Social Learning in the Field of Climate Change

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Abstract:
Climate change poses a significant threat to almost all humans. The combat against it and the provision of measures to ameliorate the most dramatic impacts from climate change contribute to the provision of a global public good. Its complexity implies manifold uncertainties from scientific as well as policy-making points of view. Nether do we exactly know how and when climate change will cause damaging impacts nor can we predict future consequences of our actual choices. Preference formation is thereby heavily biased far from perfect.

This paper, therefore, discusses social learning as an approach to reduce these uncertainties and to facilitate the policy process by allowing actors to form their preferences on a better knowledge base. It first develops a conceptual approach to the study of social learning phenomena on the basis of contributions from economics, political science and management studies. Second, this framework will be applied to a case study of one particular social actor in the field of international climate policy, namely the Intergovernmental Panel on Climate Change (IPCC). This scientific assessment body will be analyzed with regard to its learning processes and the implications for the policy process at large. Findings show that moments of crisis as well as the existence of a small network of highly committed individuals in the core functions, functioning communication structures, and the existence of mechanisms for reflection helped the social learning processes to emerge.

1 Introduction

Climate change is a problem that poses manifold challenges to humankind. The mitigation of greenhouse gases through a revolution in energy efficiency as well as through the use of renewable energies requires the restructuring of entire industrialized economies. Adapting to the impacts of climate change through the construction of dams, dikes and other measures seems most challenging in particular for developing countries. However, all solutions to this paramount problem remain under the threat of uncertainty. Causal chains are complex and global in scale. No simple solutions or explanatory schemes apply in the case of this problem.

Moreover, preferences of individuals, communities and states are highly diverse in climate politics. Climate change is closely linked to the constitution of the energy system and the reliance on fossil fuels. Manifest and conflicting interests characterize this policy arena. In addition, the manifold impacts of climate change in the form of droughts, sea level rise, flooding, rapid ecosystem change, extreme weather events etc. are hardly taken into consideration by most individuals and groups in the process of forming their preferences. This is partly due to a lack of actual knowledge on them, partly due to lacking diffusion of existing knowledge and partly due to ignorance on the basis of interest-based perceptions by the different interest groups.

In this situation, neither conventional regulatory nor market based approaches will hardly do the job. Governments have difficulties implementing technical or institutional solutions to the problem due to the lack of knowledge or because of the lack of consensual preferences among the citizens. Compliance deficits and resistance would be the result. Market solutions suffer from the lacking knowledge of the actors on the actual consequences of their choices. Moreover, many solutions to climate change are either unknown or the knowledge on them has not yet diffused throughout large parts of society. In this situation, other governance approaches are called for that consider the particular role of knowledge, learning and consensus building. One of these will be introduced in this paper labeled as social learning. It is understood as a collectivity's mechanism to gather knowledge and implement solutions to a relevant problem.

More precisely, this paper asks what social learning is and how it could be conceptualized. Subsequently, the case of climate policy will be addressed under a social-learning perspective. It focuses particularly on the science-policy interface and the central actor in this area, the Intergovernmental Panel on Climate Change (IPCC). In the face of the described uncertainties and knowledge gaps, scientific information is seen as inevitable by most actors in the field. It is the task of the IPCC as a collective actor to collect, synthesize and prepare the existing knowledge on climate change and possible solutions for the policy making process.

2 Conceptualizing social learning

Processes of social learning have been studied under various labels within different social science disciplines. To qualify as social, learning processes have to refer to a level that exceeds the realm of individual decision making. All approaches have to conceptualise the link between individual behaviour and collective processes; they also have to provide answers to what counts as learning as opposed to non-reflective evolutionary processes. Here, I will refer to concepts from evolutionary economics, political science and management studies that contribute key building blocks for an integrative concept of learning of social actors.

In *economics*, rational choice concepts have dominated the debate that assume fixed preferences and complete information of individual actors. However, recently a growing body of literature[1] has developed that is concerned with social learning being broadly defined as occurring "in any situation in which agents learn by observing the behavior of others" (Gale 1996, p. 617). Other approaches address collective learning processes on a population level or in social networks. For instance, evolutionary algorithms use the paradigm of genetic selection to model learning processes within populations over time (Brenner 1998, Goldberg 1989). The neuronal network approach, by contrast, builds on the idea that learning processes take place in some network structure for the processing of information. These networks can be modelled within individuals as well as within groups or social networks (Salmon 1995). More recent concepts of social learning in economics are concerned with herd behaviour and informational cascades. These are instances when individuals ignore the private information and subjective probabilities they usually employ and follow the behaviour of others whom they assume to be better informed than they are. These models have been used to explain mass panics, social customs, and the persistence of inefficiencies in companies although the agents do have better information at their disposal (Gale 1996). As yet, these approaches, however, have scarcely been applied to more or less coherent actors that are able to exhibit collective behaviours. Neither do they address the problem of how new knowledge is being generated.

Evolutionary economists have addressed the problem of learning since very early. In their survey paper Dosi et al. (1996) compile a number of stylised facts about individual and social learning from various disciplines that include insights on the role of mental models or cognitive frames that by themselves are context dependent. Therefore, learning processes are also shaped by the social and technological environment prevalent at the time of their inception. In their notion, learning is required in situations where high uncertainties exist about the substance of a given problem and about the process how to address it. In these situations, new knowledge can be created on the basis of heuristics, recombination of cognitive categories and individual mistakes. They highlight that organisations have to be regarded as "behavioural entities on their own right" while acknowledging that the relations between individual and social learning remain an interesting research problem (Dosi, *et al.* 1996, p. 12). Also the relationship between learning agents and evolving environments that are characterised by selection dynamics are named as a key research question for evolutionary economics.

A recent co-evolutionary concept might provide an answer to both challenges. Bergh and Stagl (2003) develop a framework for the understanding of the dynamic interactions between individuals and institutions where learning is one process of institutional change among other evolutionary processes such as replication, regulation, selection etc. Different environments will influence behavioural changes differently: In slowly changing environments, genetic variation will be the dominant mode of change while more rapidly changing environments require cultural learning by the agents. However, this concept focuses on a highly abstract level and gives little specific insights into social actors and their adaptation and learning.

Other approaches in evolutionary economics address processes of change and learning in firms as key actors in market environments. For instance, Witt (1998) analyses the role of cognitive frames in firms shaped by the entrepreneur as a key requirement for the existence and the success of the company. Here, individual learning is a key requirement for the advancement of the collectivity if it is based on the vision and cognitive frames of the entrepreneur. While intensive communication is seen as pivotal for the integration of new knowledge into the tacit dimension of the firm, he describes individual reflection as the prime mechanism for deviation and invention in the firm that, thereby, learns as a collective actor. In

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[1] For an overview over the economic approaches to learning see Brenner 1999, Clemens, Haslinger 2001, Kirman, (Eds.) 1995, Slembeck 1999.

a similar vein, McKelvey (1998) addresses learning in and of corporations as a process that results in technical and economic information and that requires to be integrated into routines. Within this concept, internal learning has to be linked to external dynamics of markets in order to allow the company to survive. For the market dynamics the quality of the learning is key: whereas the generation of new knowledge might contribute to macro-economic change, mere diffusion of knowledge contributes to a conservation of existing structures. These studies head into the direction towards a better understanding of learning dynamics of social actors.

Studies in *organizational learning* contribute further insights in learning processes that help to understand the dynamics as well as the drivers and the hindrances of those processes. Concepts of organizational learning—also named as "the learning organization"—have been developed in management studies to describe processes of organizational change that take place at a collective level.[2] In this body of literature the distinction between individual and collective action is crucial—in particular for the choice of the appropriate theoretical and analytical approach. It is commonly assumed that organizations exist on the basis of collective action.

Also in these approaches it becomes clear that social learning encompasses a dimension of changes in values, norms and beliefs that transcend the sphere of explicit cognitive knowledge. Therefore, simple training of cognitive skills or technological improvements might be helpful but will hardly suffices to tackle the tacit dimensions of commonly shared values, norms and general convictions. This body of literature has studied social learning processes in large detail with a particular focus on business corporations, but less so with a view on other forms of social actors. Nevertheless, these insights and concepts prove helpful for the transfer to other actors as is to be shown in the subsequent section. They direct the focus of theoretical and empirical research also on the quality of the learning processes in different phases.

In the field of *political science*, a number of theories emerged that contribute to the topic of social learning of different social actors other than corporations.[3] As opposed to Etheredge (1981) who solely studies governments as learning agents, Heclo (1974) examines different societal actors such as elites, networks, and other social groups as agents in larger societal learning processes. The prominent advocacy coalition framework as developed by Sabatier (1988, Sabatier, Jenkins-Smith 1999) conceptualises policy-oriented learning as "relatively enduring alterations of thought or behavioural intentions that result from experience and that are concerned with the attainment or revision of the precepts of one's belief system" (Sabatier 1987, p. 672). These changes have been studied empirically within coalitions of actors that share one belief system and one conviction on how to solve a particular policy problem. Sabatier's focus lies on "issue domains" that have been constituted around a policy problem such as agricultural policy or air pollution control and within which different advocacy coalitions strive to realise their preferred solution. Through learning, these coalitions change their belief systems and consequently their policy goals will be altered with a possible influence on the actual policy process.

The concept of epistemic communities as formulated by Peter Haas (1992) and Adler (1992) draws attention to mostly internationally organized network that are united by their shared beliefs and convictions about particular political problems and the favourable solutions to them. These networks usually consist of scientists, lobbyists, political decision makers and advocacy groups that need to be analysed when collective learning in a political realm is studied. In a seminal study of the international response to environmental threats, the Social

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[2] For prominent studies in the field see Argote 1999, Argyris, Schön 1996, Berthoin Antal 1998, Denton 1998, Senge 1990, Shrivastava 1983.

[3] For an overview of the policy science perspectives on learning see Bennett, Howlett 1992, Busenberg 2000, LaPalombara 2001, Parson, Clark 1995.

Learning Group (2001) simultaneously analyses the influence of ideas, interests, institutions, actors and their interactions on the actual practices how societies addressed these problems. The key actors studied in this book are industry, the media, national governments, science and the non-governmental organizations. Interestingly, the learning processes studied here take place merely between these actors and less so within the focused actor groups.

In sum, social learning processes have been in the focus of different disciplines even though no integrative concept has emerged yet. Most approaches focus on diffusion and adaptation processes, only very few give insights about the generation of new collective knowledge. Concepts of organisational learning have addressed these issues but have concentrated on business corporations. Social learning of different sorts of actors such as non-governmental agencies, public authorities, private firms or scientific bodies have scarcely been studied under one framework. The following concept tries to provide an integrative framework for exactly this purpose.

Definition

The attempt to conceptualise learning processes of social actors in evolving environments that is apt for empirical research on diverse actors and their individual dynamics will require a broad but precise definition of learning. Following Parson and Clark (1995), every concept of learning needs to address four questions: (1) Who (or what) learns? (2) What kind of things are learned? (3) What counts as learning? (4) Why bother asking?

Ad (1) Who (or what) learns? In this conceptual model, social actors are addressed as the prime learning agents. Actors in this sense are citizen groups, interest groups, business corporations, governments, non-governmental organisations or actor networks. However, the distinction between individual and collective levels is particularly tricky when it comes to learning concepts. Although the notion of collective learning implies that it is more than the mere sum of individual learning by its members, it is dependent on individuals, their learning and their behavioural changes. In this line of thought, social learning can be seen as the change of procedures, structures, shared beliefs and knowledge that are assembled from individual contributions on the basis of division of labour and responsibilities. For instance, the knowledge how to produce cars, telephones or computers is inherent to the relevant organisation but individuals usually oversee only a small part of the whole production process. Applied to collective actors in general, one can assume that individual members barely know all aspects of the collective behaviours, but they know parts of it very well. In this sense, division of labour allows for the possibility of social learning. Another argument comes from systems theory, which regards organisations as entities by themselves that are more than the sum of their individuals. They devise of a special quality of internal relationships and a clear distinction between the inside and the outside. In this view, organisational learning is mostly studied on the basis of analogies to individual learning. It conceives organisational learning as an emergent phenomenon building on individual processes that contribute to a larger whole in the knowledge and the practice of the supra-individual entity, titled the organisation (Marquardt 1996, Probst, Büchel 1997). In sum, it is the general assumption underlying the following research that social actors can be analysed under a perspective of social learning that cannot be reduced to the sum of the individual learning processes although it is based on individual contributions and on individuals as change agents. This assumption does not imply a complete analogy between all forms of social actors. It merely maintains that learning of and in these actors can be more than mere individual learning because of the existence of division of labour and an existing structural framework of internal relationships between the members of the collective entity. These structures and relations need to change in social learning processes.

Ad (2) What kind of things are being learned? These actors might learn a broad variety of things such as to create, diffuse and implement technologies, images, collective belief systems, norms, forms of their internal organisation or ways of communication. Every empirical inquiry will require a distinct analytical focus on the objectives of the learning process in order to carve out a precise tableau against which progress or failure of the learning process can be measured. In the learning processes discussed below, the objectives are related to improvements of how to deal with fundamental uncertainties and how preferences are formed with regard to climate change.

Ad (3) What counts as learning? While the abovementioned approaches have delivered a multitude of definitions of learning, here, it will be *understood as a process in which individual or social actors acquire knowledge that leads to a change in their behaviour in a certain direction*. Behavioural change is the noticeable result of the cognitive change on the side of the actors that is, nevertheless, a necessary element of a learning process. Bennet and Howlett (1992, p. 285) formulate with a view to policy learning: "most of the authors argue that learning does not actually occur unless there is some kind of policy change which results from that learning process". This notion of learning starts from the assumption that actors act in an uncertain environment and on the basis of incomplete information. They even do not have fixed preferences since these might change over time due to learning processes. This assumption mirrors insights from constructivism, where actors have to construct meaning in an environment of uncertainties (Haas 2001).

Ad (4) Why bother asking? According to Parson and Clark (1995), the relevance of studies of social learning processes either derives from a pure interest in a better understanding of the observed processes or from a more activist approach that promotes societal objectives by generating insights into means and ways to further the realisation of these targets. For the purposes of this study, the question will be a mixture of both: A better understanding of learning processes is seen as helpful in the process of providing global public goods such as a stable world climate.

Forms of learning

In the various models of social learning, different types and levels of learning have been distinguished. With regard to the definition of learning employed in this study, further specification seems appropriate to single out an empirically meaningful notion of learning applicable to social actors.

In their seminal study, Argyris and Schön (1996) distinguish between three types of learning. The fundamental criteria for this classification is how far the underlying "theory in use", i.e. the often unconsciously and tacitly used set of values and causal beliefs that the members of an organisation share, have changed during the learning process. The basic level of learning has been framed as *single-loop learning*. It is the simplest form of learning that addresses the adaptation of new knowledge to existing frameworks of objectives and causal beliefs. Based on a simple feedback loop between given expectations and the real outcomes of a process, this instrumental type of learning allows for error correction and leads to an adjustment of results that deviate from the pre-existing expectations. According to Argyris and Schön (1996), the advanced form of learning can be labelled *double-loop learning* which also includes the underlying theory of use into the learning process. Thus, there will be two feedback loops, an instrumental one of error correction and a more fundamental one that connects the former to changes in the general framework of beliefs, norms and objectives. *Deutero-learning*, the third level of learning, takes place on a meta-level. This is the rare form of learning of the ability to learn itself. In their studies of business corporations, Argyris and Schön could hardly find forms of deutero-learning. Most learning processes usually remain in the scope of the first two categories of learning. In general, single-loop learning is largely sufficient when

limited errors or deviations from goals have to be corrected, but it is not sufficient any more when the underlying norms and belief systems of an organisation or social actors conflict with new internal or external developments or requirements.

The adoption of Argyris and Schön's framework for empirical studies confronts researchers with the task to discern the scope of the involvement of the theory-in-use in the learning process which is particularly difficult given the tacit nature of this form of knowledge and the broad definition of the theory-in-use. Therefore, Fiol and Lyles (1985, p. 811) proposed a more clear-cut theoretical approach that helps to conceptualise learning as opposed to adaptation. In their notion, learning comprises "the development of insights, knowledge, and associations between past actions, the effectiveness of those actions, and future actions" whereas adaptation denominates the "ability to make incremental adjustments as a result of environmental changes, goal structure changes, or other changes." Thereby, Fiol and Lyles gain a clearer distinction between the forms of learning and the role of cognitive change that results in observable changes in behaviour.[4]

For the purposes of this paper, the distinction will be retained by separating between *adaptation* and *reflection* as two forms of learning that lead to changed behavioural patterns. However, the forms of change differ in the underlying knowledge structures and the related belief systems. In the case of adaptation, the changes in behaviours result from induced changes through external processes that do not include changes in the cognitive framework of the organisation and its members. By contrast, reflection incorporates a change in the prevalent knowledge structure including the prevalent cognitive frame. The former comprises error correction but not an inclusion of the fundamental knowledge and belief systems behind these forms of behaviour. Thereby, reflection is confined to higher-level processes involving cognitive and behavioural changes. A specific form of reflection is related to the improvement of learning capacities of the actor that has been coined as deutero-learning by Argyris and Schön. While the learning process in this case remains in a reflection mode, it differs in the substance of the knowledge and the behaviour being learned. Its substance is the learning capacity of the actor itself and not a different mode of production or an innovative solution to a societal problem.

3 Social learning in climate policy: Case study of the Intergovernmental Panel on Climate Change

After the conceptual framework addressing particular social actors within a policy field has been developed, this section seeks to apply it to the analysis of a social actor in the field of climate policy, namely the Intergovernmental Panel on Climate Change (IPCC). While this analysis represents only one part of the entire social learning process in climate policy on local, national, regional and global levels[5], it can be viewed as crucial given its position as an intermediary body between science and the international policy process. It provides information to the negotiation bodies of international climate politics and thereby potentially influences policy outcomes. As such, this intergovernmental body has been designed to reduce uncertainties and, thereby, support processes of preference formation and revelation in climate policy.

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[4] A similar distinction between learning and adaptation has been made by Haas 1991.
[5] For an overview and further insights into the development and the particular problems of international climate policy see Andresen, Agrawala 2002, Grubb, Yamin 2001, Levy, Rothenberg 1999, Oberthuer, Ott 1999, Ott 2001, The Social Learning Group 2001, Yamin, Depledge 2005.

Following the conceptual framework, the direction of the learning process needs to be defined from the outset to provide a focus for the study of learning processes. The particular position of an international scientific assessment body such as the IPCC gives an indication about the relevant direction of learning processes that can be seen as helpful in the provision of global public goods.

Research conducted within the Global Environmental Assessment Project brought up insights in when and how assessment are able to affect political decision making. On the basis of the findings of the project it could be assumed that assessments have the most influence when they manage to be salient to the potential users, credible in regard to the scientific methods, and legitimate in the way the assessment is designed (Clark, Dickson 1999, Mitchell, *et al.* forthcoming). Thus the following three criteria indicate the direction in which learning in a qualified sense takes place:

- *Saliency:* Learning in assessments takes place when the assessment process or its products are made better known to participants in a certain area of policy making so that they will perceive the assessment as relevant to them and their decision-making situations.

- *Credibility:* As assessment or its participants are learning to become more credible when the facts, causal beliefs, and options outlined in the assessment are regarded as "true" or, at least, worth using instead of other, competing information.

- *Legitimacy:* Learning in an assessment takes place when it is increasingly able to convince a participant that the goals pursued in the assessment correspond to those that the recipient would have kept in mind had s/he conducted the assessment.

Assessment that are able to advance in establishing a balance between these criteria can be expected to help the policy process to reduce uncertainties in regard to provide relevant knowledge for the solution of global public goods problems. They will be likely to endow policy makers with relevant knowledge on the actual and future causes and consequences of climate change, on possible solutions and the decision levels and actors involved. Moreover, decision makers will lend their ears to these assessment processes and will be able to grasp their messages and integrate them in their decision making. Thereby, these assessments will support processes of preference formation among actors and their revelation in the policy process. Ideally the learning process helps to improve the process as depicted in figure 1.
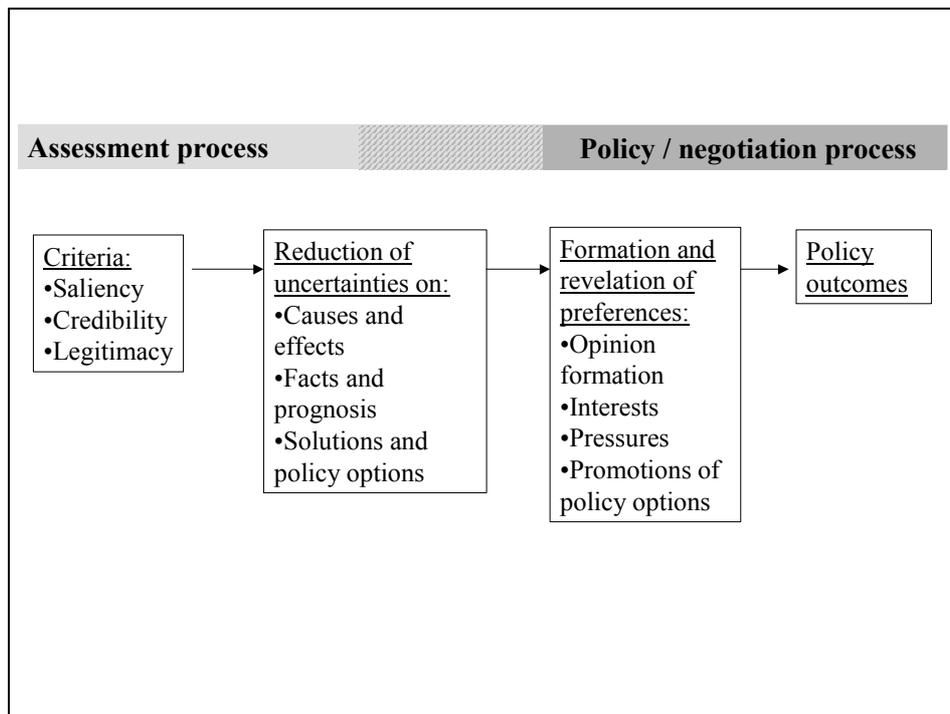
Figure 1: Criteria for social learning processes at the science-policy interface

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 as a scientific advisory body to the United Nations Environmental Programme (UNEP) and the World Meteorological Organization (WMO). It has been designed as an intergovernmental organization that is basically scientific in its membership but involves governmental participation in the process of approval of the major conclusions. It is designed to provide scientific knowledge for the negotiation processes in international climate negotiations. Thereby, its main purpose is to reduce uncertainty about the complex interactions and related policy options to combat climate change.

Since its beginning, the IPCC has produced three major assessment reports (concluded in 1990, 1995 and 2001) and is about to conclude a fourth one in 2007. In addition, it published a considerable number of special reports and technical papers as well as supporting materials such as guidelines and documentary materials. Over the years, the IPCC has undergone several changes in regard to the internal structures and procedures, which renders the case interesting from a learning perspective. As shown in figure 2, the interaction between science and policy in the field of international climate politics is institutionalised by several organisational bodies. In the context of this paper, the IPCC processes will be analysed with regard to predominant social learning processes that target at the generation of policy-relevant knowledge and a general reduction of uncertainties in climate policy. Moreover, the subsequent case study will analyse the IPCC's actual contribution to climate policy through the provision of knowledge. These learning processes will be classified with regard to the predominant forms of learning.[6]

Which crucial learning events can be observed in the IPCC assessments that reflected past experiences, made use of experiences from other assessments and fed them into changes of future assessment designs? In he following, I will describe some of the key processes chronologically along the sequences of the assessment reports.

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[6] This case study is based on an analysis of written documents and on personal and telephone interviews with the ten experts in the field. Its findings are documented in Siebenhüner 2002.
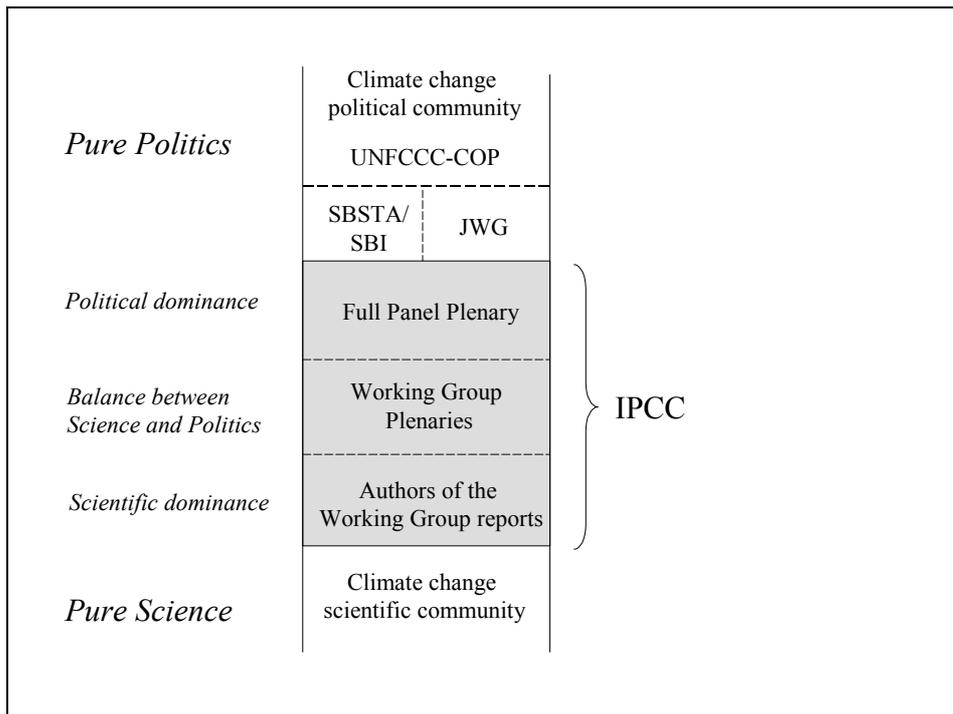
Figure 2: The Science-Policy Interface at IPCC

Source: Based on Alfsen, Skodvin 1998

3.1 First Assessment and Supplementary Reports (1988-1992)

When the IPCC was founded in 1988, it exhibited a unique and innovative structure and design. Its precursor in the international arena, the Advisory Group on Greenhouse Gases (AGGG), established in 1986, consisted of a handful of scientists almost exclusively from Northern industrialized countries (Agrawala 1999). By contrast, the IPCC was based on an intergovernmental approval mechanism being open to governments from all over the world. The centrepiece of this intergovernmental mechanism was the involvement of numerous governments in the formulation of the questions addressed and in the approval of the final reports (Bolin 1994b).

When studying the first phase of the IPCC in the light of the typology of learning, one could find the set up of the IPCC with its unique organizational structure as a form of reflection in comparison to the previous attempts to design the science-policy interface in the climate area. The IPCC provided a new and advanced way to facilitate the science-policy communication by ensuring saliency and credibility which clearly affected the underlying cognitive frames and strategies in the assessment. The government's ownership of the whole process and the final documents lead to a significant increase in saliency when compared with the loosely connected AGGG assessment (Agrawala 1998a). Credibility was granted through the design of the IPCC as a scientific body with no political decision makers being involved as authors. Moreover, even the First Assessment Report had a review procedure that was deemed to ensure high scientific standards. Even legitimacy had been increased through the establishment of the IPCC when compared to previous climate assessments. The attempt to include scientists from all parts of the world was a significant progress in this respect—even though scientists from developing countries were highly underrepresented in the preparation of the First Assessment Report.

The finalisation of the First Assessment Report in 1990 provided the opportunity to reflect on the experiences of the IPCC processes themselves and what could be learned for future assessments. This reflection took place in form of discussions in the Bureau and the plenary sessions but there was no formal document prepared. One of the main lessons learned by the participants of the first assessment certainly were the political aspects of the IPCC-process, which was new to most of the scientists. When they had to adapt to the fact that the agenda of the assessment was mostly set by political needs, major discussions emerged and significant scepticism was expressed by some of the scientists involved. Nevertheless, acknowledging the political function of the whole endeavour, a supplementary report was prepared that— together with the first assessment report—was said to be highly influential on the negotiations of and final agreement on the framework convention in 1992 (Agrawala 1998b, Bolin 1994a).

Findings of the first assessment report demonstrated the urgency and the relevance of the problem of climate change to the international community. However, it had to acknowledge the fact of numerous uncertainties regarding the actual human influence, regarding the reliability of the model predictions and regarding the causal relationships in the global climate system (Intergovernmental Panel on Climate Change - IPCC 1990). Policy makers, nevertheless took the findings significantly more seriously than those of previous assessments such as those of the AGGG. This success of the knowledge generation process that at the same time helped a preference formation process with governments and international bodies can in parts be credited to the organisational set up and the government approval mechanism of the IPCC. The reflection process within the IPCC can be seen as helpful to impact on the policy process by raising saliency for political decision-makers. It led policy makers to form particular preferences towards this policy issue that have been fed into the formulation of the UN-Framework Convention on Climate Change, signed at the World Summit on Environment and Development in 1992 in Rio de Janeiro.

However, these learning processes in the later period of the First Assessment Report stick to an adaptive mode since they did not lead to fundamental changes of the underlying assumptions and norms of how to conduct the assessment. The changes in regard to saliency, credibility or legitimacy of the assessment process remained limited since the general design of the assessment was untouched.

3.2 Second Assessment Report (1992-1995)

The Second Assessment Report was completed in 1995. It integrated the results of the flourishing climate research in the early 1990ies. The emergence of the IPCC and the signature of the UNFCCC gave a boost to the entire field of atmospheric and climate research, in particular in natural science realms. Governments were increasingly willing to fund this type of research. New institutes were founded and novel global circulation models were developed or significantly improved. While the problem itself has gained significant awareness among governments, NGOs and business actors, the insights in the paramount uncertainties and knowledge gaps spurred the scientific debate and research. It was the main objective of this body of research to reduce the uncertainties and to find clear evidence for the human causation of climate change.

After the experience in the ozone negotiations, scientists as well as political actors hoped to boost international negotiations through the provision of a scientifically sound proof. In ozone policy, the emergence of the scientific proof for the damaging effects of CFCs to the ozone layer fostered the efforts of the international community to negotiate an international treaty and to phase out CFCs. By contrast, in the field of climate change no similar proof could be found, causal chains turned out to be much more complex and indirect in the global climate system and research into the issue has not yet matured. However, it can be perceived as a fundamental success of the second assessment report that policy makers obviously felt the

need to negotiate a legally binding international agreement that was signed in 1997 in Kyoto, two years after the second assessment report was published.

At the time of the preparation of the second assessment report, one crucial incidence of learning in the sense explicated above took place. At its sixth session, the Panel established a special Task Force on the IPCC Structure that reported to the eighth session of the IPCC in 1992. Its purpose was on the one hand to comply with the requirements of the framework convention introducing several new bodies like the Conference of the Parties and two Subsidiary Bodies. On the other hand, the Task Force was asked to outline the Working Group structure of the second assessment and to suggest ways to allow for the participation of NGOs in the IPCC process, which was demanded by several environmental NGOs. The Task Force was open to all the members of the IPCC including government representatives, authors and the Bureau members. The Task Force convened three times and prepared a report that led to the adoption of a 4-page-long document about new rules of procedure of the IPCC at its ninth plenary session.

The core of these new rules dealt with the specific and highly sophisticated type of review procedure that was imposed to ensure scientific quality and credibility to both the scientific and the political community. Whereas in the first assessment each chapter had been reviewed by two or three experts and government officials simultaneously and no precise formal rules on the issue had been available, in the second assessment the review process was much more refined. Now, the review process took place in two subsequent rounds.

The report of the Task Force and the resulting decisions by the plenary reacted to critical comments from the political world, whereas only a few criticisms from the scientific community were addressed in the report and in the revision of the rules of procedure. Nevertheless, the Task Force can be seen as a first institutionalised effort to reflect on the experiences of the first period of the IPCC's existence and it was fairly successful in promoting changes of its procedures. Moreover, due to its set up it was open to all the members of the IPCC and provided a high degree of legitimacy to the outcome.

In terms of a learning typology, these learning efforts can be characterized as adaptation considering that the changes were rather reactive and complied to external criticisms. There was no fundamental change in the underlying assumptions perceivable that would allow for a characterization as a reflective learning process. Such a reflection process would have required significant increases changes in the cognitive frames regarding saliency, credibility or legitimacy of the assessment process. The acknowledgement of the role of NGOs and industry in the preparation of the assessment was an important step towards increased legitimacy but their actual impact in the process remained limited given that they were only allowed to consult but not to vote in the plenary sessions. Moreover, the inclusion of these groups did not result from a thorough reflection of the assessment process and its political functions but from political pressures these groups were executing. The additional formalisation of the peer-review process as expressed in the document prepared by the special Task Force aimed at increasing credibility, but the suggestions made implied few significant changes to the processes already in place. However, they led to a tremendous increase in the number of reviews each author had to take into account. By contrast, significant changes in the direction of increased credibility while maintaining legitimacy and saliency might have lead to a more reflective selection of reviewers e.g. through a voting mechanism by all the governments and scientific experts.

3.3 Third Assessment Report (1995-2001)

A somehow different approach was taken to facilitate the learning from the second assessment and to feed the results of the reflections into the design of the Third Assessment Report starting in 1996. At that time, the first chairman of the IPCC was about to step down

and his successor had been elected new chair. In a one-year transition period both were working closely together to ensure continuation of the work and to allow for a transfer of knowledge from the predecessor to the successor.

The new chairman started out with the attempt to consider what was the right structure of the IPCC. Instead of establishing a specific task force, he himself prepared a White Paper addressing a number of key questions and suggesting a new structure and procedural improvements for the third assessment. The draft was based on critical articles in the scientific literature, on government statements and on a number of workshops on specific substantial matters such as mitigation technologies, regional projections of impacts and on uncertainty (Moss 2000). The chairman received over 90 responses from governments, NGOs and scientific experts and he attempted to consider them in the preparation of the final decision paper on the design of the Third Assessment Report, which was then adopted by the plenary session. Altogether, this iterative process took a little over a year and it was certainly a larger effort than the design of the second assessment when measured in comments considered and in rounds of iteration.

One of the main challenges for the design of the third assessment report was how to deal with the criticisms raised in the so-called chapter-8-debate.[7] In the aftermath of the release of the second assessment report, a number of US-based scientists backed by the Global Climate Coalition (GCC) launched a massive assail against the final version of chapter 8 of Working Group I which concluded that "the balance of evidence suggests a discernible human influence on global climate" (Houghton, *et al.* 1996, p. 4). The accusations published in widely read magazines such as the Wall Street Journal were serious. They charged that the lead authors of the chapter had changed the text of the final version after it had already been officially approved by the Working Group plenary. Thereby, they claimed, the chapter authors violated the IPCC's rules of procedure and the fundamental standards of peer-review. However, the accused authors and the leaders of the IPCC process could successfully prove these accusations wrong and no IPCC-member state government joined in the criticism (Edwards, Schneider 2001). Yet, the debate brought some deficits to the surface that had to be addressed in future assessments.

The awareness of these deficits on the side of the IPCC leaders lead to another institutional innovation in the preparation of the third assessment. The incoming chairman suggested in his White Paper the introduction of so-called "review-editors" whose function was to oversee the review process, i.e. to ensure that authors appropriately deal with the comments from the expert and government reviewers. Because sceptics were afraid of delays in the timing of the assessment, the number of review editors was limited to two and they were invited to the author meetings to witness the processes and to give timely comments and suggestions. Thereby, their work was not a blind (i.e. anonymous) review process but on the other hand, no serious delays occurred due to review editors although they had to work under intense time pressures. Not all authors regarded the installation of review editors a completely helpful improvement of the process since not all of the review editors were similarly diligent in fulfilling their job—a task that required readings and consideration of the various versions of the chapter drafts and of up to 200 comments.

The introduction of the review editors demonstrated a considerable degree of reflection of the ongoing processes and can be seen as more than a single-loop learning because it surmounts the framework of previous conceptions of the IPCC process. These changes got along with a shift in the general perception of the IPCC process. When the IPCC scientists were confronted with legalistic arguments in the debate about their scientific statement and the procedures that

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[7] An extensive analysis of the chapter-8-debate can be found in Lahsen (1998). An in-depth study of the arguments concerning peer-review put forward in this discussion is included in Edwards and Schneider (2001).

led to it, they had to realize that the form of scientific discourse they were used to was not appropriate under these circumstances. They encountered procedural arguments from lawyers that could not be dealt with on the basis of scientific arguments based on a common notion of truth and credibility. Therefore, they had to reflect the conditions of a legal discourse, which resulted in the more precise formulations of existing rules of procedure and in procedural innovations. It seems hardly exaggerated to state that the IPCC had to incorporate a new rationale that originated in the political realm. Nevertheless, the outcome of this reflection was the introduction of another refinement of the scientific procedures that were certainly able to increase credibility at the expense of further bureaucratisation and extension of the assessment process. In so doing, saliency of the assessment has been put under jeopardy because the processes were extended and the IPCC had even more problems in delivering timely policy relevant information. In retrospect this reflection process helped the IPCC to immunise against legalistic claims and the increase its policy impact since criticism was much more difficult to be brought forward on legal grounds.

With regard to the treatment of uncertainties, the third assessment report exhibited another reflection process. Since the launch of the IPCC, the topic was intensely debated among the participating scientists and authors have been using different approaches to estimate and document uncertainties. Many of them even refused to give any estimation on uncertainties because of their scientific ethos to focus exclusively on reliable and certain research findings. Several researchers had to be convinced that the policy-oriented approach of the IPCC urgently required these estimations to advise political judgments on specific risks—even when no scientific certainty was available.

In order to give better advice to the policy community and to achieve more consistency in the use of language on uncertainty, in the third assessment, Moss and Schneider (2000) developed a guidance paper that was sent to all Working Groups. They introduced a qualitative framework to describe "states of knowledge" and suggested a numerical scale of the various degrees of confidence. The objective was to allow authors to make their partly inevitably subjective estimations more transparent and understandable for policy makers and to increase consistency in the whole report.

While most authors adhered to this framework, one group of lead authors from Working Group I refused to do so. Instead of using the suggested scale with intervals of 5 percentiles (5%, 10% … 95% confidence) they employed numbers of a third or 99% likelihood and avoided the exact description of uncertainties by referring to the assumptions of various models leaving policy makers without clear guidance how to evaluate the related risks. After lengthy discussions among the authors and following a request from governments, the authors partly revised the chapter but the other Working Groups that had to build on the results from Working Group I had hardly any chance to adapt to these changes because of the short time frame in between the sessions of the Working Groups to approve the third assessment report. Therefore, minor inconsistencies can also be found in this report although the general treatment of uncertainties is significantly more reflective, consistent and clear than in the previous assessment reports.

Central findings of the third assessment report demonstrated the increased urgency of political action against climate change. The report presented matured simulation results with severely increased estimates of temperature and sea level rise until the year 2100. In addition, first evidence for climate change is documented in the report. Changes in the migration of species, rising mean temperatures on a global scale and over-proportionally increased numbers and costs of extreme weather events alerted even many policy makers. After publication, little criticism was voiced publicly. Most of the scientifically accepted critics were integrated in the process and the sophisticated procedures of the IPCC ensured the credibility and legitimacy of the process.

As regards the policy impact, the third assessment report has been discussed critically. In 2001, the US administration decided to withdraw from the Kyoto Protocol and caused significant troubles in the international negotiation process. The publication of the report was unable to motivate the US government to refrain from this step. Nevertheless, an inquiry by the US administration with the US academy of science whether the IPCC process is legitimate and delivers credible results brought new support for the IPCC, but it not result in reflection processes among US officials. However, the remaining signatory states of the Kyoto Protocol continued their efforts to implement the accord and finally succeeded to reach the necessary number of signatory states for its entry into force. In 2005, the Protocol became legally binding international law and the novel policy instruments foreseen in the treaty are currently being implemented. These results can in parts also be credited to the third assessment report that helped to reduce uncertainties in particular with regard to the current and future impacts of climate change.

3.4 Fourth Assessment Report (2001-2007)

While still concerned with the process of completion of the Third Assessment Report in early 2001, the IPCC Bureau was already reflecting on the past assessment process and developing ideas about future steps. As in the third assessment, the chairman prepared a so-called "Issues Paper on the Future Work Program of the IPCC" and submitted it to the Bureau for discussion. Comments were again expected from the vice-chairs, the co-chairs, the lead authors and the governments but not really from individuals or organizations external to the IPCC.

Nevertheless, the second chairman who initiated this process was not allowed to conclude this process. His strong and elaborate position motivated his critics to convince a majority of governments to vote for another nominee. Thus a new chair was elected that came from a developing country but as it turned out, he continued in most respects on the path of his predecessor. In particular, the elaborate review mechanism was maintained. Nevertheless, IPCC Bureau members agreed in 2001 that the next report will take more time since research output was expected to be slower and more time consuming. They decided not to publish the next report before 2007.

With regard to the treatment of uncertainties, authors of the fourth assessment report received new and more elaborate guidance. In several documents issued by the IPCC Secretariat, different forms of uncertainties are distinguished. This relates to the separation between unpredictability, structural uncertainty and the uncertainties of particular parameter values. These specifications improved the way, participants in the assessment process deal with uncertainties representing a learning process in the adaptation mode.

So far, participants in the process report some new findings of the fourth report. This relates first to new modeling results. Latest simulations show an even stronger increase in global mean temperature and more severe damaging impacts that in the third assessment report. Moreover, insights in the actual impacts of climate change and the current trends lead scientists to a greater awareness for adaptation and vulnerability to climate change with a strong regional focus. Policy outcomes and other learning processes beyond the improvements of the assessment procedures remain to be seen.

3.5 Summary

In sum, the IPCC proved to be able to learn in reflexive and in adaptive modes. It improved its procedures to accommodate political claims towards legitimacy while maintaining and even strengthening its scientific standards towards credibility. In addition, most participants in the IPCC process learned to target the process at the decision needs of the policy making process. Nevertheless, the balance between the three criteria is a delicate one. Many scientists had and still have difficulties with the political aspects of the IPCC process, in particular the

government approval mechanism. On the other hand, many negotiators feel challenged by the scientific contents of the reports and the political implications. In particular, many of them remain critical against policy options described in the reports since they see them as too strong an influence on the political process.

In terms of the study of social learning processes in entire policy fields it remains difficult to evaluate the contribution of the IPCC process to the formation of preferences and the political decision making in domestic and international realms. The magnitude of influences and sources of relevant knowledge does not allow to trace back individual decisions to one particular cause or one particular insights provided by a social actor. However, the sequence of the published results of the IPCC assessments and the steps in the international negotiation process show a pattern that might allow to assume a certain causal influence. This relates particularly to the signature of the UNFCCC, the Kyoto Protocol and to some extent also to the decisions taken at the Johannesburg summit in 2002. If this conclusion is correct, the study of the IPCC also allows for conclusions for the overall social learning process in international climate policy. The IPCC seems to be a crucial actor in this process who's strength is derived from the provision of policy relevant knowledge and the reduction of uncertainties.

The IPCC exhibited different modes of social learning processes. The incidences of reflection remain limited to two critical events where fundamental reconsiderations of former practices and cognitive frames took place. These moments of crisis in the beginning of the IPCC and during the chapter-8 debate required rather radically new ways of thinking and action to address the problems and external criticisms raised. This finding resonates well with insights from organizational learning, where crises have been described as key triggers for learning processes (see e.g. Kim 1998, Nonaka 1994). The other described learning processes in the case of the IPCC fall into the category of adaptive learning with incremental changes and adaptations in the cognitive frames and stepwise improvements of procedures. They demonstrate the IPCC's ability to change and monitor its procedures and the outcomes. General supporting factors for this ability have been found in three main factors (Siebenhüner 2002).

First, learning has been promoted by the existence of a small and well-connected group of scientists in the Bureau that coordinate the work of the IPCC. This group was able to exchange knowledge and new insights rather quickly, it has considerable authority in the preparation of the assessment reports and it has been selected according to scientific as well as political criteria. Moreover, their commitment to learning and to solving the problem of climate change helped the learning processes a great deal.

Second, the communication structures in the IPCC allow for the broad diffusion of new knowledge. The inclusion of most relevant scientists enabled the assessment body to gather the latest scientific knowledge and its sequential process turned out to be effective in synthesizing this knowledge. However, formal communication structures still have room for improvement as far as the internal interaction between the working groups is concerned. External communication with the negotiating bodies and the general public is also not entirely optimal when viewed from a learning perspective. In particular, the dialogue with the general public is scant in the preparations of the IPCC-reports. Communication remains in a one-way mode where scientists try to explain their findings to the public. The procedures are still scarcely prepared to foster a more open dialogue to include so-called lay knowledge or the general concerns, thoughts and attitudes of the public in different parts of the world which might trigger significant learning processes within the IPCC.

Third, the IPCC established functional mechanisms for its learning and improvement. The organisation of the sophisticated review process offers manifold opportunities to reflect and reassess substantial findings and procedures. Moreover, each new assessment process started

with a re-consideration of the procedures to be implied and led to changes of the procedures and the emergence of well-elaborated cross-cutting guidance papers.

Despite these characteristics and capabilities, the IPCC remains to be criticized from a structural point of view. Haas (2004) maintains that the IPCC is highly dominated by northern political interests and its set up as an intergovernmental process kept the scientific process on a "tight leash" of the governments. He assumed that the highly complex approval mechanisms of the IPCC hampers the political leverage of the assessment products. However, in the situation of no existing alternative approach to a more effective design of a climate related assessment process, no final decision on that matter can be filed.

4 Conclusions

What would need to be done to improve policy outcomes of the assessment process in international climate policy? Given the multiple influences on the international climate politics, no clear-cut answer can be provided for this question. The IPCC assessment process and its reports represent only one factor in the often heated negotiation rounds. In particular, the specific structure of the problem of climate change and the relation to the existing energy system render direct comparisons to other environmental policy fields difficult.

The findings of this study suggest that continues efforts to improve the balance between saliency, credibility and legitimacy enable the IPCC process to provide knowledge that also has political power to reduce uncertainties and to lead to a better reflected formation of preferences. The actual policy process where preferences are being articulated and compromises and implementable solutions are being sought can hardly be directly influenced by assessment bodies. Past experiences show, however, that IPCC assessment reports had an influence on policy outcomes. Even though they might not have been optimally timed, as Haas (2004) maintains, they motivated government representatives to advance in the political process and to negotiate and sign the UN Framework Convention on Climate Change in 1992 as well as the Kyoto Protocol in 1997 that entered into force after lengthy debates and follow-up negotiations in 2005.

Nevertheless, as recent assessment reports show, political progress is much too slow to halt climatic change and to prevent massively damaging impacts. Much stricter policy measures towards mitigating greenhouse gas emissions will be of the essence if most dangerous impacts should be averted. Given the actual situation of significantly risen CO_2-concentrations in the atmosphere, additional efforts to improve adaptation measures and adaptive capacities will be inevitable, in particular in most developing countries. This is also a highly challenging social learning agenda for our and the at least the next generation.

5 Acknowledgements

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