientization of politics and the politicization of science, have generated a vast array of hybrid boundary arrangements.
- Largely due to the complexity inherent in boundary work conditions, many scientists and policy analysts appear to be *lost in translation* – between global and local aspects of climate change, between long and short term issues, between the need to show results and the need to learn.
- For effective boundary work it is important to resist the pitfalls in trial-and-error learning. Instead, we should learn to adhere to the principles of fast and intelligent trial and error – especially at the project level of boundary work.

We only imperfectly understand the world's complexity, yet want to shape it to our ideals. This condemns us to permanent learning. The competition of on-going experiments creates myriads of problems that need to be made governable, somehow, in order for the trials not to result in collectively self-destructive errors. After the current financial-economic crisis, the ecological and global climate change issue is one of the principal challenges of our time that exemplifies this condition. Good governance of problems will always entail a form of cooperation between non-experts and experts. The notion of good governance expresses the never-ending challenge to maximize the intelligence of democracy by fostering mutually creative links between the wisdom of the crowds (Surowiecki, 2004) and innovative expert knowledge in intelligent, fast, and sustainable trial-and-error learning (Lindblom & Woodhouse, 1993).

In the framework of good governance, good boundary work is about the creation and maintenance of a productive tension between science-as-puzzling and politics-as-power-struggle-over-policy in modern societies. Productive and creative boundary work at project level is important for its own sake, but even more for its impacts on the sustainability of meso-level boundary arrangements, on the quality and relevance of activities in professional-academic and politico-administrative networks, and finally because it can help create a cultural climate that is favourable to the emergence of a true knowledge society.

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