The interplay of meaning and power in the science-policy-society triangle: powering, puzzling and co-producing climate change adaptation

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Climate change adaptation at the boundaries between science, policy and society

Decision-making in relation to climate change is knowledge-intensive (Termeer et al., 2011). Without systematic observations and advanced mathematical models, even awareness of climate change would be very limited. At the same time, important uncertainties about the nature and scale of risks and the effectiveness of solutions will persist. In addition, climate change is also a high-stake issue, affecting a range of sectors and policy domains. Taking climate change mitigation seriously requires drastically reconsidering current practice in domains like energy, transport, agriculture, housing etc. Depending on the severity and timing of climate impacts, more or less drastic adjustments will be needed in domains like water management, spatial planning, agriculture, tourism, nature etc. The variety of interests and ideas which are brought to bear on the climate change issue is considerable (Hulme, 2009). In spite of these inherent uncertainties, ambiguities, and conflicts of interest, decisions about adaptation strategies are being taken or prepared now.

In this paper, we attempt to gain insight in how this variety might be handled at the boundaries between science, policy and society in producing climate adaptation policy. We develop a perspective informed by the concepts of co-production (Jasanoff, 2004b), powering and puzzling (Heclo, 1974) and interactive framing (Dewulf et al., 2009) that enables to shed light on the practices of meaning making and relational positioning when actors coming from different groups interact. As such it enhances our understanding of the dynamics in the science-policy-society triangle. This perspective grants agency to actors in sensemaking and the interactive production of meaning, and in the political game of negotiating interests. We also try to take structure on board. Through action the constraining and enabling effects of norms, power relations, institutions and discourses becomes visible when they are implicitly referred to, are mobilized and are used in the process of interaction.

We take two well-known domains of practice and scholarship as our starting point: the production of knowledge at the science-policy nexus, and the production of policies at the policy-society nexus. We discuss these in relation to climate adaptation and in terms of the variety of interests and ideas that they have to deal with.

Historically, the science-policy nexus has been conceptualized as a linear model in which scientific 'truth' discovered in fundamental science was transferred through applied research into the political arena (Pielke, 2007). Actual science-policy interactions turn out to look much more varied and two-sided than this model suggests. In the case of climate change, different scientific models are put forward and different climate change scenarios are produced. These climate change scenarios further rely on different future socio-economic scenarios and assumptions. Using these models for policy decisions requires choices about which knowledge and results to rely on, and how to deal with the associated uncertainties. Using worst case scenarios leads to different decisions compared to using more moderate predictions of climate impacts. Deciding on adaptation measures can be informed by particular climate change scenarios and impact assessments, for which knowledge has to be rescaled and made relevant to regional policy decisions, but also requires a variety of field-specific knowledge such as water management, ecology, transport, tourism, etc. In important respects, the policy domain of climate change adaptation has been defined by this arsenal of scientific concepts and scenarios, and vice versa, climate science has been driven in important respects by government funding for policy-relevant research.

At this nexus where science and policy interact and mutually constitute each other (Jasanoff, 2004b), dealing with the variety of scientific knowledge is further complicated by the variety of policy issues

demanding attention of administrators and politicians. Climate change adaptation is but one item on the agenda, competing for priority, manpower and budget with issues that are often considered more urgent, more pressing or more relevant to voters, the financial crisis being an obvious example. Due to the nature of the climate change issue, adaptation policy also needs to be addressed at different scale levels (from the municipal to the global level), which involves a variety of challenges that potentially interact – adaptation policy that seems reasonable from a national perspective (e.g. creating water storage capacity to protect the country from flooding) may be unacceptable at the local level (e.g. inundating areas of economic, natural or cultural value).

In a traditional model of government, public policy is shaped by governmental agencies being accountable to society through some form of representative democracy. In this traditional model of public policy formation the realms of policy and society remain rather separate except at the institutionalised nexus of a national parliament, regional water board or local municipality council. At this interface society's chosen representatives explicitly interfere with the policy domain by either setting the policy agenda or requesting accountability form the policymakers. However, through processes like stakeholder participation, interactive policymaking and citizen initiatives, the world of policy has also an more direct link with society, through which a variety of different societal demands regarding climate change adaption enter into the policy processes. The institutional void (Hajer, 2009) characterising the domain of climate adaptation results in a more horizontally organised, or even 'decentred' form of governance (Bevir & Rhodes, 2003b). Together with the on-going trend towards decentralisation and privatisation, different governmental layers and new interdependent (societal) players interacting through (ad hoc) stakeholder consultation, characterise the relative new decentred domain of climate adaptation. In this way not only public authorities make public policies but also societal actors like companies, ngo's and citizens take part in shaping these policies. Whether these actors act on behalf of their own interest or not, they operate in close cooperation with each other filling the void where traditionally the public authority developed the policies for the public.

Analysing the variety that flows across the boundaries of the science, policy and society can be done by trying to identify the different processes that are involved and analyse them separately, like sensemaking and politics, developing ideas and negotiating interests, or creating useful knowledge and taking decisions. Another option is to focus on how these processes are interwoven at different interfaces between science, policy and society, for this interplay between meaning and power is often neglected (Majone, 1998). Research traditions from public administration, political sciences, policy sciences, social psychology, science and technology studies or organization studies tend to develop assumptions on the nature of the social world. To make a very rough distinction, at one extreme, the social world can only be understood by studying worldviews, meaning and learning processes. At the other extreme, the social world can only be understood by studying power relations, conflicting interests and political games. Although very few approaches or studies will be found at these extremes, the distinction does help to identify those approaches or studies that do engage seriously with both the ideational and the political. To understand how the ideational and the political are intertwined in the science-policy-society triangle, we will focus on two approaches that, in their own specific way, claim to address this interplay at different interfaces in the science-policy-society triangle: (1) puzzling and powering policies through interactive framing at the policy-society nexus; (2) co-production of science and social order at the science-policy nexus. After discussing these approaches and how they are or can be applied to the governance of adaptation to climate change, we reflect on the connections between these approaches, and what they can contribute to dealing with variety in the science-policy-society triangle, and to designing more effective, legitimate and resilient governance arrangements.

Co-production and changing patterns of science–policy interactions in the governance of climate adaptation

Central to the linear model of the science-policy nexus is the assumption that science and politics are clearly distinguishable and independently evolving worlds, where the former deals with facts and the latter with values. In this model the 'bridging' of the 'gap' between science and politics had to facilitate the expert in 'speaking truth to power' or the politician in 'tapping the reservoir of science'. This linear model continues to inform common knowledge as well as the way policy-makers portray the relationship between science and policy (Millstone, 2009, p. 626). For instance, the Dutch *National programme on*

climate adaptation and spatial planning resonates the linear model in its plea for more fundamental climate research and demand-led applicable knowledge (Ministry of Housing Spatial Planning and the Environment (VROM) et al., 2008, p. 32). Another example can be found in the Delta programme fresh water, which emphasises the absence of values in the first assessment phase and the introduction of interests in the strategy selection phase.

This rationalist-modernist approach to science-policy interactions and science itself has been gradually critiqued and discredited from four different paradigms: normative, epistemological, organizational and participatory (Leroy, Driessen, & Vierssen, 2010). The normative critique, from within the legacy of the Frankfurter Schule, questioned science as being ideology-driven. The supposed objectivity of science and its truth claims had proved to be tainted by prevailing power relations and vested interests. From an epistemological perspective, the disciplinary organization of science and particularly its disciplinary reductionism has been critiqued. Too little attention was given to the comprehensive and complex character of environmental issues that transcend disciplinary boundaries. From an organizational perspective, it has been noted that scientific expertise (e.g. regarding nuclear energy) was indeed very unevenly distributed among the proponents and opponents of such issues. Finally, from a participatory perspective, scientists and experts have been critiqued for not using the often implicit local and layman's knowledge.

Recently, more dynamic and sophisticated views on the science-policy nexus have been developed. The concept of 'co-production' (Jasanoff, 2004a) offers a perspective in which knowledge-making affects governance and, in reverse, in which governance influences the production of knowledge in which no category is prior to the other. Thus, rather than just pointing at the process of joint production of knowledge between agents, the concept refers to the intertwined constitutive links between knowledge making and social order. Scholars have shown how science, normativity, power and culture are entangled and solidified in entities such as socio-scientific arrangements for global climate governance (Miller, 2001), technological artefacts such as levees (Bijker, 2007) or the boundary objects translating uncertainty (Shackley & Wynne, 1996). Simultaneously, as these entities grow more obdurate they reproduce order by stabilizing ways of thinking and patterns of interaction.

As the issue of climate change is 'epistemologically distant' (Carolan, 2004) scientists play a pivotal role in identifying, framing, assessing and explaining the issue at hand to both policy makers, politicians and the public. Thus expertise is indispensable and trust in experts crucial, in a time where expertise is simultaneously hotly contested (Nowotny, 2003). In the wake of the rise of attention for climate adaptation a wide array of interactions between scientists, politicians and policy-makers emerged. With respect to climate mitigation one can distinguish a more or less routinized science-policy interface with an ensemble of emission registration authorities, boundary organisations, policy programs, policy instruments and so on. This is not the case for adaptation; a stable science-policy interface does not exist. Even more so, one can ask whether there will be a comprehensive interface for adaptation. As climate change thus far mostly intensifies existing issues rather than raise new ones, the issue of climate adaptation will, at least in part, be addressed by pre-existing policy sectors such as water management, agriculture, nature conservation, public health and spatial planning. The issue of adaptation is cut up into pieces and dragged into existing arrangements and handled by different communities with their own routines, norms, repertoires and institutions. The perspective of co-production can shed explanatory light on how the particularities of these existing arrangements may affect the issue of adaptation. It raises questions onto what science-policy patterns emerge in the region, how climate adaptation is handled and redefined there, and how existing arrangements might be affected.

To illustrate the process of co-production in a regional arrangement, consider the example of a group of water board experts and provincial civil servants dealing with the local water system. This group has been asked by their governors to assess the impact of climate change on the water system in the polder for the coming century. Roughly spoken, in this region increased winter precipitation, soil subsidence, sea-level rise, dryer summers, and economic development is expected. In interaction this group starts framing the issue at hand and what is needed to resolve it: what effects of climate change should be included in the assessment, what useful knowledge would be, which knowledge institutes should be involved, how the group should anticipate on possibly affected stakeholders such as farmers and citizens, etc. Furthermore, they discuss what the role of the water board experts should be in relation to the role of the provincial bureaucrats, what type of decisions are to be made by politicians, and how the group will organise cooperation. Hence, the group engages in an episode of boundary work in which the

coordination and demarcation between the involved worlds is central. By drawing on their rhetorical repertoires actors give meaning to the issue of climate adaptation and how to translate it to inform policies. The debate has consequences for the local constellation. It prescribes which actors are (to be) included and excluded, and how they can and should behave.

In translating climate change actors produce and mobilize a set of boundary objects (Star & Griesemer, 1989). For these objects to work in translating, they should be sufficiently ambiguous and flexible to allow the actors of both worlds involved to interpret their meaning differently, while at the same time it enables actors to share parts of the meaning across the involved worlds. In our example, actors come to agree upon a project name. This carefully chosen name should reflect the scope of the project and is used to communicate with actors outside the group. 'Droge voeten 2050' presumes a more narrow scope than 'klimaatbestendig watersysteem 2050' and has substantial consequences for the assessment project. Furthermore, the group formulates a project plan specifying the division of labour and responsibilities. Also, the hydrological model of the water board plays an important role. This model has to be adjusted to incorporate the effects of climate change, but possibilities to do so are restricted and require a significant effort in time and financial resources. Thus, episodes of boundary work are stored in objects such as project names, work plans and models. Simultaneously these objects are mobilised by actors as instruments in subsequent periods of interaction. Hence, translation and the creating of useful knowledge is facilitated and constrained by boundary ordering devices. Central to the study of these devices is to understand how these devices favour a particular translation and form of interaction over another.

Obviously the process of translation does not evolve in a void. The pre-existing repertoires, rules, norms and routines constrain and enable the interaction of our group in making the regional assessment. For instance, the governance of the water system has been organized in such a way that flooding policy and drought policy are relative separate fields. As actors refer to this separation and discuss the expected difficulties to overcome it, it is made relevant for the issue at hand. This hampers the making of an integral assessment of climate effects on the water system. That integral assessment is further hampered by the fact that one of the water boards wants to set up a participatory process to open up the assessment to a variety of perspectives and values, while the other water board does not. Also, because of contracts with knowledge institutes and interactions between these institutes and the policy makers particular types of hydrological knowledge enter the arrangement, while other types of knowledge, say on land use change, does not.

Puzzling and powering climate adaptation policies through interactive framing at the policy-society nexus

Climate adaptation governance not only represents a challenge of designing adequate long term measures to overcome climate change impacts during this century, but also consists of political negotiations over a wide variety of values and interests associated to both climate change and climate adaptation measures. Values and interests that are not constant but may change over time when new issues such as economic decline or severe weather events enter the societal discussion. In addition the uncertainty associated with climate change and the heavily debated knowledge base at the science-society nexus make the negotiation over values and interests at the policy-society interface rather wicked. When there is no scientific consensus about which regime of river discharge is to be expected in fifty years, at what speed the sea level will rise over ten years, or what the implications of new safety norms are to the local economy, negotiations over the allocation of scarce resources or responsibility are likely to strand in Babylonian confusion.

Considering its far-reaching consequences and scientific complexity, climate adaptation policy development manifests itself as a thorny interplay of changing interests and ideas at and between different stakeholders and governmental levels. At this interface between society and public policy the intrinsic uncertainty over long term climate change impacts may be used by both private stakeholders as well as public authorities as a reason not to act, protecting vested interests. Or the other way around, new interests may be formulated following new scientific claims or ideas which trickled down in society or public institutions. Hence, an important question regarding climate adaptation governance is how to

make sense of this interplay of ideas and interests in formulating legitimate adaptation strategies aiming at a time horizon far beyond the usual policy cycle.

In this context neither the traditional technocratic view of policymaking, where the 'best' policy option can be derived out of proper calculation and modelling, nor the more political perspective on policymaking where stakeholders negotiate over their interests based on a rational micro-economic thinking, are applicable nor realistic (Schön & Rein, 1994). Or as Majone (1998) describes, neither interests and power fully determine the policymaking process, nor the search for the good ideas or the right solutions. In cases where policy problems represent issues of resource distribution the process of policy formulation is mainly about interests and organising power, but when policy problems are represented as efficiency issues a more technocratic way of policy making is usually adopted where professionals negotiate over ideas of how to reach the highest efficiency. However, as Majone (1998) points out as well, this distinction is not clear-cut: there are usually winners and losers when efficiency measures are implemented, and compelling ideas will be necessary to organise power.

Therefore an interesting way of conceptualising policy making might be what Heclo (1974) and Hall (1993) call a process of both 'powering and puzzling', where politics is about organising enough 'power' to get things done, and about collective 'puzzling' over ideas and concepts to come up with plausible storylines and solutions. Hence policy formation is more than a power play over interests, but also more than a process of dialogue and learning. Although Heclo derives his idea from a study over welfare state reform in different state traditions we consider his notions useful for understanding the formation of climate adaptation policy. On a theoretical level both welfare state reform and climate adaptation governance are processes of policy change requiring societies to overcome a new reality threatening a public good.

Where Heclo theorizes policymaking processes on a rather general level as the interplay of both powering and puzzling, other scholars in policy analysis (Schön & Rein, 1994; Stone, 2002; Wagenaar, 2011; Yanow, 1996) put forward the concept of framing. They understand policymaking on a more linguistic level as a 'contest over the framing of ideas' in which they consider framing as '…a way of selecting, organising, interpreting and making sense of a complex reality to provide guideposts for knowing, analysing, persuading and acting' (Schön & Rein, 1994, p. 146). These frames often take shape as short storylines or metaphors, explicitly or implicitly saying something about the cause of the often problematic reality taking a normative standpoint towards this reality and pointing towards possible solutions.

Originally the concept of framing stems from two different paradigms (Dewulf, et al., 2009). On the one hand framing originates from an individualist psychological paradigm in which frames are understood as cognitive representations or knowledge schemas in human memory. Historically, some scholars in this field considered these frames as rather rigid structures that help us to organize and interpret incoming perceptual information (Minsky, 1975), but others viewed these frames as mental schemes constantly undergoing revisions (Bartlett, 1932). On the other hand, from a communication paradigm, frames and framing are understood as the interactive alignment of meaning in a process of 'sensemaking' (Weick, 1995). In this paradigm framing refers to a highly dynamic process of actors continuously negotiating over meaning through language. Since each participant co-develops the discussion, they negotiate the relevant framing on the spot. Hence, where the cognitive paradigm locates meaning 'between the ears', the interactive paradigm locates meaning 'between the noses' (Dewulf, et al., 2009).

The puzzling over uncertainty and the collective wondering what to do is clearly a process in which interactive framing plays an important role. In addition, to gain support in strife for power agents might strategically choose both their *partners* with whom they wish to interact, and the *frame* they employ in interacting with these partners. Therefore interactive framing is also about powering. But puzzling and powering are not separate things (Heclo, 1974; Majone, 1998); one might puzzle over interests: e.g. defining coalitions, proposing or undermining ways to formulate stakeholders' interests, or defining the 'common good'. Or one might power over ideas: e.g. achieving alignment with others in how to frame the issue, or getting certain ideas high upon the policy agenda. Hence both the organization of power in a governance process and the puzzling over the ambiguity to be solved, get shape in a constant interplay of interests and ideas among stakeholders that can be at least partly grasped through the concept of interactive framing.

How climate adaptation manifests itself as a process of interactive framing between interests and ideas at the policy – society nexus can be observed in the case of the Delta Programme lake Ijssel, a policy development process in which different governmental layers and local stakeholders puzzle over solutions for a national problem of an expected increase in high water events and summer droughts. In this process of puzzling not only the ideational aspects of the problem are central in the discussion (how should we understand what is at stake?) but also the interests of the stakeholders and regional representatives (which individuals or groups will carry the burden for a future national good). Hence the frames used for addressing technical solutions reveal specific interests and vice versa. National government concerned with national water security responsibility presents climate adaptation as a 'not acting is not an option' issue, where the local public authorities concerned with the execution of water management consider the issue as 'a problem of uncertainty and ambiguity in national policy', and local authorities, private stakeholders and societal interests groups directly affected by possible measures question the 'urgency' of the issue and the 'nature' of the proposed solutions. In other words they consider the government, or the governmental bias as the main problem, not the changing climate.

This interactive process of framing is neither purely ideational nor pure strategic power play, though they represent different problem definitions and ways of understanding what is being talked about or presented. Because cooperation is essential for policy development and the implementation of measures, and considering the vast amount of stakeholders (both public and private) with their different frames, conflict and controversy is not unlikely. With a still on-going controversy between climate 'believers' and 'deniers' at the society- science nexus, and a current lack of political momentum at the national policy – society nexus, there is little to rely on in formulating national policy for the far future when this will cause frame conflicts at the current policy-society nexus. Therefore understanding the rise and fall, development and effect of interactive framing as the interplay of ideas and interests is of great importance for successful climate adaptation policy. An issue that can be researched by focussing on discussion in meetings between public authorities, societal actors and other stakeholders, and the condensed textual material of these meetings found in (intermediary) policy outcomes possibly resulting in new meetings or textual interactions at the society-policy nexus.

Discussion

Here we build on the two approaches we have analysed and discuss the connections between them, under the headings of (1) knowledge frames and networks, (2) the science-policy-society triangle, and (3) the interplay of meaning and power.

Knowledge frames and networks

How are climate adaptation policies to thrive in the midst of frame conflicts? We argue that theory development and further research on framing, knowledge and networks are needed to better inform policy debates (see also Boykoff, Frame, & Randalls, 2010; Scrase & Ockwell, 2010). In order to move forward we need to understand better the nature of *knowledge frames*, and how these are tied to networks. The idea that knowledge is embedded in networks and practices is central to our argument. Wenger speaks of *knowing-in-practice* and argues that 'as a regime of competence every practice is in some sense a form of knowledge, and knowing is participating in that practice' (Wenger, 1998: 411). Knowledge as enacted in practice implies a strongly relational underpinning of knowledge, tied to specific communities. Related to this are two different conceptions of knowledge: 'knowledge-as-substance' and 'knowledge-as-participation' (Bouwen & Taillieu, 2004). The knowledge-as-substance metaphor considers knowledge as substance or content that can be transferred from one mind to another mind. The knowledge-as-participation metaphor conceives knowledge as being formed and enacted in the interaction among different actors. Knowledge is situated in the coordinated actions among actors that engage in some form of collaboration.

Linking framing to knowledge emphasizes the point that knowledge implies perspectives (Dewulf, Francois, Pahl-Wostl, & Taillieu, 2007). The presence of multiple knowledge frames can result in ambiguity (Brugnach, Dewulf, Pahl-Wostl, & Taillieu, 2008), referring to the situation where there are different, and possibly conflicting, views about how to understand the system, resulting in conflicting knowledge (van Buuren & Edelenbos, 2004). It is important to note that these different knowledge frames may all be plausible and legitimate. Ways of understanding a system can differ on where to put

the boundaries of the system or what and whom to put into the focus of attention. Multiple knowledge frames are linked to multiple networks of actors engaging in different practices, in which knowledge is created, enacted and transformed. Knowing is a social process, and it is formed and moulded by interacting with others in specific situations. To understand disagreements, misalignments and tensions in policy processes, insight is needed in the knowledge frames and networks from which these arise.

The science-policy-society triangle

Co-producing the policy – society nexus?

As we have seen, at the science-policy nexus policymaking and science-making are strongly interwoven acts, resulting in a simultaneous co-production of both domains. Similar to the co-production of knowledge and social order at the science-policy nexus, decentred governance therefore might represent a form of co-production at the policy-society nexus. Both policy makers and societal actors simultaneously develop policies that ideally fit the societal agenda and simultaneously receive public legitimacy on the spot. The question however remains whether the complex and often torturous political game traditionally determining the policy agenda in parliament is sufficiently embedded in this form of co-production for effective and legitimate policy development.

According to various authors (Bevir & Rhodes, 2003a; Hajer, 2009; Wagenaar, 2011) this form of 'decentred governance' does not simplify the process of policy making. Due to the lack of institutional structure decentred governance gives more room to agency making narratives and frames more important in creating the conditions for (productive) cooperation. Since different stakeholders or governmental agencies might employ different narratives or frames, co-producing the policy becomes a thorny process of both deciding over relevant actors as well as negotiating over the frames and interests of these actors. Involving new actors will automatically result in new frames entering the co-production, and vice versa by introducing new frames certain actors might either decide to leave the process or join.

Considering policymaking at the policy-society nexus as a process of co-production shows the thorny character of these processes and indicates the way in which the constellation of such a process will have the endogenous tendency of reproduce itself; choosing actors determines the frames at stake, and choosing frames determines which actors are 'relevant'. In other words; in a decentred co-production of policy, policies create their stakeholders and stakeholders create their policies. On the other hand in the unlucky event of a co-production stranding in conflict or controversy with the tendency of reproducing itself, the idea of co-production also shows the ability of exogenously creating breakthroughs in policy controversies; by frame reflection ideas might change resulting in new actors entering the fore changing the equilibrium in the conflict, or by actively involving new actors new frames might steer the discussion in to a more productive direction.

Puzzling, powering and interactive framing at the science – policy nexus?

While the linear model would suggest that bureaucrats power over policy and experts puzzle over knowledge at the science-policy nexus, taking the interplay of powering and puzzling seriously directs attention to moments and activities of puzzling over policy and powering over scientific knowledge. The latter can take many different forms, from influencing the choice of experts to be consulted, strategically allocating research funding, or interfering in the wording of the conclusions of a research report.

In the discussions that take place in various science-policy interfaces experts and policy makers engage in prolonged debates about how to interpret particular research results and how to account for particular policies. In the case of the policy-oriented summary documents of the IPCC assessment reports, experts and policy makers spend ample time in reviewing, revising and interactively framing the results, implications and conclusions, in the light of the latest scientific discoveries and in the light of on-going policy processes in the climate change domain. This entanglement is both the strength and the weakness of the process – it allows for policy-relevant science and scientifically informed policy, but faces at the same time the double risk that scientific inquiry is too strongly driven by particular policy processes, or that policymaking is too strongly driven by what happens to be known and researched in the scientific realm.

A new science – society nexus in the science-policy-society triangle?

Citizens and non-governmental organizations, who claim to represent society's concerns, not only voice their demands towards policy but increasingly also directly to the scientific community, leading to the development of a science-society nexus in various forms. Non-governmental organizations have since long been engaged in building network relations with scientists who are sympathetic to their cause or who can provide crucial information for ngo's to promote or challenge particular policies. Examples of citizen science (Irwin, 1995; Ottinger, 2010) have shown that direct relations between interested citizens and open-minded scientists can lead to fruitful collaborations for data collection, awareness raising or exchange between scientific and local knowledge. And as the 'climategate' case has shown (Berkhout, 2010; Jasanoff, 2010; Nerlich, 2010), a virtual network of very active climate sceptic bloggers can be quite effective in taking advantage of the unauthorized publication of e-mail correspondence between climate scientists, to broadcast their claims about alleged flaws and misconduct in climate science.

Without taking this direct science-society nexus seriously, it is difficult to understand how climate change became widely accepted as one of the major problems for the coming generations, but even harder to understand how this established notion was challenged. The controversy that emerged at the science - society nexus resulted in serious image damage for the involved climate scientists and the IPCC but also for controversy throughout the entire science-policy-society triangle. This seems that pushed the issue downwards on many national policy agenda's. Where it was a major priority for the previous Dutch government, the latest elections made the whole issue of climate change vanish from the governmental agenda. Correspondingly, earlier proposed climate policy investments in water safety and CO_2 storage were postponed or cancelled. This volatility at the society – policy nexus not only indicates that the effective and legitimate planning of long term climate adaptation strategies requires more than a temporarily political notion that the issue is important, but also demands new ways of dealing with the variety, the two-way interaction and the potential for controversy at the science – society nexus. It is as if a new layer of contestation is added to the policy process: a policy issue that is stabilized in the science-policy nexus (with the usual experts) and in the policy-society nexus (with the usual stakeholders), can still be challenged in the direct and of on-line science-society nexus. Therefore, we propose to consider the science-society nexus as one of the three crucial sides in the larger science-policy-society triangle.

The interplay of meaning and power in the science-policy-society triangle

Developing an analytical perspective on the interplay between meaning and power when actors engage with each other in conflictive and collaborative ways at the boundaries between science, policy and society might sound like an overly ambitious endeavour. However, we believe that our exploration of conceptualizations of the science-policy-society triangle provides interesting starting points.

A basic notion to start with is that there are no neutral ideas or neutral knowledge (hence the relevance of the concept of knowledge frames) and there are no neutral policies (hence the relevance of the concept of interests). One way to conceive of the relation between knowledge frames and interests is as a reciprocal, but nondeterministic, relationship: "frames and interests are logically independent concepts … interests are shaped by frames, and frames may be used to promote interests" (Schön & Rein, 1994, p. 29). One the one hand, issues can be strategically framed to promote certain interests, but, on the other hand, the frames used by the actors guide and constrain what they define as being in their interest and where these conflict with others' interests. In line with the aforementioned interplay between powering and puzzling, one could say that sensemaking is full of politics and politics is full of sensemaking, or, in line with discussion of co-production, one could say that creating knowledge orders the social world, and that ordering the social world creates knowledge. The concept of interactive framing tries to capture this notion at the level of day-to-day interactions. Throughout the web of interactions at different places and at different times, people continuously negotiate the meaning of the issues they face and simultaneously negotiate their mutual relations and positions.

Without adopting a Foucauldian approach to knowledge and power that tends to privilege structure over agency, we try to understand the structural aspect of the interplay between meaning and power by identifying two levels of influence. The first level is the level of engaging in the debate, a game in which arguments and reputations can be lost or won, in which frames guide interests and interests guide frames. The second level focuses on what the debate is about and who is involved, in other words what the playing field looks like, and asks the question who has been involved in setting the terms of the

debate and selecting the players. No matter how many actors and issues are included in a debate, there are always many others that are excluded from it. Although particular agents can have an important role in setting the terms of the debate and selecting the players, more structural forms of power become visible here. Institutionalized criteria for who is to participate in the debate can monopolize the selection of players, and engrained routines for determining the agenda for the debate can set the terms of the debate. Conversely, actors that do not dispose of the minimally required resources to engage in a debate, or things that are so unconceivable at a particular place or historical juncture that there are no words for it in the available discourses, are very unlikely to even appear on the playing field, let alone being taken seriously.

To understand interactions at various interfaces in the science-policy-society triangle in this light, we rely again on the concept of variety. Each interface can be seen to connect varied elements, but involves only a particular slice of the broader variety. A particular subset of the variety of interests and ideas is tied together in an interface in the form of an on-going debate that allows more or less coordinated action, such as determining the expected amount level of sea level rise to be referred to in policies, or defining compensation measures for a particular policy in a stakeholder consultation process. In our view, the capacity to engage in a joint game is what ties an interface together, not a set of shared ideas or shared interests. Allowing for this variety of meanings, goals and values is what makes coordination across boundaries possible. At the same time, there are other interests and ideas which are not part of the game. This simultaneous inclusion and exclusion of interests and ideas at a particular interface can be understood by considering both the debate that is contained within the interface, and the actions and structures that select the players and set the terms of the debate.

Finally, an established playing field is not to be taken for granted. Interests and ideas outside the game may manifest themselves and may be able to contest what's going on, claiming that particular knowledge frames are neglected, that the game is biased towards certain interest, or that access needs to be provided for themselves or for others. In this way, the playing field itself may turn into the topic of a debate, adding a layer of contestation to a particular interface in the science-policy-society triangle. In other words, there is always the possibility that "diversity keeps reappearing and reasserting itself, even in the most entrenched institutions of modernity, such as expert bureaucracies" (Jasanoff, 2004b).

Implications for designing effective, legitimate and resilient governance arrangements

Implications for science-policy arrangements

Accepting the conclusions of interconnectedness of science and politics in the co-production paradigm has also yielded implications for the design of science-policy interfaces. Entanglement is not just an observation as these studies also show the need for policy makers and scientists to work together. Unceremoniously dropping expertise at the doorstep of policy makers does not lead to mutual exchange. However, institutional guidelines for designing interaction schemes are under researched (Cash et al., 2003, p. 8086; Guston, 2001; Jasanoff, 2003, p. 235). Even more, the heterogeneous nature of the interactions between science and policy might not be fertile soil for an essentialist account of design principles. Several accounts, however, from different scientific traditions with different ambitions do shed light on practices, strategies and elements of the science-policy interface that can be termed productive in facilitating exchange. Many of these accounts are rather reluctant in claiming any kind of causal relations.

A first strand of literature draws on boundary organizations theory. Cash et al. (2003) state that knowledge is effective when it is simultaneously perceived as *credible, salient and legitimate. Credible means* that the produced knowledge is being conceived as scientifically adequate by experts and trustworthy by potential users. *Salient* means that the knowledge is relevant, useful and timely to decision makers. *Legitimate* refers to the idea that the produced knowledge must be acceptable to divergent stakeholders and believed to be produced in a process with a minimum of bias. These three 'intermediate variables' (Cash, et al., 2003, p. 8090) are influenced by three types of strategies and by three types of institutional features of boundary organizations. The strategies are reciprocal communication between experts and decision makers, active translation to create mutual understanding, and active mediation of conflicts. Institutional features are the systematic commitment to before

mentioned strategies, structures for dual accountability of boundary workers, and a forum for joint production of 'boundary objects' (Star & Griesemer, 1989) or 'hybrids' (Miller, 2001). Reasoning from principal-agent theory, Guston (2005) adds four institutional design principles for boundary organizations: balanced expert participation; clear rules to come to scientific judgments; multiple sources of advice operating under similar rules; transparent rules for addressing the scope of scientific agreement. Bijker, Bal & Hendriks (2009) point to the importance of coordination between different front stage and backstage practices in maintaining the authority and effectiveness of boundary organizations. This coordination facilitates cooperation and disentanglement, transparency and shelter, and scientific dissent and speaking with one voice at the same time.

A second strand of literature develops normative principles from grand theories of science in society, termed 'Mode 2' and post-normal science. Restoring the trust in, credibility of, and 'social robustness' of expert advice requires organizational reform and changing 'institutionalized habits of thought' (Nowotny, 2003). Scholars (De Marchi & Ravetz, 1999; Jasanoff, 2003; Nowotny, 2003) in this tradition emphasise a need to open up expertise by extending the peer community to allow for a plurality of relevant knowledge; to increase transparency in uncertainties, procedures and normative assumptions; and to systematically engage with normative principles such as precaution and distribution upstream in the advisory process. Jasanoff (2003, p. 242) adds the need for advisory committees to engage in venues where the ambiguity of their findings can be discussed and recommendations can be assessed vis-à-vis alternatives, to allow for learning and reiteration of advice. Furthermore, she pleads for systematic methods for frame reflection in the advisory process. Finally, Nowotny (2003) stresses the need for accountable and transparency of science by improving expert review systems, utilization of standardized norms for quality and the need for showing the evidence in policy making. However, she also points at the trade-off this 'expertisation' has on the possibility of entrance of non-experts.

Implications for policy-society arrangements

In general terms, our analysis implies that approaches that assume either that 'if only people can understand each other, they will agree' or 'if only people can negotiate their interests, they will agree' are too one-sided. Both sides of the coin will need to be addressed in multi-actor governance arrangements, even if these entail different kinds of processes and logics.

Developing arrangements for dealing with different frames of reference in decision-making processes generally starts from the analysis of the diversity of the different governmental and societal stakeholders involved in the climate change discussion, and the frames they employ to make sense of the adaptation issue. Theories like collaborative governance (Gray, 1989; Huxham & Vangen, 2005), network governance (Klijn & Koppenjan, 2000; Klijn, Koppenjan, & Termeer, 1995) or reflexive governance (Hendriks & Grin, 2007) provide strategies to find workable ways to take multiple frames into account. Between the extremes of rational problem-solving (assuming that frame differences are non-existent or easily reconcilable) and oppositional modes of action (where the clash of ideas is reduced to a clash between people), three broad modes of action may be distinguished (Brugnach, Dewulf, Henriksen, & van der Keur, 2011): (1) attracting others into a particular frame, (2) connecting the different frames, or (3) negotiating a deal despite the frame differences.

The first mode assumes that a convincing account can dissolve differences by persuading people of the meaningfulness of one particular frame of reference, thus creating the common ground for action (Benford & Snow, 2000). The second mode assumes that the different frames need to be somehow connected in the way the situation is addressed. The connection could take different forms, including integrating existing frames through a creative synthesis, adding a new superordinate frame that overarches the variety of existing frames, bridging different frames at points where they overlap, or collectively redesigning the situation so that the differences in the frames are accounted for (Schön & Rein, 1994). The third mode assumes that the different frames are there to stay and that connecting them is not feasible or desirable. The goal is to find a mutually beneficial deal that is meaningful from multiple perspectives (Susskind & Landry, 1991), albeit potentially for very different reasons. This requires skilful negotiations in which the various frames are explored but not questioned.

However, if we want to take the interweaving of meaning and power throughout the science-policy-society triangle seriously, what are then promising design principles the implications designing effective, legitimate and resilient governance arrangements? When designing an arrangement for interaction between a variety of actors in a governance process, an important design principle would be to not to

design learning processes without possibilities for negotiation, and not to design negotiation processes without opportunities for learning. There are indeed indications that good negotiators are eager to learn about their opponents and to able to empathize with the perspectives of their opponents, even if they do not sympathize with them. Conversely, there are indications that frame reflection requires a focus on particular, therefore concrete and interest-laden, situation in order to be successful. While some people may be comfortable with mixing learning and negotiation in the same interaction process, others may find this constraining. Another way of organizing the unique contribution and the complementarity of learning and negotiation is to install a looser coupling between power networks and learning networks . This facilitates more creativity in the learning network and better bargaining and positioning in the power network, while the connection between the two is provided through overlap in key players or regular contact between the two kinds of networks.

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