Reducing Air Pollution in Europe

A study of boundaries between science and policy

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Table of Contents

Chapter 1 Introduction – communication between science and policy in assessment processes

1.1 Background

1.1.1 The role of scientific expertise in European air quality policy making

Environmental policy aims at the improvement of the quality of the physical environment in the context of sustainable development. For the decision-making process and its policy solutions this means taking into account ecologic, economic and social aspects of the problem. In the field of air quality policy making in Europe a long tradition exists in using scientific information to support negotiations and decisions (e.g. Hordijk, 1991; Levy, 1993; Castells, 1999; Grünfeld, 1999; Tuinstra et al., 1999; Bäckstrand, 2001; Wettestad, 2002; Grennfelt and Hov, 2005). Examples of this science-policy interaction are the activities of the United Nations Economic Commission for Europe (UN-ECE) in preparing international conventions and protocols in which countries agree on reducing emissions of atmospheric pollutants (Sliggers and Kakebeeke, 2004). Another example is the preparation of EU legislation, e.g. directives on national emissions ceilings and air quality standards (Wettestad, 2002). Both examples show an intensive communication process between scientists and policy makers, where knowledge from different scientific disciplines e.g. economy, soil-science, ecology, meteorology and other knowledge sources is integrated in such a way that it provides information that can be used in decision making. These special communication processes can be referred to as assessment processes (e.g. Farrell et al., 2001). Assessment processes are embedded in a variety of institutional settings, within which scientists, decision makers and other stakeholders communicate to define relevant questions for analysis, mobilize certain kinds of experts and expertise, and interpret findings in particular ways (Farrell et al., 2001).

1.1.2 Scope of the thesis

This thesis focuses on the exploration of the communication process between science and policy actors in assessment processes in the field of air quality policy in Europe. In particular it focuses on the negotiation of the boundaries between science and policy and on the processes that shape assessment frameworks. It presents a framework for analysis that combines the concept of effectiveness of scientific assessments in policy processes in terms of scientific credibility, political legitimacy and policy relevance, with the notion of "boundary work". Credibility refers to the scientific and technical credibility of the assessment to a user of the assessment. Legitimacy refers to the political acceptability or perceived fairness to a user. Relevance refers to the extent to which an assessment and its results address the particular concerns of the user (Farrell et al., 2001). Boundary work is the practice of maintaining and withdrawing boundaries between science and policy, shaping and reshaping the science-policy interface (Halffman, 2003). In the next section I will discuss existing research on these issues and specify the problem setting, the objectives and the research questions of this thesis.

1.2 General problem description, objectives and research questions

1.2.1 General problem description: The complex dynamics of the interaction between science and policy in European air quality policy making

The communication process between science and policy is more complex than could be concluded on first sight from the section above. The complexity of this communication process has been illustrated in various studies and by various authors (e.g. Jasanoff and Wynne, 1998). It appears not to be a matter of "just getting the science right" and pass on the answers to policy. Neither does science simply inform policy in an instrumental way and make policy decisions more rational. This would imply a simplified one-directional image of the relationship between science and policy which is not consistent with what can be observed in practice as has been discussed by e.g. Habermas (1970), Clark and Majone (1985), Shackley and Wynne (1995), Rein and Schön (1996), Jäger (1998), Woodhouse and Nieusma (2001) and Sarewitz (2004). Furthermore there is no straightforward way to draw a sharp line between scientific and policy making activities in an assessment process (Gieryn, 1995; Shackley and Wynne, 1995; Jasanoff and Wynne, 1998; Guston, 2001; Miller, 2001; Nowotny, 2003). Part of the communication process between science and policy involves negotiations about the roles and responsibilities of science and policy actors (Halffman, 2003). Boundaries between science and policy are (re)defined and negotiated and research agendas and policies are mutually constructed (Shapin and Schaffer, 1995). Still, Cash et al. (2002) note that scientists have an interest in maintaining a boundary to assure the credibility of their work and politicians have an interest in maintaining a boundary to ensure their claims of representative legitimacy.

These notions of the relationship between science and policy, which will be further discussed in chapter 2, are of significance for current questions and debates with regard to the role of science in public policy. What demands have to be made on the communication process between scientists and policy makers in order to create assessments that indeed provide useful information to decision making? When are assessments considered to be useful? How can scientists maintain their credibility when they engage in policy issues? These are questions which are of concern at various levels of the science and policy domain. For example assessment agencies like the European Environment Agency (EEA) and advisory bodies or think-tanks like the Netherlands Scientific Council for Government Policy (WRR) ask themselves these questions when they define their work programme or when they design an assessment framework targeted at specific issues. The questions are also relevant for those involved in designing broad international assessments that involve a large number of experts of different backgrounds, have high political stakes, and in which many different possible problem framings would be possible. Examples are the recent initiative for a Global Energy Assessment (IIASA, 2005), the organisation of the work of the Intergovernmental Panel on Climate Change (Watson et al., 2001) and the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment, 2005). From a political point of view, the relevance of questions regarding the role of science in public policy and the design of assessments is also evident in the current debate on "sound science" in the United States (Mooney, 2005).

Various studies exist which analyse the role of science in the field of air quality policy making in Europe, the specific focus of this thesis. Below I summarize the findings of several of those studies in order to identify what can be learned from those studies with regard to processes at the science-policy interface and what kind of questions are still open.

Most of the existing studies focus on processes in the context of the UN-ECE Convention on Long-range Transboundary Air Pollution (CLRTAP) only (e.g. Hordijk, 1991; Wettestad, 1997; Gough et al., 1998; Grünfeld, 1999; Tuinstra et al., 1999; Bäckstrand, 2001; Castells and Ravetz, 2001; Lidskog and Sundqvist, 2004). Some of the studies on UN-ECE CLRTAP address especially the effectiveness of institutions and negotiation outcomes itself in terms of environmental impact. The use of scientific knowledge is pictured as a factor in these outcomes (e.g. Levy, 1993; Grünfeld, 1999). Others evaluate the development of the role of science and the special role of computer models (e.g. Hordijk, 1991; Gough et al., 1998; Tuinstra et al., 1999; Castells and Ravetz, 2001).

Only a few studies analyse both the processes at the level of the EU and the level of UN-ECE CLRTAP (Ishii, 2001; Wettestad, 2002; Selin and VanDeveer, 2003). Wettestad (2002) gives a detailed account of different stages of the negotiations and the role of scientific input both within the UN-ECE CLRTAP process and the EU process up to 1999 and 2001. He demonstrates that there are many linkages between the two processes. Selin and VanDeveer (2003) analyse the interactions between the EU and CLRTAP policy setting and they stress the role of organizational and individual actors in creating and utilizing linkages. They conclude that member organizations, non-member organizations and individuals link scientific and technical activities and policy making processes and outcomes in CLRTAP and the EU. Selin and VanDeveer argue that environmental leader states often use linkages in their attempts to strengthen policy in one or both institution

A recent set of studies has focused explicitly on the effectiveness of scientific assessments in the European air quality policy domain. Eckley et al. (2001) have analysed the effectiveness of the assessment process in UN-ECE CLRTAP in terms of credibility, legitimacy and saliency. They show that accountability to the scientific community affects the credibility of an assessment. Assessment processes that encourage iterative communication between scientific experts and policy-makers can increase salience and legitimacy. Within CLRTAP this kind of communication has built trust among participants in the assessment process. VanDeveer (2005) discusses the issue of participation of transition countries in the negotiations and in scientific cooperation in UN-ECE CLRTAP. He concludes that early patterns of participation within assessment processes and initial framing of scientific, technical, and research questions are closely interrelated and often persistent over time. Furthermore he concludes that linking assessment issues to larger political, economic, and social interests may enhance the salience and policy impact of assessment findings, but it may also be a vehicle for the channelling of political and economic power through scientific and technical assessment. Farrell and Keating (2005) discuss the issues of dissent and trust in air quality assessments both in UN-ECE CLRTAP the United States. They conclude that the assessment activities undertaken under CLRTAP helped significantly by reducing concerns about the economic implications of unilateral emission cuts, by providing important information about environmental conditions and technological options that might not have been available otherwise. Furthermore they conclude that the credibility of the analysis was derived in large part from the trust that participants developed for the individuals who conducted the analysis. Trust also existed in the methods used in the analysis, and the overall decision making process in which the analysis was conducted and presented. Trust in the individuals who conducted the analysis developed through repeated interactions throughout the overall assessment process. Farrell and Keating (2005) conclude that the participatory nature of the assessment process was important to the expression and resolution of dissent.

With regard to the mutual construction of policy and research agendas and the negotiation about the boundary between science and policy Bäckstrand (2001) has explored the science policy interplay in UN-ECE CLRTAP using a discursive framework. Her study gives insight in the various discourses surrounding the critical loads[1] approach in the negotiation of the 1999 Gothenburg "multi pollutant-multi effect" protocol. VanDeveer (2004) uses the concept of "co-production" of knowledge and policy to argue that within UN-ECE CLRTAP not only scientific knowledge is organised and policy options are identified. He argues that this way of working frames a common feeling of the "pan-European region" and frames air pollution as a trans-boundary problem (instead of a national or local one). Sundqvist et al. (2002) examine the relationship between science and policy in UN-ECE CLRTAP in terms of "boundary work" and show that the concept of critical loads and the computer model RAINS[2] have different meanings for the various involved

[1] "Critical loads" have been defined as the maximum exposure to one or several pollutants, at which according to current knowledge no harmful effects occur to sensitive ecosystems in the long run (Nilsson and Grennfelt, 1988). The critical loads approach is an effects-based approach to base pollution abatement strategies on.

[2] The Regional Air pollution Information System (RAINS) model, developed and maintained by IIASA was one of the models which had supported the negotiations on the 1994 Oslo Sulphur Protocol

actors, which include heterogeneous views on the boundary between science and policy.

The overview of the literature above illustrates that several studies have been carried out on science-policy interaction in air quality policy making in Europe. However it would be interesting to examine in more detail the processes at the science-policy interface in order to understand how assessment processes are shaped and how this influences the “usefulness” or “effectiveness” of assessments. Furthermore, only few studies analyse both the UN-ECE CLRTAP process as well as the processes within the EU (e.g. Wettestad, 2002) and no study exists on the most recent developments within the EU i.e. the recent science policy interaction process leading to the 2005 EU Thematic Strategy on Air Pollution within the so called Clean Air for Europe (CAFE) process. It would be interesting to compare this recent science policy interaction process which has been taking place at European Union level with the processes within UN-ECE CLRTAP in order to find out whether similar approaches are being applied in the two policy settings or whether different ways of science policy interaction can be discerned. Is the boundary between science and policy drawn in different ways? What could we learn from differences? Can lessons be learned for other policy areas such as climate change or biodiversity issues?

This thesis adds to the existing literature by analysing and comparing science policy interaction processes both in UN-ECE CLRTAP and the EU CAFE process. To this end I will develop an analytical framework that enables a focus on the science policy interface. Below I further specify the objectives and research questions.

1.2.2 Objectives and Research Questions

The objectives of this thesis are (1) to contribute to the understanding of the processes at the interface between science and policy in shaping assessment frameworks and assessment processes in the field of air quality policy making in Europe and (2) to contribute to the understanding of the role of boundary work in enhancing credibility, legitimacy and relevance of assessments.

More specifically this thesis addresses the following research questions:
1. How do participants in different settings of air quality policy making in Europe divide and co-ordinate work between science and policy?

(Tuinstra et al., 1999). It is a tool for integrated assessment of multi-pollutant emission control strategies addressing multiple environmental effects including ground-level ozone, acidification and eutrophication. The model combines information on the sources of emissions (e.g., economic development, the present and future structure of emission sources, the potential and costs for controlling emissions) with scientific information about the dispersion of pollutants in the atmosphere including the ozone formation processes. It compares the resulting regional air quality with various indicators (e.g., population, critical loads and critical levels for vegetation, etc.) (Amann et al., 2004). See also http://www.iiasa.ac.at/rains/index.html

2. How does this division of work shape the design of these assessment processes and enhance credibility, legitimacy and relevance of the assessments?
3. How do the roles and division of tasks between scientists and policy makers differ between different settings of air quality policy making in Europe and how do these differences influence the way credibility, legitimacy and relevance of the assessments are established?

In order to answer these questions, I will develop a framework for the analysis of the interactions between science and policy in assessment processes. This framework will build on and integrate insights from current literature on the impacts and effectiveness of assessments and literature on boundary work.

1.3 Research Strategy: a case study approach

1.3.1 Rationale for choosing a case study approach and selection of the cases

As a research strategy I have chosen for a comparative case study approach. A case study is "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" Yin (1994, p.13). Thus, the case study method is used when the researcher wants to cover contextual conditions, because they might be essential to the phenomenon of study. The case study enquiry copes with situations in which there will be many more variables of interest than data points and relies on multiple sources of evidence (Yin, 1994, p.13). In a comparative case study several interrelated cases are compared (Verschuren and Doorewaard, 1999, p.166).

This case study is limited to the analysis of the communication process between policy and science in the field of air quality policy in Europe in two specific cases[3]. The two cases studied in this thesis refer to different policy settings in air quality policy making in Europe. One is set in the framework of the Long-range Transboundary Air Pollution (LRTAP) convention of the United Nations- Economic Commission for Europe (UN-ECE which includes EU and non-EU countries), the other is set in the context of the work of the European Commission within EU, the Clean Air for Europe Programme (CAFE). The two cases have their European setting and the fact that they use scientific data and models to inform the policy process in common. A difference is that the UN-ECE setting is a setting of multilateral negotiation and diplomacy leading to international agreements and protocols, while in the EU setting common European legislation is developed. The broader

[3] It is important to acknowledge that the cases should not be seen as "sampling units", because statistical generalization is not the method to generalize the results of the cases (in contrast to generalization from experiments or when doing surveys) (Yin, 1994, p. 30). The method used in this study is an explorative and qualitative one, using the framework for analysis to organize, compare and interpret the empirical results of the cases.

context for both cases is scientific research and policy making in the field of European air quality. Box 1.1 provides some more information on the cases.

Box 1.1 Two cases in European Air Quality Policy

Since its adoption in 1979, the *Convention on LRTAP* has addressed some of the major environmental problems of the UNECE region. This has been achieved through a process of scientific collaboration and policy negotiation. In this way, since its entry into force in 1983, the Convention has been extended by eight protocols, which identify specific obligations or measures to be taken by Parties. Besides laying down the general principles of international co-operation for air pollution abatement, the Convention provides an institutional framework linking science and policy. Its scientific Working Groups, the Working Group on Effects and the Steering Body of EMEP, and their Task Forces and international centres address the issues that enable the Convention to develop the science-based policies and control measures in its protocols. In this thesis the focus will be on the work of the Task Force on Integrated Assessment Modelling (TFIAM).
Source: www.unece.org/env/lrtap/

CAFE is a programme of technical analysis and policy development which has led to the launch by the European Commission of a thematic strategy under the Sixth Environmental Action Programme of the European Union in 2005. The programme started in March 2001. Its aim is to develop a long-term, strategic and integrated policy to protect against the effects of air pollution on human health and the environment. The intention is that CAFE will develop further into a five-year policy cycle. CAFE-work is intended to be science-based and to involve stakeholders at all levels of policy-making. A steering group composed of representatives of the Member States, the European Parliament, stakeholders and relevant international organisations meets two or three times a year to advise the Commission on the strategic direction of the programme. A technical analysis group co-ordinates the technical analysis work carried out within CAFE. In this thesis the focus will be on the work of the Steering Group, the Technical Analysis group and the Working Group on Target Setting and Policy assessment which result under the Steering Group.
Source: www.europa.eu.int/comm/environment/air/cafe.htm

I will use the theoretical framework that will be described in chapter 2 to study the CLRTAP case and the CAFE case first independently, addressing both research question 1 and 2 for each case. Then I compare the results to find explanations for similarities and differences between the two cases to analyse them on a higher level of abstraction in order to address research question 3.

For my purposes the case study approach is useful, as I am interested in the contextual conditions of science-policy interactions in European air quality policy, and expect that they play an important role in the way the communication between science and policy develops in each of the two cases. Furthermore a case study approach is appropriate, because the practice of science-policy interaction in European air quality policy making is a contemporary phenomenon with historical roots and which has to be studied together with its context.

1.3.2 Data Collection

For this study both primary and secondary data sources have been used. Primary data sources are:

(1) Official documents and negotiation reports of meetings of various bodies operating in the science-policy interface within the CLRTAP and CAFE. These include for CLRTAP reports of the meetings of the Task Force on Integrated Assessment (TFIAM) in the period 1986 - 2005, of the Working Group on (Abatement) Strategies and Review (WG(A)S) in the period 1989 - 2005, of the Executive Body (EB) in the period 1986-2005, of the Working Group of Effects (WGE) in the period 1989 – 1994 (till 1999 incidentally), of the Task Force on Mapping (TFM) in the period 1989-1994 (till 1999 incidentally), for the Group of Experts of Cost and Benefit Analysis (GE CBA) in the period 1985-1994 incidentally. The reports were accessed through archives at the UN-ECE Secretariat in Geneva, the International Institute for Applied Systems Analysis (IIASA) in Austria and Netherlands Research Institute for Health and Environment (RIVM, now Netherlands Environmental Assessment Agency) and for recent documents via the UN-ECE website. For the TFIAM also scientific input material for the meeting was studied. For CAFE these include meeting reports of the Steering Group, Technical Analysis Group (TAG) and the Working group on Target Setting and Policy Assessment (WGTSP) in the period 2001-2005, all of which were accessible through internet;

(2) Informal documents, including letters, faxes and e-mails provided for CLRTAP from the personal archives of the chairmen of TFIAM for the period 1989-1994 (till 2005 incidentally) and the head of the Coordinating Centre for Effects (CCE) and for CAFE from Dutch delegates to the CAFE Steering Group;

(3) Interviews (20) with delegates of various countries, members of NGOs, chairmen of working groups and scientists involved in the processes, as well as interviews with scientists and civil servants who were not directly involved but followed the processes from a distance. All interviews were semi-structured and conducted directly or by phone in the years 2004 and 2005;

(4) Participant observation for CLRTAP through various meetings and workshops of TFIAM (Bilthoven (1995) The Hague (1995), Laxenburg (2002), Laxenburg (2003), Gothenburg (2005) and observations of working processes and informal meetings of involved scientific institutes (IIASA, April- July 1995 and August 1996 - June 1997). For CAFE through various meetings of Dutch civil servants and scientists (ELAN) in preparations of CAFE meetings and observations of working processes and informal meetings of involved scientific institutes (Netherlands Environmental Assessments Agency, September 2005 - December 2005; European Environment Agency, August 2005).

Secondary sources include secondary literature on the CLRTAP and CAFE processes, reports by various research institutes, websites and newsletters.

1.4 Outline of the thesis

This chapter, chapter 1 has provided a general introduction to the content, objectives and methods of analysis of this thesis.

Based on a literature review Chapter 2 then develops a framework for analysis that enables a focus on the science policy interface, building further on and integrating insights from current literature on the impacts and effectiveness of assessments and literature on boundary work.

In the chapters 3 and 4 the CLRTAP and CAFE cases are each introduced and analysed individually using the framework developed in chapter 2. The analysis of the two cases focuses on the question how participants in different settings of air quality policy making in Europe divide and co-ordinate work between science and policy (research question 1) and on the question how this division of work shapes the design of these assessment processes and enhances credibility, legitimacy and relevance of the assessments (research question 2).

Chapter 5 compares the differences between CLRTAP and CAFE in the roles and division of tasks between scientists and policy makers and the influence of those differences on the way credibility, legitimacy and relevance of the assessments are established in the respective settings. Thus it addresses research question 3.

Chapter 6 presents conclusions and a discussion on the role of boundary work in shaping assessment frameworks and assessment processes in the field of air quality policy making in Europe and in enhancing credibility, legitimacy and relevance of the resulting assessments.

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Chapter 2 A framework to explore the science policy interface

2.1 Introduction

In this chapter I describe the framework for analysis as developed for this thesis to analyse the interaction between science and policy in assessment processes. The aim of the framework is to provide a focus on the processes at the interface between science and policy in shaping assessments. The framework builds on insights concerning science policy interactions from the policy science and science studies literature. In particular it builds on an existing framework for considering effective assessments and connects this to the concept of boundary work.

In section 2.2 I first elaborate on the complex relationship between science and policy in order to clarify the background and the broader scientific context of the framework. Various traditions within the social sciences deal with the relation between science and policy in different ways. I briefly introduce the insights from a selection of these traditions, in particular with regard to the notions of "boundary work" and "co-production" of science and policy. This is not meant to be an extensive or complete overview. Rather it will put the choices made in developing the framework into perspective.

In section 2.3 I introduce an existing framework for considering effective assessments which has been developed under co-ordination of the Kennedy School of Government at Harvard University in the so-called Global Environmental Assessment (GEA) project. In section 2.4 I show how the concept of boundary work can be operationalised to study the science policy interface. Finally I present how I combine the GEA framework with boundary work into a new framework.

2.2 The role of science in environmental decision making processes: society, science and policy.

Dealing with environmental problems, both in the policy and the science field asks for a multidisciplinary approach because different aspects have to be taken into account. A multidisciplinary approach usually leads to multiple perspectives on these problems. This is one of the reasons why a one-directional image of the relationship between science and policy is problematic. It is not really possible to "get the science right" and pass the scientific results on to policy because different equally valid scientific insights may exist. "Nature itself […] is sufficiently rich and complex to support a scientific enterprise of enormous methodological, disciplinary and institutional diversity" (Sarewitz, 2004, p. 386). Holling (1998) observes that unanimity of agreement among peers rarely exists, "- only a credible line of tested argument." In addition he observes that the knowledge about the system we deal with is always incomplete and the system itself is a moving target.

People define or frame particular problems in different ways based on their knowledge and underlying views of the world (Rein and Schön, 1996). The framing of a problem also has consequences for the appropriateness of certain data, analytical methods and indicators and the choice of the direction of solutions involved (Keating and Farrell, 1998). "Facts" are thus not independent from disciplinary lenses and different ways to view the world. Worldviews inherently include particular values. This makes it difficult to separate "facts" from "values"[4]. Limiting the domain of science to the facts, while situating values exclusively in the domain of policy, is therefore not such a straightforward issue as it would look like on first sight.

The image of science and policy as static and strictly separated domains with their own cultures, goals and quality criteria creates the dilemma that scientific criteria for knowledge do not match with criteria for the "usefulness" of that same knowledge for policy (see e.g. Turnhout, 2003). Limiting the scientific domain to facts and the policy domain to values makes the dilemma even more difficult. In this image policy influence on science can have negative consequences for scientific quality and in that way threatens scientific authority. Scientific influence on policy can lead to technocracy and have negative consequences for democracy (see e.g. Turnhout, 2003).

From this linear perspective on the relation between science and policy it would seem almost impossible to be scientifically credible and perform "good science" and at the same time be useful for policy. But can "good science" be defined? Diverging views exist on what "good science" is and these views can differ in various situations[5]. As noted above, different disciplines generate divergent perspectives on the world. At the same time disciplinary orientations also embody divergent notions of good and relevant science (Lövbrand and Öberg, 2005). Peer review for example can only guarantee that scientific conclusions are based on science which is acceptable within rather strict disciplinary constraints (Lövbrand and Öberg, 2005; Herrick, 2004).

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[4] Note that this does not mean that the world or environmental problems "in fact" do not exist. It only implies that our means to know the world are limited. Epistemological relativism is often mistaken for ontological relativism. Epistemology refers to "what we can know". Ontology refers to "what exists" See Jones (2002) for a systematic discussion of these differences.

[5] Lövbrand and Öberg (2005) note that good science is still conceived in realist terms and scientists are hence trained and expected to generate an objective representation of the natural world. Representations of science as a social and value-laden activity can then easily be misunderstood as accusations of misconduct or bad science. They also note that much of the science study literature contributes to this misunderstanding by using a conceptual framework that is often difficult to access for scholars with other disciplinary orientations.

Literature within the field of science studies offers a dynamic image of the relationship between science and policy which takes different disciplinary worldviews and contexts into account. The term co-production is used to refer to processes that connect the production of knowledge with the organization of policy-making (Shapin and Schaffer, 1985; Shackley and Wynne, 1995; Jasanoff, 1996; Miller, 2001; Jasanoff, 2004). A linear relationship between science and policy, in which policy formulates the questions and science provides the answers does not exist in the co-production model. Instead, science and policy together define problems and create knowledge. In the science-policy interface through boundary work knowledge is produced. Simultaneously the social structures to produce this knowledge are being organised and the scene is being set for the framing of the policy problem and the organization of dealing with the problem. The distinction between science and policy is the result of a division of roles and labour between science and policy depending on a given context. Negotiation takes place about the identity of practices (e.g. "science" and "policy") and actors (e.g. "scientists" and "policy makers") and their collaboration. This process of maintaining and redrawing boundaries between science and policy, shaping and reshaping the science-policy interface has been referred to as "boundary work" (c.f. Jasanoff, 1990; Gieryn, 1995; Guston, 2001; Halffman, 2003). Note that this fluid image of the dynamics of the science-policy interface is different from an image in which a "gap" between science and policy exists that has to be bridged, or a manifest boundary between science and policy that has to be crossed. The negotiation and establishment of the boundary itself and the definition of what is science and what is policy is part of the science-policy communication process[6]. Thus, boundaries between science and policy do exist but vary according to different contexts or changing contexts.

Boundary work has two sides. One side is a demarcation side separating two actions or groups by defining distinguishing characteristics and prescribing proper ways of behaviour for e.g. science and policy. The other side is a co-ordination side defining how the two relate to each other by defining proper mutual conditions of exchange (Halffman, 2003). Boundary work leads to a division of labour between science and policy. The word "division" can be used in two ways: on the one hand as a result, something static, and on the other hand as a form of action. Boundary work can result in the definition of a boundary: being the division of labour between science and policy (division as a result). However this boundary does not need to be constant and the division of labour can be a continuing process (division as a form of action).

Within the field of policy studies, notions like *governance* (Stoker, 1998) and *policy networks* (Kickert et al., 1997) acknowledge from a policy perspective the

[6] Note that in this light it is even difficult to talk in terms of communication between "science" and "policy" or in terms of a "science-policy interface" as the definition of what is science and what is policy is also part of the negotiation. Nevertheless, this thesis refers to the division of labour between those who see themselves in the given context as being part of the science-domain and those who see themselves as part of the policy-domain.

fluid dynamics between policy, science and society. Governance implies that decision making is not in the hand of one actor (e.g. government), but takes place in a network of interdependent actors. Science can be part of that network. "Governance identifies the blurring of boundaries and responsibilities for tackling social and economic issues" (Stoker, 1998, p18).

But if the boundaries between science, policy and society are so blurred, if facts and values cannot be separated, how can credibility of science then be maintained? Because of the blurred boundaries between science, policy and society and because of the complexity of environmental issues, several authors have argued for alternative ways to organize the production of knowledge and decision-making. In cases where uncertainties and stakes are high, values diverge and decisions are urgent Funtowicz and Ravetz (1994) have proposed "extended peer review" to involve different members of society to provide insights in e.g. the context of the problem, different problem frames and feasibility of solutions. They label this new organisation of science a "post normal science". Instead of objectivity, relying on an absence of values and judgements, integrity and accountability should be quality criteria for science. Similar views are given by Gibbons et al. (1994) and Nowotny et al. (2001) when they describe "transdisciplinary science" and Mode-2 science.

In conclusion, what is "credible science" is largely determined by the context. The concept of boundary work helps to clarify why. Because boundaries between science and policy are not given, boundary work draws boundaries between science and policy in different ways in different contexts. Boundary work at the same time prescribes "proper ways of behaviour" and defines "how the two relate to each other by defining proper mutual conditions of exchange" (Halffman, 2003). What is "proper" thus depends on the context and boundary work.

2.3 A framework for understanding how assessments affect policy: the GEA-project

2.3.1 Credibility, legitimacy and salience of assessments

Between 1995 and 2001 the Kennedy School of Government at Harvard University in co-operation with other institutions carried out the Global Environmental Assessment (GEA)-research project. The GEA-project was "an international, interdisciplinary effort directed at understanding the role of organized efforts to bring scientific information to bear in shaping social responses to large-scale global environmental change" (Clark et al., 2005). It included case studies of the use of science in policy at the international, national, and local levels on climate change, biosafety, acid precipitation, persistent organic pollutants, coastal zone management, agriculture, fisheries, and water use (Mitchell et al., 2006). The project attempted to "advance a common understanding of what it might mean to say that one effort to mobilize scientific information is more "effective" than another" (Clark et al.,

2005) The framework and insights from the case studies are presented in various journal articles and in three edited volumes (i.e. Jasanoff and Long, 2004; Farrell and Jäger, 2005; and Mitchell et al., 2006). Farrell and Jäger (2005) focus specifically on the question how "environmental assessment processes [can] be designed such that scientific and engineering knowledge will most likely influence decision making."

The framework used in the GEA project is of interest for this thesis because it starts from the view that assessments are essentially communication processes. (Farrell et al., 2005; Clark et al., 2006). The framework acknowledges that it is not really possible to define effectiveness, because effectiveness relates to the achievement of goals, and goals of various participants in the assessment differ among each other. Effectiveness is therefore difficult to measure in a context in which issues are complex and dynamic (Eckley, 2002). Nevertheless, an assessment can be considered "effective", if it results in a change in the *issue domain*. In other words it changes, in one way or another, opinions, goals and behaviour of actors in the domain of the issue at hand, e.g. acidification or climate change. Clark et al. (2006) define issue domains as "arenas in which interested actors interact over a problem or issue of common concern but about which they may have different beliefs and policy preferences". The issue domain includes actors and their opinions, goals and behaviours (decisions, policies, agreements); institutions within which those actors interact; the framing and agenda related to the issue; and the state of the issue itself (e.g. improvements in environmental quality) (Clark et al., 2006; Farrell et al., 2005). Effective assessments sometimes influence issue development directly but more often do so in an indirect way and delayed in time (Clark et al., 2006).

A simplified representation of the conceptual framework for considering effective assessments as developed within the GEA project is visualised in Figure 2.1.

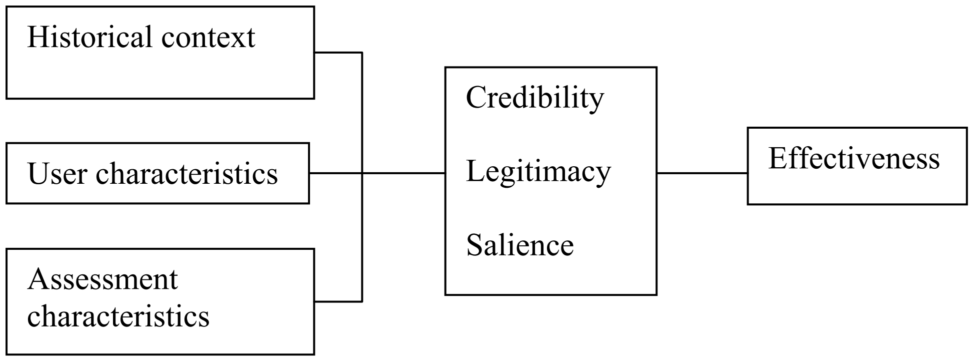

Figure 2.1 A conceptual framework for considering effective assessments as used within the Global Environment Assessment Project (GEA) (source: Eckley et al., 2001).

Drawing on earlier work from the Social Learning Group (2001) and Clark and Majone (1985) the framework presents three important qualities that an assessment needs to have in the view of users in order to be effective: *Credibility, Legitimacy* and *Salience* (Farrell et al., 2005; Clark et al., 2006). *Credibility* refers to the scientific and technical believability of the assessment to a defined user of that assessment. The assessment has to satisfy users that it is scientifically and technically sound. Users accept assessments as credible when the information is consistent with other information already available, when they trust the source as authoritative or when the assessment process has been according to scientific standards. *Legitimacy* refers to the political acceptability or perceived fairness to a user of that assessment. The assessment has to satisfy users that the assessment process has been fair and that the users' interests and concerns have been taken into account. *Salience* (or, in more common terms: relevance) refers to the extent to which an assessment and its results address the particular concerns of the user. In the first place the user has to be aware of the assessment and the assessment must be relevant to current policy and behavioural decisions. The assessment has to address questions that are relevant for the user (Farrell et al., 2005).

It is important to note that no straightforward way exists to ensure credibility, legitimacy and salience of an assessment. These assessment qualities are partly dependent on each other and there are complementarities and trade offs between them. Attempts to increase salience, for example by focussing exclusively on the issues seen as important by a certain decision-maker, can influence credibility for others negatively. Also, though it can increase the legitimacy with the decision-maker, it can decrease the legitimacy with other decision-makers. Likewise, attempts to increase credibility by isolating science from policy can decrease salience and legitimacy. However, trying to increase credibility by including different scientific disciplines can increase both salience and legitimacy. It is therefore important not to focus on one aspect at the expense of the other. Thresholds exist, and if one falls below them, the assessment is likely to be ineffective. Effective assessments balance between trade offs (Cash et al. 2002).

Furthermore, credibility, legitimacy and saliency are viewed differently by various actors, and therefore it will not be possible to design an assessment process in such a way that it will be salient, credible and legitimate for all actors in the same way (Cash et al., 2002).

The credibility, legitimacy and salience of an assessment are not only determined by the characteristics of the assessment itself. Eckley et al. (2001) distinguish next to the assessment characteristics two other ultimate determinants: the historical context of the assessment and the characteristics of the users of the assessment. Like Mitchell et al. (1998) put it: "the effectiveness of an assessment is a function of the interaction between assessment characteristics and the social and political context within which the assessment is conducted". The context of an assessment includes the position of the issue at the policy agenda and the characteristics of the issue domain itself (see for an elaboration in various cases Mitchell et al., 2006). User characteristics are, for example, their interest in the issue, resources to engage in the assessment or to use the results, and the openness to different sources of advice (Eckley et al., 2001; Farrell et al., 2005).

2.3.2 Design choices for effective environmental assessment processes

No straightforward way exists to increase the credibility, legitimacy and salience of an assessment. Nevertheless, the GEA project concluded from various case studies that certain design elements for assessment processes influence their credibility, legitimacy and salience. Farrell et al. (2005) identify the following design elements: 1) Initiation and Goal; 2) Science/Policy Interface; 3) Participation; 4) Treatment of uncertainty; 5) Treatment of dissent; 6) Framing; 7) Transparency; 8) Scale; 9) Capacity; and 10) Quality Control.

Relevance, credibility and legitimacy with multiple users, can be enhanced if context and user characteristics are taken into account in the *design* of the assessment. Assessment characteristics are the practical result of the design, taking into account the context and user characteristics. Below I visualise the assessment characteristics as the practical result of the design, (Figure 2.2)

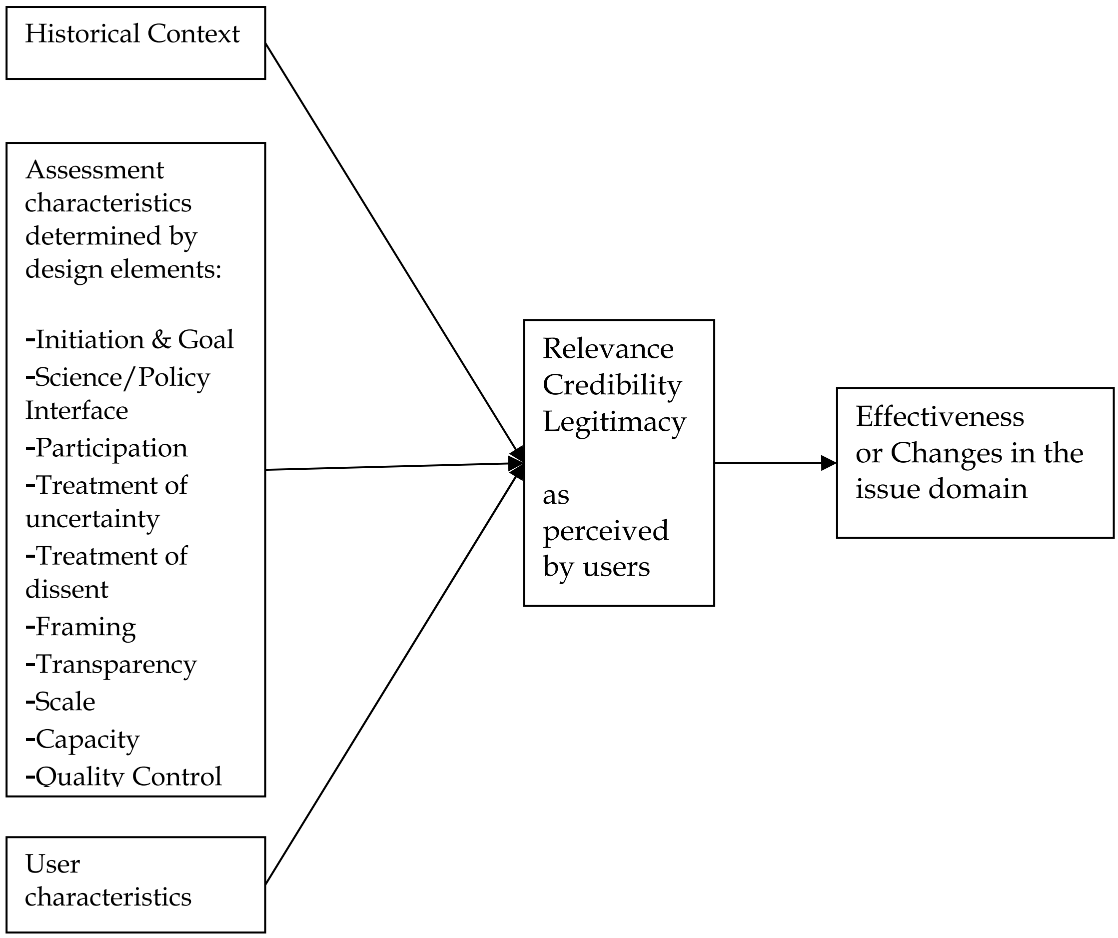

Figure 2.2 The relation between determinants "context" ,"user characteristics" and "assessment characteristics" (influenced by design elements, taking into account user characteristics and context), the different qualities assigned by users to the assessment (credibility, legitimacy and relevance) and effectiveness (adapted from Eckley (2001) and Farrell and Jäger (2005)).

The *Initiation and goal of an assessment* are important because the assessment is to a considerable extent shaped by the origin and initial goals of the assessments. By whom and why was the assessment set up and what is the organisational context of the assessment? The initiation and goal of the assessment will also to a great extent determine the framing and the focus of the assessment. The *Science/policy interface* refers to how the interaction between science and policy is organised. *Participation* refers to which individuals and organisations are involved in the process and how and when they participate. *Treatment of uncertainty* and *Treatment of dissent* refer to how uncertainty is being managed and how different and opposing insights are dealt with. *Framing* is the process of limiting the scope of an (environmental) problem under consideration, choosing what sorts of knowledge and actions are relevant. Framing determines what should be the appropriate data, analytical methods and indicators needed and the direction of solutions involved (Keating and Farrell, 1998). The framing of the problem also determines who are the people involved in e.g. scientific assessment processes, ideas about the "stakes" involved and the appropriate policy process to be followed. (Farrell et al., 2001) *Scale* refers to the specific spatial or temporal boundary level in which an assessment is framed. *Capacity* is the ability of relevant groups, to meaningfully engage and participate in an assessment including necessary skills, financial resources. *Quality control* is the process used to ensure the substantive material contained in the assessment report agrees with underlying data and analysis, as agreed to by competent experts. *Transparency* means that interested observers can readily see into an assessment process and judge for themselves the data, methods, and decisions used in the process (See Farrell et al., 2005).

2.3.3 Overview

The GEA framework is a useful framework to study the impacts of assessments and the way how credibility, legitimacy and salience of assessments are achieved. First, it acknowledges both scientific and policy-needs with regard to the usefulness of assessments. Second, the presentation of different design elements helps to identify the elements that constitute assessments characteristics. Third, it acknowledges that not only the assessment characteristics play a role but that characteristic of users and the context are of importance as well. In short it offers a straightforward way to study scientific work in policy processes, while acknowledging the complex dynamics of science, policy and society.

2.4 A new framework relating boundary work to effectiveness of assessments

Because the objective of this thesis is to contribute to the understanding of the processes at the interface between science and policy in shaping assessment frameworks and assessment processes, a framework for analysis is needed that provides a detailed focus on the science policy interface.

The GEA provides a useful a framework for describing the different pathways that lead to “effective” assessments in terms of credibility, legitimacy and salience of the assessment to different audiences. Also it shows which design elements play a role in shaping these assessments. However it does not provide a detailed focus on the science policy interface. The GEA-framework presents the design of the science-policy interface as only one of the assessment design elements. However, that makes it difficult to study what processes at the science-policy interface influence e.g. other design elements like management of uncertainty and dissent. It also may lead to overlooking the fact that other design elements such as participation and the treatment of uncertainty and dissent together *constitute* the science policy interface. Thus, it is more useful to use the GEA-framework *as a whole* to study the science policy-interface. In order to focus on the processes at the science policy interface that shape assessments, the concept of the science-policy interface needs to be operationalised further. It has to be operationalised in such a way that it guides the exploration of the way how processes at the science policy interface e.g. define the scope and framing of the assessments, facilitate participation, uncertainty management and treatment of dissent.

The concept of boundary work offers anchors to operationalise the science policy interface. As described in section 2.2, boundary work leads to a division of labour between science and policy. Halffman (2003) provides a terminology to describe this division of labour in more concrete detail. Halffman distinguishes three forms in which the division of labour can be observed: Texts, Objects and People. *Boundary Texts* (or language or discourse) imply spoken and written texts in which scientists and policy makers distinguish between science and policy and define their respective roles. *Boundary Objects* refer to the tools that actors use, e.g. computer models, concepts or measuring standards. *Boundary People* refer to networks of scientists and policy makers or individual people who through their position or actions mark a boundary between science and policy. Together, texts, objects and people form the boundary configuration between science and policy. This boundary configuration is constructed throughout various stages of the communication process between science and policy within the context of a particular policy issue.

GEA publications pay attention to boundary negotiation as well. Guston et al. (2000) focus on so called "boundary organizations". These boundary organizations "adhere to distinct lines of accountability to both science and politics, facilitate the transfer of usable knowledge between science and policy and give both policy makers and scientists the opportunity to construct the boundary between their domains. Environmental assessments can be seen as boundary organizations." (Farrell et al., 2005). However, the GEA publications do not show systematically how this concept has been applied to particular cases in practice. Jäger and Farrell (2005) suggest that future research could focus on the role of boundary organizations and of institutions playing boundary-like roles in environmental assessments. With this thesis I intend to contribute this. However, rather than using the term "boundary organization" I prefer the use of the concept of "boundary work" as introduced by Halffman (2003) and described above. One reason is that from the GEA publications it does not become completely clear what boundary organizations are. Are environmental assessments boundary organizations themselves or do boundary organizations "do" environmental assessments? A more important reason is that the term "boundary work" reflects the dynamics in the science policy interface. Halffman (2003) offers anchors for looking at what happens at the science- policy interface in detail by introducing a kind of "checklist" (texts, objects, people) to study e.g. what kind of discourse, what kind of common concepts and which different roles people do apply. This helps to make the processes at the science policy interface more concrete.

The combination of the framework for analysis of effective assessments as defined in the GEA-project and the operationalisation of the concept of the science policy interface in terms of boundary work offers the possibility to develop a powerful new framework

Figure 2.3 shows how I combine the GEA-framework for considering effectiveness as defined in the GEA-project with the concepts of boundary work into a new framework in order to be able to focus on the science-policy interface.

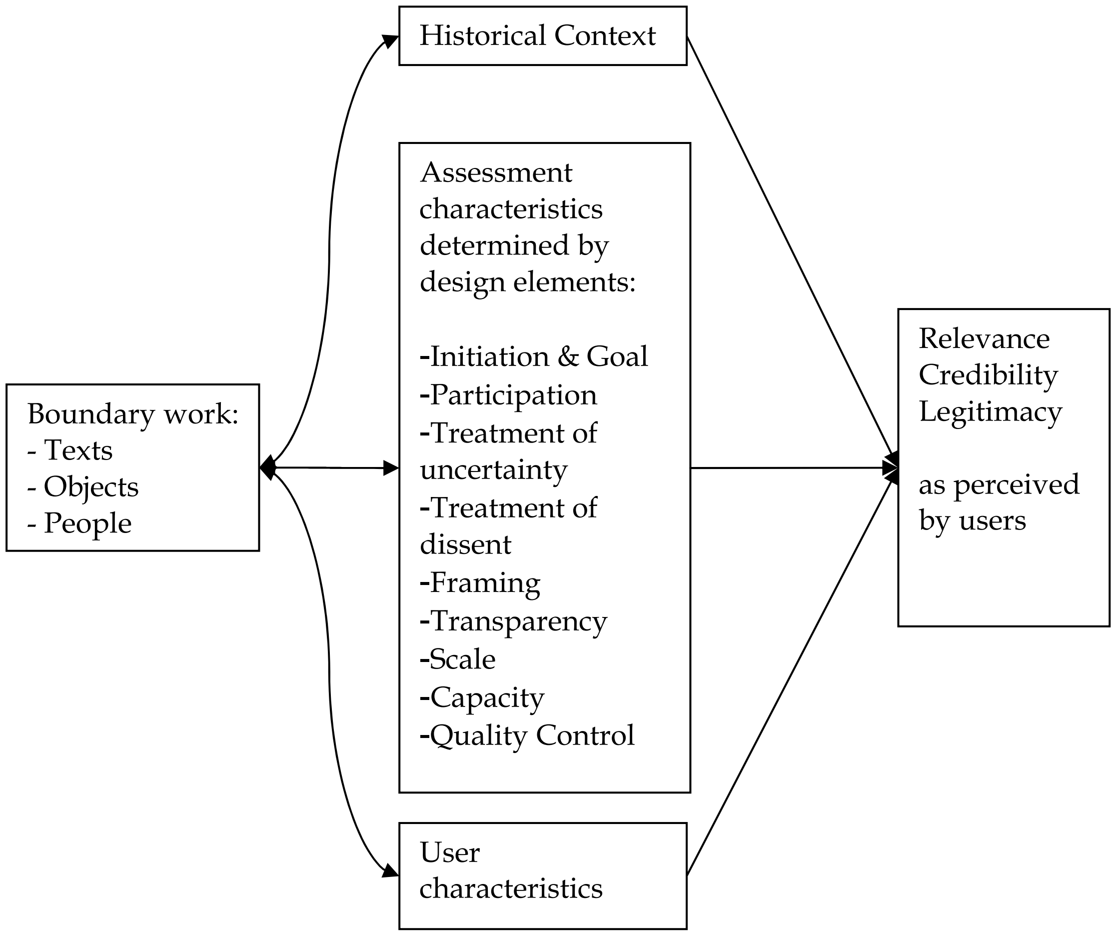

Figure 2.3 A framework relating boundary work in the science-policy interface (in terms of texts, objects and people) to credibility, legitimacy and relevance of assessments, taking historical context and user characteristics into account in the design (Initiation and goal, Participation, Treatment of Uncertainty, Treatment of Dissent, Framing, Transparency, Scale, Capacity and Quality control). Based on Eckley et al. (2001), Farrell and Jäger (2005) and Halffman (2003).

The new framework adapts the GEA framework in such a way that it does not present the science-policy interface as being only one of the design elements of an assessment. Instead it approaches the science policy interface as the site where boundary work and co-production of science and policy take place. It describes boundary work in terms of texts, objects and people. Texts, objects and people describe the way how boundary work shapes the various design elements initiation and goal, participation; treatment of uncertainty, treatment of dissent, framing, transparency, scale, capacity; and quality control. The framework presents assessment characteristics as the practical result of the design. Another change compared to the GEA framework is that the term *relevance* instead of *salience* is used. Salience implies relevance, but also being important, noticeable, eye-catching or prominent (compare the French word saillant). It is thus a much richer and broader term than relevance. However, the word salience is a term that does not give most people a first intuitive idea about what the term would mean, so the more common term relevance is used.

The new framework will help to address research questions in this thesis: how participants in different settings of air quality policy making in Europe divide and co-ordinate work between science and policy and how this division of work shapes the design of these assessment processes and enhance credibility, legitimacy and relevance of the assessments.

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Chapter 3 Moving boundaries in Transboundary Air Pollution: Co-production of science and policy under the Convention on Long-range Transboundary Air Pollution

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Abstract

This article focuses on the science-policy interaction in international negotiations in the context of the United Nations Economic Commission for Europe's Convention for Long-range Transboundary Air Pollution (CLRTAP). It addresses the question how participants in the assessment process divide and co-ordinate work between science and policy and how this enhances *credibility, legitimacy* and *relevance* with multiple audiences. For this purpose the article combines an analytical framework to approach effectiveness of scientific assessment in policy making, with the notion of *boundary work* and *co-production* of science and policy. The article argues that knowledge produced within the CLRTAP process and the institutional setting in which this knowledge production takes place cannot be separated from each other. Furthermore credibility, legitimacy and relevance are to a large extent determined by boundary work in an early stage of the process. At the same time boundary work has to take place continuously in order keep the assessment process credible, legitimate and relevant for new audiences. The application of a combined framework for analysing credibility, legitimacy and relevance *and* for analysing boundary work turns out to be helpful in describing in detail what happens in practice at the science-policy interface. In particular it helps to address the question of the way participants in the assessment process divide and co-ordinate work, how this shapes design elements and how this enhances credibility legitimacy and relevance of an assessment.

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3.1 Introduction

In the field of policy making for air quality in Europe a long tradition exists in using scientific information to support negotiations and decisions (e.g. Hordijk, 1991; Gough et al., 1998; Tuinstra et al., 1999; Castells and Ravetz, 2001; Eckley, 2002; Sundqvist et al., 2002; Lidskog and Sundqvist, 2004). This article focuses on assessment processes in air quality policy making in Europe. Assessment processes are intensive communication processes between scientists and policy makers, that aim at integrating knowledge from different scientific disciplines e.g. economy, soil-science, ecology, meteorology and other knowledge sources in such a way that it provides useful information for decision making (e.g. Farrell et al., 2001). Assessment processes are embedded in a variety of institutional settings, within which scientists, decision makers and other stakeholders communicate to define relevant questions for analysis, mobilize certain kinds of experts and expertise, and interpret findings in particular ways (Farrell et al., 2001).

Various notions of the relationship between science and policy are of significance for current questions and debates with regard to the role of science in public policy. What demands have to be made on the communication process between scientists and policy makers in order to create assessments that indeed provide useful information to decision making? When are assessments considered to be useful? How can scientists maintain their credibility when they engage in policy issues? These are actual questions which are of concern at various levels of the science and policy domain. At the same time social science research has shown that a one-directional linear relationship between science and policy in which science provides objective “answers” for policy is an illusion (see e.g. Jasanoff and Wynne, 1998). What counts as an “answer” depends on how the problem is framed in the first place. Scientific knowledge is not independent from cultural factors, society and policy. Furthermore, increased scientific knowledge raises new questions or can make decisions even more difficult (e.g. Rayner, 2006). In this particular case we focus on how participants in an assessment process within the context of air quality policy making in Europe divide and co-ordinate work between science and policy and how this enhances credibility, legitimacy and relevance of assessments with multiple audiences. The article addresses the role of science-policy interactions in shaping assessment frameworks and assessment processes.

The analysis in this article builds further upon the concept of effectiveness as developed in the Global Environmental Assessment (GEA) project (Farrell et al., 2001; Farrell and Jäger, 2005; Mitchell et al., 2006). This concept considers effectiveness as an emerging property based on three qualities that participants and users attribute to an assessment: *credibility, legitimacy* and *relevance*[7]. These qualities are co-determined by the characteristics of the assessment itself, the characteristics of the users of the assessment and the context in which the assessment takes place. In this article we refer further to this framework for considering effectiveness as "the GEA-framework". We adapt the GEA framework and take it further, connecting it to the concept of "boundary work" between science and policy.

Our starting point is that it is not easy to draw a sharp line between scientific and policy making activities in an assessment process. Neither can scientists' or policy makers' roles as actors in such processes always be precisely defined. Negotiation takes place about the identity of practices (e.g. "science" and "policy") and actors (e.g. "scientists" and "policy makers") and their collaboration. This practice of maintaining and withdrawing boundaries between science and policy, shaping and reshaping the science-policy interface has been referred to as "boundary work" (cf. Jasanoff, 1990; Gieryn, 1995; Halffman, 2003).

In this article we combine the features of the GEA framework with the notion of boundary work into a framework for analysis which adds to the literature because it has a special focus on the science-policy interface. This helps us to improve our understanding of co-production of science and policy: the simultaneous development of the problem framing, division of labour between science and policy, the assessment framework and the policy framework.

The empirical data for this article come from the science-policy interplay in the negotiations within the framework of the United Nations Economic Commission for Europe's (UN-ECE) Convention for Long-range Transboundary Air Pollution (CLRTAP). CLRTAP is a well known case for scholars exploring the role of science in policy making (see e.g. Gough et al., 1998; Grünfeld, 1999; Tuinstra et al., 1999; Bäckstrand, 2001; Castells and Ravetz, 2001; Eckley, 2002; Sundqvist et al., 2002; Farrell and Keating, 2005; VanDeveer, 2005). It is an inviting case to study boundary work and co-production. Not only because scientific information has been playing an important role in the negotiations, but also because policymakers and scientists have been dividing work in various ways on various occasions and also change roles regularly (see e.g. Eckley Selin, 2005). This offers anchors for lessons for other policy areas. The analysis in this article is based on (1) the study of official documents and reports of meetings of various bodies operating in the science-policy interface within the Convention as well as informal documents; (2) interviews with delegates, chairmen of working groups, and scientists involved in the process, as well as interviews with

[7] In the original GEA publications "salience" is used instead of the term "relevance". Salience implies relevance, but also being important, noticeable, eye-catching or prominent (compare the French word *saillant*). It is thus a much richer and broader term than relevance. However, the word salience does not give most (non-native English speaking) people a first intuitive idea about what the term would mean, so we prefer to use the more common term relevance

scientists and civil servants who were not directly involved but followed the process from a distance; and (3) observations in official meetings of CLRTAP-bodies as well as observations of working processes and informal meetings of involved scientific institutes.

The next section presents our framework for analysis. Section 3.3 presents the history of the interaction between science and policy within CLRTAP. Section 3.4 applies the framework to explore the case. The final section draws conclusions and points to wider implications of the study for other policy areas.

3.2 The role of boundary work in shaping assessment processes. A framework for analysis

3.2.1 Introduction

In this section we describe how we combine the framework for analysis of effectiveness as defined in the GEA-project with the theoretical concepts of boundary work and co-production in order to help us focus on the science-policy interface. In the original GEA framework the science-policy interface is one of the design elements of an assessment. However, our starting point is that the design of the science-policy interface determines other design elements of assessments like e.g. participation, treatment of uncertainty, and treatment of dissent. The ways by which participation, treatment of uncertainty and treatment of dissent are organized are inherently part of the science-policy interface. We are interested in what happens at the science-policy interface and how this shapes the design of the assessment. The concept of boundary work helps us to examine the science-policy interface further. Therefore, for the purpose of this article, we will not handle the science-policy interface as being one of the design elements of an assessment (as in the original GEA-framework), but we approach it as the site where boundary work and co-production of science and policy take place. Section 3.2.2 introduces the original GEA framework in more detail and section 3.2.3 introduces the notion of boundary work.

3.2.2 The GEA framework

The GEA framework (Figure 3.1) starts from the view that assessments are first of all communication processes (Farrell et al., 2005; Clark et al., 2006). The framework acknowledges that it is not really possible to define effectiveness, because effectiveness relates to the achievement of goals, and goals of various participants in the assessment differ among each other. No single, objective measure of effectiveness has been or can be established. This means that many ways to assess effectiveness exist, rather than none. The GEA framework focuses on impacts of assessments. Assessments that are considered to have impact also have three important qualities attributed to them by various audiences: (scientific) credibility, (political) legitimacy and (policy) relevance (Clark et al., 2006). *Credibility* refers to the scientific and technical believability of the assessment to a defined user of that assessment. *Legitimacy* refers to the political acceptability or perceived fairness to a user of that assessment. *Relevance* refers to the extent to which an assessment and its results address the particular concerns of the user (Farrell et al., 2005). It is important to note that no straightforward way exists to ensure relevance, credibility and legitimacy of an assessment. These assessment qualities are partly dependent on each other and there are complementarities and trade offs between them. Furthermore, relevance, credibility and legitimacy, are viewed differently by different actors, and therefore it will not be possible to design an assessment process in such a way that it will be relevant, credible and legitimate for all actors in the same way. Assessments are having impact only if they are sufficiently relevant, credible and legitimate according to multiple audiences simultaneously (Cash et al., 2002).

The credibility, legitimacy and relevance of an assessment are not only determined by the characteristics of the assessment itself. Eckley (2001) distinguishes two other ultimate determinants next to the assessment characteristics: the historical context of the assessment and the characteristics of the users of the assessment. The context of an assessment includes the position of the issue on the policy agenda and the characteristics of the issue domain itself. User characteristics are, for example, their interest in the issue, resources to engage in the assessment or to use the results, and the openness to different sources of advice (Eckley, 2001).

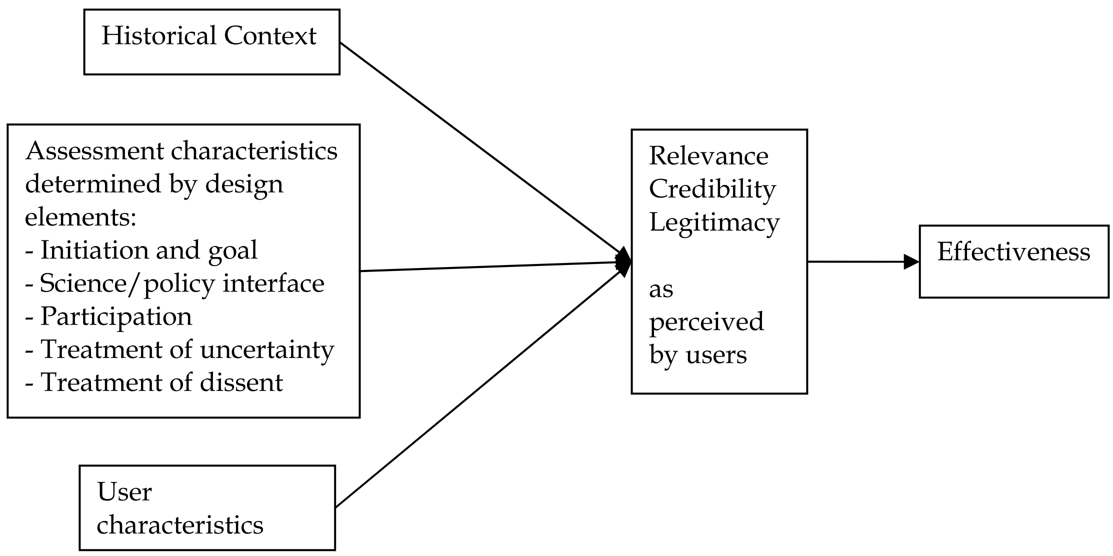

Figure 3.1 The relation between determinants "context" ,"user characteristics" and "assessment characteristics" (influenced by design elements, taking into account user characteristics and context and influencing assessment characteristics), the different qualities assigned by users to the assessment (credibility, legitimacy and relevance) and effectiveness (adapted from Eckley (2001) and Farrell and Jäger (2005)).

Relevance, credibility and legitimacy with multiple users, can be enhanced if context and user characteristics are taken into account in the *design* of the assessment. Assessment characteristics are the practical result of the design, taking into account the context and user characteristics. The effectiveness of an assessment is thus a function of the interaction between assessment characteristics and the social and political context within which the assessment is conducted (Mitchell et al., 1998).

Farrell et al. (2005) identify various design elements, of which they view as the most important in assessing the effectiveness of assessments: 1) Initiation and Goal; 2) Science/Policy Interface; 3) Participation; 4) Treatment of uncertainty; and 5) Treatment of Dissent.

The *Initiation and goal* of an assessment are important because the assessment is to a considerable extent shaped by the origin and initial goals of the assessments: by whom and why the assessment was set up and what the organisational context of the assessment is. The initiation and goal of the assessment will also to a great extent determine the framing and the focus of the assessment. The *Science/policy interface* refers to the organisation of the interaction between science and policy. *Participation* refers to individuals and organisations involved in the process and how and when they participate. *Treatment of uncertainty* and *Treatment of dissent* refer to how uncertainty is being managed and how different and opposing insights are being dealt with. Other design elements mentioned in GEA publications are scale, framing, capacity, quality control and transparency (Farrell et al., 2005).

3.2.3. Boundary work at the science-policy interface

As pointed out above, our starting point is that the way various design elements are organized in an assessment is inherently part of the science-policy interface. Therefore the science-policy interface is central in our framework (see Figure 3.2). The concept of boundary work helps us to further examine the science-policy interface.

An important aspect of science-policy communication in assessment processes is the negotiation of the division of labour between science and policy. Negotiation takes place about the identity of practices (e.g. “science” and “policy”) and actors (e.g. “scientists” and “policy makers”) and their collaboration. This process of maintaining and redrawing boundaries between science and policy, shaping and reshaping the science-policy interface has been referred to as “boundary work” (cf Jasanoff, 1990; Gieryn, 1995; Guston, 2001; Halffman, 2003). Note that this fluid image of the dynamics of the science-policy interface is different from an image in which a “gap” between science and policy exists that has to be bridged, or a manifest boundary between science and policy that has to be crossed. The negotiation and establishment of the boundary itself and the definition of science and policy is part of the science-policy communication process. It is through boundary work that boundaries are made “real”.

Boundary work has two sides: a *demarcation* side separating two actions or groups by defining distinguishing characteristics and prescribing proper ways of behaviour for e.g. science and policy, and a *co-ordination* side defining how the two relate to each other by defining proper mutual conditions of exchange (Halffman, 2003). Boundary work leads to a division of labour between science and policy.

Halffman (2003) provides a vocabulary to describe this division of labour which is useful for our study. Halffman distinguishes three forms in which the division of labour can be embodied: *Texts*, *Objects* and *People*. *Boundary Texts (or language or discourse)* refer to the way actors distinguish between science and policy in spoken and written text and define respective roles. *Boundary Objects* refer to the tools that actors use, e.g. computer models, concepts or measuring standards, for knowledge production in a policy setting. *Boundary People* refer to networks of "scientists" and "policy" makers that are formed or individual people who through their position or actions mark a boundary between science and policy. Together, texts, objects and people form the boundary configuration between science and policy which is constructed throughout various stages of the communication process between science and policy within the context of a particular issue domain.

For the purpose of our study, we are not only interested in the division of labour or boundaries between science and policy and how they are negotiated. We are also interested in the knowledge eventually produced once the boundaries are drawn, or, for that matter, in the changes in knowledge needs and knowledge production when the boundaries change again. We are therefore interested in the question how boundary work shapes assessment processes. In the science-policy interface, through boundary work, knowledge is produced, and simultaneously the social structures to produce this knowledge are being organised and the scene is being set for the framing of the policy problem and the organization of dealing with the problem. Within the field of science studies, the term *co-production* is used to refer to processes that connect the production of knowledge with the organization of policy-making (Shackley and Wynne, 1995; Jasanoff, 1996; Miller, 2001; Jasanoff, 2004). Boundary work, the division of labour between science and policy, is part of this process.

3.2.4 Relating boundary work to the design of assessments in order to study co-production

For our analysis of the UN-ECE CLRTAP assessment processes we combine the framework for analysis of effectiveness as defined in the GEA-project with the theoretical concepts of boundary work and co-production. We will describe boundary work in terms of *texts, objects* and *people*. We will address the question how boundary work did enhance credibility, legitimacy and relevance of assessments in the CLRTAP process. More precisely: *how did participants in the assessment process divide and co-ordinate work between science and policy; how did this shape design elements (initiation and goal, participation, treatment of uncertainty, treatment of dissent) of the assessment and how did this enhance credibility, legitimacy and relevance with multiple audiences* (See Figure 3.2). By addressing these questions we aim to improve our understanding of co-production within CLRTAP: the simultaneous development of the problem framing, division of labour between science and policy, the assessment framework and the policy framework.

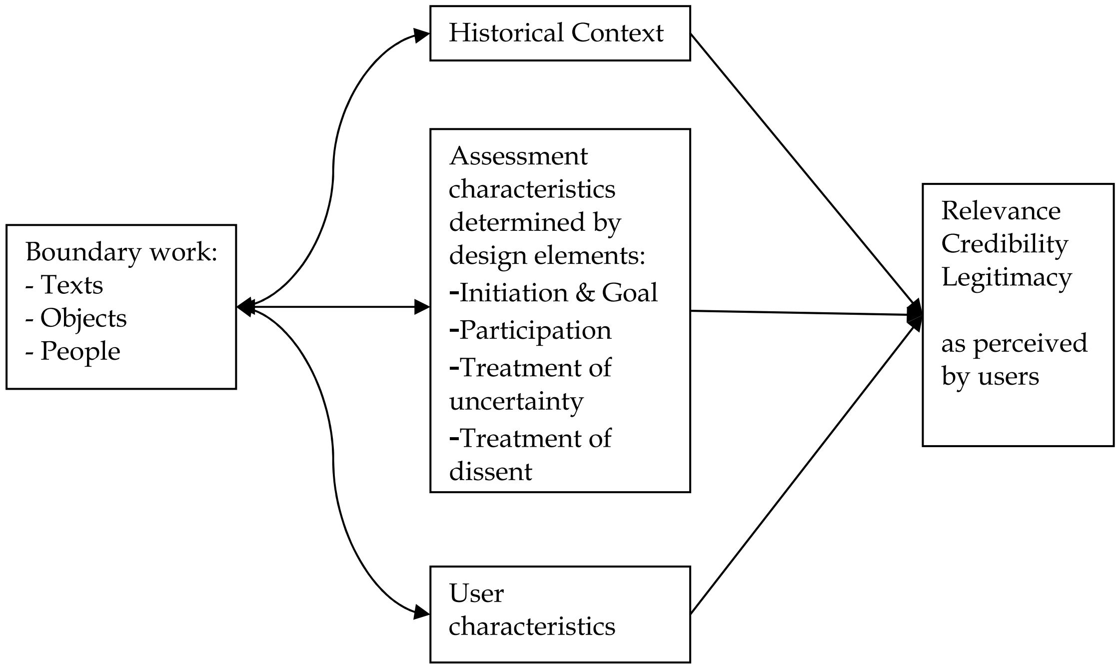

Figure 3.2 A framework relating boundary work in the science-policy interface (in terms of texts, objects and people) to credibility, legitimacy and relevance of assessments, taking historical context and user characteristics into account in the design (Initiation and goal, Participation, Treatment of Uncertainty, Treatment of Dissent). Based on Eckley et al. (2001), Farrell and Jäger (2005) and Halffman (2003).

3.3 A brief history of CLRTAP: from flat-rate and single compounds to multi-pollutant multi-effect protocols

This section gives a short overview of the history of science-policy interaction in the development of protocols and assessment frameworks in the context of CLRTAP. More detailed accounts of the history of CLRTAP and the environmental concerns, negotiation processes and scientific programmes that preceded it are given by e.g. Tuinstra et al. (1999), Grünfeld (1999), Bäckstrand (2001), Wettestad (2002), VanDeveer (2004), Menz and Seip (2004) and Sliggers and Kakebeeke (2004).

The history of CLRTAP goes back to the 1972 Stockholm Declaration of the United Nations Conference on the Human Environment which states that nations have "the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction" (UNCHE, 1972) and to the 1975 Helsinki Conference on Security and Cooperation in Europe which calls (inter alia) for cooperation to control air pollution and its effects, including long-range transport of air pollutants (CSCE, 1975).

In 1979, thirty countries adopted the Convention on Long-range Transboundary Air Pollution, establishing a general forum for international negotiations on emission reductions of air pollutants. Since then, within the framework of the Convention eight protocols have been negotiated. In 1983, the parties signed a protocol for financing joint activities of the Cooperative Program for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) in order to establish a framework for the monitoring and scientific assessment of air pollution. The next three protocols addressed concrete obligations for reducing emissions of SO_2 (1985), NO_x (1988) and VOC (1991). These three protocols used simple 'flat rate' concepts for determining the international distribution of reduction obligations, i.e., all countries agreed to reduce their emissions by the same percentage, or stabilize in the case of NO_x, relative to a base year.

The Second Sulphur protocol (the "Oslo protocol"), signed in 1994, was the first protocol which established a quantitative relation between the agreed emission reduction targets and environmental impacts. The reduction obligations of this protocol were based on the results of modelled linkages between the SO_2-emissions of each country and the exposure of different ecosystems, taking into account the sensitivity of such ecosystems to acidification, as well as atmospheric transport, and the regional differences in costs of emission reduction. In 1999 a multi-pollutant/multi-effect protocol (the "Gothenburg protocol") was signed which covered SO_2, NO_x, NH_3, and non-methane volatile organic compounds (NM-VOC) and aims at simultaneous reduction of acidification, eutrophication and ground-level ozone[8].

Early frameworks for science-policy interaction

Already the first protocol (establishing EMEP) was a protocol which explicitly addressed scientific co-operation and organized scientific input for the convention. Already from the beginning CLRTAP established a dual framework of scientific assessment and political interaction, which gradually changed and still functions. A number of Working Groups and Task Forces regularly reviewed and review the scientific information in the fields of environmental impacts of air pollution, atmospheric dispersion, emission

[8] In 1998 protocols on heavy metals and on persistent organic pollutants were signed as well in the framework of CLRTAP, but these protocols will not be discussed in this article.

control technologies, economic evaluation methods, and integration methodologies. Also, databases with quality-controlled information about the country-specific situations are prepared. The outcome of this scientific assessment process is submitted to the Working Group on Strategies, whose members are civil servants, representing governments of parties to the Convention, which uses this information to assist its negotiations on further emission control agreements.

Towards the use of "critical loads" and an "effect-based" approach and the principle of cost-effectiveness

Towards the end of the first round of protocols, which imposed uniform reduction requirements to all Parties, the so-called "critical loads" approach emerged as an overarching concept for the scientific assessment. "Critical loads" have been defined as the maximum exposure to one or several pollutants, at which according to current knowledge no harmful effects occur to sensitive ecosystems in the long run (Nilsson and Grennfelt, 1988). With fully quantified ecological damage functions for the relevant ecosystems not being available, critical loads were simplifications representing a steady-state 'no-damage' threshold. This simplification turned out to make the information collected by the Working Group on Effects operational for practical strategy development. Operationalisation of the concept of critical loads for practical strategy development was further facilitated by the acceptance of the 'cost-effectiveness' principle, used to identify options for emission reduction leading to an efficient reduction in critical load exceedance. This combined approach developed into the major concept for determining the environmental ambition level and negotiating the resulting emission reduction requirements for the Oslo Protocol, in 1994. Several authors have pointed to the importance of the development of the critical loads approach as a common basis for air pollution control both within the policy and science communities. Patt (1999) and Bäckstrand (2001, p. 125-144) respectively give a detailed description and discourse analysis of the emergence of the concept. Bäckstrand notes that its success is attributed to its capacity "to create a meaningful framework and to invoke common sense notions of adequate approaches to environmental policy-making" (Bäckstrand, 2001, p 136). According to Grennfelt and Hov (2005) it was a driving force for scientific research and policy development, and provided a "common concept" for science and policy (Grennfelt and Hov, 2005, p 4.). Also Sundqvist et al. (2002) note that the critical loads concept has served as an important tool for connecting scientific knowledge to policy-making. They show that the concept has different meanings for the involved actors, which include heterogeneous views on the boundary between science and policy.

A joint effort for data collection

The application of the critical loads concept and of the cost-effectiveness principle went together with a major coordinated effort of data collection by the parties to the Convention in the fields of energy, emissions, technology, control costs, atmospheric dispersion and mapping of critical loads.

The collection and mapping of data on critical loads was and still is coordinated by the Coordinating Center for Effects (CCE) which was established at the National Institute for Public Health and Environment (RIVM) in the Netherlands. In all parties to the Convention national focal centres were established to provide this data. A unified methodology was developed in order to ensure international harmonization. A mapping manual, workshops with specialists from all over Europe, and training sessions contributed to the harmonization. The mapping work was an iterative process and the maps were regularly updated (Hettelingh et al., 1995).

Atmospheric dispersion was assessed by models developed by EMEP with its meteorological synthesizing centres and chemical coordinating centres in Oslo and Moscow. The models of EMEP relate deposition in grid-cells, which are squares laid over a map of Europe, to emissions in each European country. The EMEP models employ official emission inventories provided by national governments and evaluated by the Task Force on Emission Inventories, use actual meteorological data and are being continuously verified against measurements (Lövblad et al., 2004).

The use of Integrated Assessment Models
To combine and analyze this complex information in a consistent and efficient way, computer simulation models (Integrated Assessment Models (IAMs)) were used by the Task Force on Integrated Assessment Modelling (TFIAM) of CLRTAP. This Task Force was established in 1986 before the actual negotiations on the Oslo Protocol began. Its task was to "to explore the possibilities to develop an analytical framework for a regional cost-benefit and cost-effectiveness analysis of concerted policies to control air pollution" (UN-ECE, 1986). At that moment several models at various institutes in Europe were under development.

TFIAM discussed and compared various model approaches and made suggestions for further development. For the actual preparations of the negotiations three different models, ASAM (Imperial College, London), CASM (Stockholm Environment Institute (SEI), York) and RAINS (International Institute for Applied Systems Analysis, Laxenburg, Austria) were used in the Task Force to calculate different scenarios with different policy options, which were presented to the Working Group on Strategies. As far as possible the models were run with the same data, provided by the parties to the Convention. The output of the model runs took the form of levels of emission reductions per country and the resulting percentages of ecosystems protected. The final calculations that served as a starting point for the negotiations of the second sulphur protocol, the Oslo protocol (1994) were done by the RAINS model, developed at IIASA. The other models were being used for comparison[9].

After the Oslo-protocol IAMs became more complex because acidification was linked to eutrophication and ozone exposure in an effort to explore cost-effective solutions (Maas et al., 2004). The modelling groups decided on a division of work: Imperial College would specialise on agriculture, SEI on traffic and IIASA on energy and overall integration in the RAINS model. RAINS became the central model in the support of the Gothenburg protocol negotiations because it was the first to incorporate ozone formation in the modelling framework (Maas et al., 2004).

Currently IIASA functions as the Conventions' Centre for Integrated Assessment Modelling (CIAM). The modelling work is extended to health risks of air pollution on the local level (particulate matter). Currently also links with the hemispheric transport of pollutants as well as interactions with climate change are considered (see for more details Maas et al., 2004).

A success story in science-policy interaction?
Generally the science-policy interaction which took place within CLRTAP has been described as a success story both by policy makers, scientists and analysts. As factors for this success are mentioned: the direct link between relevant science and policy preparation; multiple scenarios that present policy options; accessibility of science to all participants; cost effectiveness analysis rather than cost benefit analysis; strong personal networks, a science-policy network with a strong memory (Hordijk, 1991; Tuinstra et al., 1999; Maas et al., 2004). Others describe the important role of the framework offered for countries to provide their own data, the consensus based way of working (Gough et al., 1998) and the ability to adapt scientific and policy frameworks to developments in science and policy (Eckley, 2002). Farrell and Keating (2005) emphasise flexibility in matching the commitments in the increasingly complex effects-based protocols to the use of the RAINS model. Also they mention trust in the decision making processes within which the assessments were conducted.

Apparently the assessment process in CLRTAP has had an impact in various ways and has been has been sufficiently credible, legitimate and relevant in the eyes of various significant audiences. In the next section we will use the analytical framework as developed in section 3.2 to examine the process at the science-policy interface in CLRTAP in more detail in order to find out how science-policy interactions shaped the assessment framework and assessment process and to what extent and how the division and co-ordination of work between participants enhanced credibility, legitimacy and relevance with multiple audiences.

[9] See for a detailed account of the various scenarios calculated, the models used and the development of approaches, Tuinstra et al. (1999), Gough et al. (1998), Castells and Ravetz (2001) and Maas et al. (2004).

3.4 Exploring boundary work within CLRTAP

3.4.1 Introduction

We analyse[10] the role of boundary work (becoming visible in texts, objects and people) in shaping each design element as identified in the GEA framework (initiation and goal, participation, treatment of uncertainty, treatment of dissent) (See Table 3.1).

Each sub-section addresses one of the design elements of the assessment process and by presenting examples analyses in what way credibility, legitimacy and relevance have been enhanced in the assessment process. The examples presented are meant to be illustrative and not to be exhaustive. The analysis focuses mostly on the period between the early 80s and early 90s with some excursions to developments in recent years.

3.4.2 Initiation and goal

3.4.2.1 Early Boundary work at the level of international diplomacy

If we look at the beginnings of CLRTAP and the years preceding its negotiations we see that co-operation between scientists and policy makers started slowly. The scientific community identified the issue of air pollution first, formulated the first framing of the problem and together with environmental NGOs had put the issue on the agenda. See also e.g. Björkbom (1999) and Ågren and White (2004). The 1975 Helsinki conference had framed the air pollution issue as a policy problem for international co-operation (CSCE, 1975). The scientific work of Norwegian and OECD programmes eventually developed the issue further which paved the way for the establishment of EMEP and subsequently CLRTAP. See also e.g. Grünfeld (1999), Bäckstrand (2001) and VanDeveer (2005).

[10] Unless mentioned differently in the text, the analysis in this chapter is based on (1) the study of official documents and reports of meetings of various bodies operating in the science-policy interface within the Convention as well as informal documents; (2) observations in official meetings of CLRTAP-bodies as well as observations of working processes and informal meetings of involved scientific institutes. (3) interviews with the following persons: Christer Ågren (Swedish NGO Secretariat on Acid Rain), Keith Bull (UN-ECE , Geneva), Peter Builtjes (Netherlands Organisation for Applied Scientific Research, TNO), Peringe Grennfelt (IVL, Sweden), Martina Havlikova (Member of Task Force on Integrated Assessment Modelling, TFIAM and Steering Group CAFE, Country Expert Czech Republic), Jean-Paul Hettelingh (Director Coordinating Center for Effects, CCE), Leen Hordijk (former RAINS project leader and chairman TFIAM), Willem Kakebeeke (Negotiator Dutch delegation), Rob Maas (chairman TFIAM), Ton Schneider (former chairman EMEP Steering Body), Said Zwerver (former head Air Division, Ministry of Environment, the Netherlands) and André Zuber (European Commission DG Environment, CAFE secretariat).

Texts

Actors involved in the early days, both those who represent scientific institutes and those who were involved at the ministries indicate that in the early days of EMEP civil servants were not really interested in EMEP: why would scientific information be needed for policy making? Thus in the early days those civil servants made a clear demarcation between what in their view belonged to their responsibility and what to the responsibility of scientists. Only after the Stockholm Ministerial Conference on Acidification of the Environment (1982) civil servants became more open: political legitimacy paved the way for policy relevance of EMEP work. See also Kakebeeke et al. (2004).

Table 3.1 Overview of examples of boundary work (in terms of texts, objects and people) in relation to credibility (C), legitimacy (L) and relevance (R) within different categories of design elements. This table does not intend to be complete. Rather it presents some illustrative examples.

Design elements		***Boundary work (Texts, Objects, People) and Credibility (C), Legitimacy (L) and Relevance (R)***
Category	*Example*	
Initiation and goal	Early boundary work at the level of international diplomacy	Texts: Discussions on the role of science *L,R*
		Objects: Acceptance source receptor matrices *C,L*
		People: Changing Participation in the EMEP steering body *L*
	Early boundary work at the level of model development	Texts: Need for a "menu" instead of a "recipe" in scenario analysis *L*
		Objects: RAINS model *C,R*
		People: Role of individuals *C,L, R*
Participation	Participation in an international data collection effort	Objects: Standardization of data: whose task and responsibility? *C,L*
	Participation in TFIAM	People: Two way role of participants *C,L*
Uncertainties	Dealing with uncertainties in models and measurements	Texts: RAINS review 2004 *C,L*
		Objects: Lowest common dominator *C,L,R*
		Objects: Using multiple models *C,L*
Dissent	Dealing with dissent through consensus documents and consensus concepts	Texts: TFIAM as consensus documents *C,L*
		Objects: The 60% gap closure concept *L,R*

Objects

The importance of role of scientific data evolved slowly and step by step: the first step was to make sure that an operational Europe-wide (both East and West) monitoring network for measuring air pollutants was available. Estimation of emissions was a next step. Tables were used showing the extent to which regions were sources or receptors of pollutants. Those came from so called source-receptor matrices produced and used by the EMEP models. The matrices in fact show which countries are responsible for pollution in certain other countries. The use of those "blame-matrices" was only received very hesitantly in the policy community (Schneider and Schneider, 2004). The availability of those matrices would limit space for manoeuvring in the negotiations. Policy makers felt that the existing division of labour between science and policy was being contested. The blame-matrices were therefore carefully introduced by the EMEP steering body at first only to enable a general idea of the air quality situation in Europe. Slowly EMEP proceeded in building credibility and legitimacy in a continuous interaction with policy-makers, negotiating and establishing areas of responsibility for the policy domain and the science domain and establishing the position of the source-receptor matrices.

<u>People</u>
After the adoption of CLRTAP in 1979 it took quite a long time to negotiate the protocol for EMEP (1983).The context of the Cold War period made that the exchange of data on e.g. emissions of pollutants or activity data of industry was a sensitive political issue. Not only the parties had to build up trust in each other's data, also ways had to be found to present and share information which could be strategically sensitive, like the location or specifications of power plants (Nordberg et al., 2004). The setting of the discussion on "scientific" issues initially was highly "political". The Steering Body of EMEP itself at the beginning was established as a political body like other bodies under the UN-ECE. This meant that permanent representatives of member countries of the UN-ECE were present at the EMEP Steering Body meetings in Geneva, though mostly scientific and organisational issues were being discussed. However it was decided after a few meetings that the Steering Body was a scientific body, in which no permanent national policy representatives were needed (Kakebeeke et al., 2004). That was a clear action of demarcation and co-ordination between science and policy. It implied the redefinition of the identity of an official body with consequences for who belong to that group and who do not. This proceeded in quite a smooth way as it followed from the actual content of the discussion and work of the group, as such enhancing the legitimacy of the work of the group.

3.4.2.2 Early boundary work at the level of model development
An eye catching feature in the science-policy interface in CLRTAP is the prominent role of the RAINS-model which was one of the integrated assessment models used in the process. It is interesting to have a look at the way members of the RAINS team took efforts to enhance the relevance of the model for policy makers and how policy makers reacted to this.

Texts

The UN-ECE seemed to be the appropriate forum for the RAINS model to be used, because it involved countries from Eastern and Western Europe and the host institution of RAINS, IIASA, was a product of East-West collaboration itself. This East-West background of IIASA has been important for the legitimacy of the use of the model, as it was not representing the view of one country (Hordijk, 1991; Farrell and Keating, 2005). In 1983 the RAINS team paid a fist visit to the Air Pollution Unit of the UN-ECE to present the possibilities of the RAINS-approach. However, initially UN-ECE was not very enthusiastic, because they could not quite see what it would add to the EMEP models and because IIASA was neither party to the convention nor a recognised NGO in air pollution issues. However, some members of the ECE Secretariat with a vision on an integrated approach on air pollution, i.e. integrating environmental and economic aspects of mitigation of air pollution, liked the model and recommended to expand RAINS with a sub-model that could address economic issues. In 1985 representatives of UN-ECE attended a workshop at IIASA which simultaneously served as a scientific review of the RAINS model and a workshop for policy makers. It gave the attending policy makers an impression of the scientific credibility of RAINS. It also gave them the possibility to do suggestions to improve the possibilities of the model to use it as a tool in policy making. See also Farrell and Keating (2005) and VanDeveer (2005). Several suggestions were made by policy makers at that workshop which were later implemented in RAINS. This proved to be crucial for the relevance of RAINS later in the CLRTAP process. One of the recommendations was to improve flexibility of the model: negotiators of countries present at the workshop pointed out that "politicians need a menu to choose from: not a recipe". In other words: they made clear that policy makers need to be able to make the decisions themselves. The possibility of choice and sufficient alternatives for negotiations were important for the negotiators. Thus at the workshop policy makers specified what they saw as their own role and what the role of scientists should be. This paved the way for an enhanced legitimacy of use of the models in the process.

Objects

In the same year UN-ECE arranged a channel in which RAINS could be used. The Group of Experts on Costs and Benefit Analysis, at its second meeting in 1985 considered that "the IIASA model (i.e. RAINS) could provide a useful tool for cost-effectiveness analysis" (UN-ECE, 1985). In 1986 the Task Force on Integrated Assessment Modelling (TFIAM) was established in which RAINS and other models would be used more and more intensely in the years that followed. In this process the models were tuned towards the needs of the negotiators. The further development of the models became policy-driven, but at the same time stayed in touch with latest scientific developments, thus carefully balancing between policy relevance and scientific credibility of the model. See for more discussions of the RAINS model as a boundary object Sundqvist et al. (2002) and Cash et al. (2003).

People

In this early phase halfway the 80s, certain individual people, through their specific qualities, interventions and visions, have been playing an important boundary role. The representatives of for example the RAINS-team, but also the EMEP-modelling team and the developers of the critical load concept, enhanced simultaneously credibility, legitimacy and relevance through the way they could present the possibilities of the model, and the way they could take policy considerations into account in new model formulations and concepts. See also VanDeveer (2005). At the same time, by doing so they played an important role to provide new framings for the policy problem and enhance discussions and negotiations. In other words, they did not merely communicate "science results to policy makers" or played the role of scientists offering a listening ear to policy makers, but played an important role in the policy problem framing itself. As important was the ability of those individuals to maintain credibility in the science domain.
Also individual policy makers, negotiators in country delegations like the Dutch delegation mentioned above, and civil servants like the people in the UN-ECE secretariat mentioned above, played an important role. Not only did they identify specific tasks for the modelling groups, like asking for menus instead of recipes, but also they enhanced model development by being visionary about possible applications like proposing to add economic modelling to make the modelling work more integrated. Thus, they played an important role in enhancing legitimacy and relevance of the models.

3.4.3 Participation

3.4.3.1 Participation in an international data collection effort

The number of science and policy actors participating in the CLRTAP process is large. One of the reasons for this large network of actors is the need for data collection. The signatories of CLRTAP are responsible for the provision of the data from their own country. Data are needed for e.g. the calculation of atmospheric transport of pollutants in the EMEP models, for emission inventories and for the compilation of maps with critical loads, all of which are integrated in the modelling work performed by TFIAM. Furthermore, emission inventories are needed for the monitoring of compliance. The fact that countries are responsible for their own data contributes to the credibility and legitimacy of the modelling work of EMEP and TFIAM.

Objects

One element of the data collection within CLRTAP is the standardisation of the methods to collect data. Different methods for data collection exist, within CLRTAP certain choices have been made and agreement has been reached on the appropriate way of collecting data in this setting. See for example the EMEP/CORINAIR Guidebook (EEA, 2001) and the UN-ECE Mapping Manual (UN-ECE, 2004). This included several compromises and simplifications. Gough et al. (1998) describe how data used in CLRTAP are in fact “negotiated” data, (see also Tuinstra et al. (1999)). Whether those data belong to the science domain or the policy domain depends at what stage of the process of the data collection they are considered. The development of the EMEP/CORINAIR Guidebook is seen as a scientific activity. The collection of the data is in most countries done by national scientific institutions. However, at the moment that the data are used as an input for model calculation within TFIAM, the modellers label the datasets as being the input from the countries, and thus being political. In the modellers view the international data collection effort, which facilitates participation of all the countries, enhances rather the legitimacy than the credibility of their work.

3.4.3.2 Participation in TFIAM

Participation in the TFIAM gradually changed during the years of its existence. First it was a forum for different modelling groups for comparing and discussing different modelling approaches. As such, it functioned as a kind of peer review group for experts mainly meant to build credibility for the modelling work. Important for this credibility was, that in the beginning not one but various models were used to perform similar calculations. Currently, RAINS is the main model used. The main goal of TFIAM is now to advice on the development of RAINS.

<u>People</u>

Over the years, TFIAM has grown and the current participants do not necessarily represent groups that contribute to the modelling work in TFIAM itself. Rather they represent countries. Participants have the possibility to give presentations of national modelling efforts and in this way TFIAM remains being the forum to be kept up to date with the latest modelling developments. However the active participation of the different national experts also serves another goal. It can avoid a feeling among the parties that the RAINS model and what happens in TFIAM is a “black box” on which the countries can have no control. Credibility and legitimacy of RAINS increases when representatives of countries have the capacity to know what is going on and can explain the “black box” to their governments. In doing so, the participants in TFIAM play a boundary role. At the same time it should be noted that some countries within UN-ECE are more active than others and some countries do feel more involved than others. Castells and Nijkamp (1998) elaborated on this point for southern European countries. See for more details about the participation of eastern European countries Botcheva (1998) and VanDeveer (2005).

3.4.4 Treatment of uncertainty

3.4.4.1 Dealing with uncertainties in models and measurements

Texts

Above we discussed the current strategy of TFIAM in avoiding problems in terms of credibility now that only one model is the central model. A more recent example of securing credibility is the RAINS review in 2004. This review was conducted for the purpose of the use of RAINS by the European Commission in preparation of a thematic Strategy on Air Pollution which was published in 2005. An international team of reviewers scrutinized the different modules of the model and also addressed uncertainties. In the report which the reviewers presented to the European Commission they concluded that the RAINS model was sufficiently credible to be used as a tool in policy making (Grennfelt et al., 2004). For ensuring credibility and legitimacy in the CLRTAP process however, another step had to be taken. In January 2005 a special session of TFIAM was organised to discuss the results of the review and present the RAINS features once again. This meeting resulted in a consensus report that was added to the "collective memory" of CLRTAP and as such serves as a boundary text.

Objects

Within the CLRTAP assessment framework a pragmatic approach to dealing with uncertainties was taken. For example in the modelling and monitoring work, EMEP adapted the level of uncertainty management to the "lowest common denominator". More important than to keep the highest standards of sophistication, was to keep all parties "on board". This meant in practice performing calculations which were possible also on less advanced computers (i.e. simple models) and setting measuring standards which were also achievable with equipment in Eastern Europe. See also Farrell and Keating (2005) and VanDeveer (2005). The "lowest common denominator standard" served a boundary role between satisfying scientific standards and standards meeting policy needs. Thus there was a trade off between credibility and legitimacy which however was seen as very important for consensus and continuation.

Objects

As mentioned above it is important to note, that initially more integrated assessment models were considered in TFIAM than RAINS only. Current literature frequently overlooks this fact. The availability of three integrated assessment models in CLRTAP played an important role in building credibility and legitimacy (Gough et al., 1998; Tuinstra et al., 1999). Jäger (1998) also notes that using multiple models with different approaches to the problem in integrated assessment processes can enhance the credibility and legitimacy of the processes. Currently there are two tendencies within TFIAM with regard to the use of multiple models. On the one hand there is the tendency to avoid "duplication of work" and to stress the consensus already reached on the use of certain models, like the atmospheric model EMEP, and the integrated assessment model RAINS. But there is another tendency as well: the development of ensemble modelling, meaning comparing and analysing the outcomes of different models in calculating the same phenomena. This is being done for atmospheric modules in the context of the work for the European Commission. For economic modules this is not being done, apparently because approaches in various models available are comparable. Apparently in different scientific domains there are different views of the amount of possible approaches to a problem.

3.4.5 Treatment of dissent

3.4.5.1 Dealing with dissent through consensus documents and common concepts

Texts

Above we already discussed the importance of boundary texts to establish credibility for the use of the RAINS model. In general in CLRTAP a very important role can be attributed to the reports produced of the various meetings of working groups and task forces. Those are consensus documents which form together the collective memory of CLRTAP and ensure credibility and, even more, legitimacy of the work. That the content of those reports and the procedure leading to the report have not been going undisputed can be illustrated by the correspondence between the TFIAM chairman and one of the UK-delegates in TFIAM about a crucial meeting in 1993 in the last phase of the preparations for the Oslo Protocol. The UK-delegate challenged the wording in the document with regard to the use of one model and also expressed his concern about the way the document was produced, not reflecting the discussions, but only final conclusions. This led to an in-depth reaction of the chairman in which he not only discussed the procedure leading to the report and the actual wording but in which he also sketched what he considered the appropriate way of working of the TFIAM and the supposed behaviour of delegates. He argued that the TFIAM was not a political body but a scientific one and that the way of operating of the UK-delegation was not according to that. He also argued that participants in the TFIAM, different than in WGS, are in fact not considered “delegates”, but experts not representing any country. This example illustrates the apparent importance of the TFIAM reports as boundary texts and the reactions which are provoked when challenging those texts.

Objects

At the 7th meeting of WGS in 1992 the gap-closure concept was proposed by the Norwegian delegation. This concept implies that “the gap” between current levels of atmospheric deposition and the critical loads is “closed”. The introduction of the concept happened when it was difficult to reach an agreement on the kind of targets for ecological protection to base further negotiations on. It was accepted by all parties and was a break through in both the science and policy processes in the preparatory phase of the Oslo

Protocol. It was appealing because it formed a direct link to critical loads in each grid-cell, but also implied a kind of equity, because the percentage for closing the gap is the same everywhere. The concept offered a way to deal with dissent and formed an important point of departure to reach consensus. Finally, the negotiators chose a "60% gap-closure" scenario as a starting point for the negotiations, in the 10th WGS meeting 1993. Interestingly, the concept was proposed in the WGS, which is a "political" body under the Convention, and not, which one could have expected, in TFIAM, which is a "scientific" body. However, it was a scientific expert in the Norwegian delegation who made the proposal, a meteorologist. This is also interesting because this kind of concept one would expect from an economist rather than form a meteorologist. Looking more closely, we see that though in this meeting the Norwegian expert acted being part of the Norwegian delegation, in the Convention he also played an important role in the scientific work of the Convention, because he was the director of the institute that developed the EMEP model.

3.5 Discussion and conclusions

The main question of this article was what role science-policy interaction or boundary work plays in shaping assessment frameworks and assessment processes within CLRTAP. Also we asked how participants in the CLRTAP assessment process divided and co-ordinated work between science and policy and how this enhanced *credibility, legitimacy* and *relevance* with multiple audiences. The application of a combined framework for analysing credibility, legitimacy and relevance and for analysing boundary work turned out to be helpful in describing in detail what happens in practice at the science-policy interface. Overall, we can conclude from the analysis of the CLRTAP assessment process that credibility, legitimacy and relevance to many audiences were enhanced by boundary work in an early stage of the process. Furthermore we conclude that boundary work in the assessment processes in CLRTAP has been enhanced because a forum was provided, where boundaries between science and policy could be discussed. This enabled a successful division and co-ordination of work between science and policy which made the boundaries in the CLRTAP process to remain quite stable through the years. Finally we conclude that this has as implication that new boundary work is needed when knowledge produced in the context of CLRTAP is used in other policy contexts or when new participants enter the arena.

Boundary Work and design elements in the CLRTAP assessment process

Our analysis of *initiation and goal* of the CLRTAP and the *participation* in CLRTAP shows that what is considered to be credible, legitimate and relevant is established already in an early stage of the development of the assessment framework. It is therefore important for actors to be involved in boundary work in an early stage of the communication process. As we have seen, for example members of the RAINS team were very early participants in boundary work. The features of the RAINS model currently match quite well with what is considered relevant in the CLRTAP community. RAINS, the policy development within CLRTAP and the set up of the data collection structure developed in parallel and influenced the course of each others developments. RAINS clearly participated in setting the scene and could therefore enhance its own relevance. An example of this is the development of the use of the concept of Critical Loads, which could not have been operationalised without integrated assessment models such as RAINS and the other models used.

With regard to dealing with *uncertainties* we also see that this requires careful boundary work balancing between credibility and legitimacy eventually leading to operational structures and effective assessment procedures. The example of the use of models and monitoring equipment which could be managed and applied in all countries ("lowest common denominator standard") shows that this balance is of crucial importance for continuation of e.g. the monitoring programme without which this programme never could have been effective for policy making. The context determines what kind and degree of uncertainty is being accepted. With regard to dealing with *dissent* we see that the consensus structure of CLRTAP, which is inherent to the way of working of the UN-ECE, offers ample room for boundary work. We showed this in the example of the production of consensus reports but also in the creation of the "gap-closure" concept which was inspired by the necessity to come to consensus in the policy debate. The concept served a boundary role by being relevant through its ample timing and in fitting both to the policy concerns and the framing of the scientific debate at that stage. In its context it was both to multiple audiences politically legitimate because of its equity dimension, and scientifically credible because of its connection to environmental effects.

Co-production of science and policy in CLRTAP

The assessment process within CLRTAP is an interesting illustration of co-production of air quality science and air quality policy in Europe. The development of e.g. the concept of critical loads as an important example has been described elsewhere (Bäckstrand, 2001; Sundqvist, 2002; Grennfelt and Hov, 2005). The example we highlight here is the establishment of the TFIAM and the iterations between the RAINS team and national negotiators and UN-ECE staff. They played an important role in the further development of the model. Simultaneously the possibilities of the model itself inspired the extension of the then existing CLRTAP structure with another expert body

(TFIAM) and the involvement of other integrated assessment models. In the course of the years the importance of TFIAM increased in CLRTAP because of its integrative function in the science-policy network. The air pollution problem was further framed through the tools and data available. The fact that TFIAM with the help of integrated assessment models was able to produce quantitative scenarios for alternative policy decisions helped the CLRTAP process to move forward.

In this light it is not surprising that the outcome of the RAINS-review in 2004 has been positive in the sense that it judged the model "sufficiently credible to be used as a tool in policy making" (Grennfelt et al., 2004). The terms of reference for the review have been developed in the same social structure and knowledge frame as the structure and knowledge frame that developed RAINS. The evaluation was positive because it focused on exactly those issues that were found important by the community which themselves had produced the Integrated Assessment framework of which RAINS is a part. It is important to note that this does not mean that the review has not been scientifically correct or credible itself. Rather it shows that apparently certain boundaries are quite stable. What is expected from science within policy, and the conviction on what in this setting is credible, legitimate and relevant, has remained quite stable within the issue domain of air pollution in Europe.

Moving boundaries
An issue strongly related to co-production and the importance of being involved in an early stage in boundary work is transparency of the process. For "newcomers" transparency may be lower than for those involved from the beginning. The language used and rules of the game might have developed and established slowly to a kind of jargon within the existing group. What will be discussed, what is relevant, what is the "language" spoken and what scientific disciplines are supposed to be relevant has already been established. Together with the knowledge and the framing of the problem also the social structure for providing that knowledge has been established. For those who were not participants in this co-production process this might be difficult to change. Ideas about what should be the tasks of science and policy might differ for newcomers, because they were not involved in the early boundary work. Thus they will have a different view on credibility and legitimacy because they will have different expectations of scientific and policy actors, and on relevance, because they have a different problem frame of the assessment.

This observation regarding different views on credibility, legitimacy and relevance is of importance because 1) it has consequences for the transferability of the knowledge produced within CLRTAP into other arenas and 2) when more newcomers enter the arena, credibility, legitimacy and relevance will be contested and new boundary work and adaptation of knowledge frames is needed. Currently, knowledge produced within the

CLRTAP arena, indeed is being transposed into another arena, namely the work of the European Commission. It will be interesting to follow this development further. See also for an analysis of the linkages between CLRTAP and European Commission work Wettestad (2002) and Selin and VanDeveer (2003).

The actors within CLRTAP are currently confronted with the question of the future and the relevance of the Convention itself. What role can it play next to EU policies? What is the relevance of the air pollution issue in broader contexts? Is it possible to extend to other issue areas like climate change and hemispheric (global) transport of air pollutants? What is the effect of increased stakeholder involvement? All those issues ask for new stages of boundary work. Early boundary work is important but boundaries also move when new participants enter and when contexts change. It shows that views on credibility, legitimacy and relevance of assessments change with moving boundaries and that credibility, legitimacy and relevance have to be worked upon continuously.

These are also important lessons for other policy areas. In environmental policy, be it on a local, European, or global scale, problem framing and knowledge-needs are not a given. We see this for instance in the field of climate change. In time, problem framings of the climate issue have been ranging from a carbon dioxide problem and an energy problem to an issue of global environmental change in general and sustainable development to an issue of human security and adaptation. These differing problem frames imply differing knowledge-needs. Other scales apply and other data and computer models are relevant then previously. In addition, not only knowledge-needs change, also the relevant policy settings, timing of decisions and relevant stakeholders to deal with the issue change. On a regional scale, the climate issue in e.g. the Netherlands is now being connected to spatial planning and water policies (Kabat et al., 2005). This involves other policy makers and stakeholders then those previously involved, like e.g. water boards and regional planning authorities. It also asks for a different kind of scientific expertise and application of scientific knowledge. Adapting assessment designs, careful communication between the various relevant policy and science actors and awareness of the context will enhance credibility, legitimacy and relevance of assessments in such changing settings.

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Chapter 4 The Preparation of the European Thematic Strategy on Air Pollution: what happened at the interface between science and policy?

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Abstract

In 2005 the European Commission launched a Thematic Strategy on Air Pollution for the European Union. We use an analytical framework that relates credibility, legitimacy and relevance of assessments to "boundary work" between science and policy to address the following questions: (1) What kind of integrated assessment process was established in preparation of this strategy?; (2) How did experts, stakeholders and policy makers in the process distribute roles and tasks between them and how did they work together; and (3) To what extent and in what way did this constitute credibility, legitimacy and relevance of the assessment? We conclude that the European Commission took great effort to organise a transparent assessment process based on scientific knowledge and with extensive involvement of stakeholders and Member States. Bilateral consultations, review of integrated assessment models, and transparency and documentation of integrated assessment work played an important role in enhancing credibility, legitimacy and relevance for the Member States. On the other hand, some industry groups were not satisfied with their role as stakeholders instead of experts. Also the real place and time where decisions take place (and thus where the integrated assessment work is relevant) was considered by some stakeholders not to be transparent in the CAFE process. This view was particularly held by stakeholders from industry.

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4.1 Introduction

In September 2005 the European Commission presented a thematic strategy on air pollution as one of seven environmental strategies. The launch of the thematic strategy on air pollution has been preceded by a long and extensive preparation phase in which a large number of experts, stakeholders and Member States have been involved. This happened in the context of the so called Clean Air for Europe Programme (CAFE) which was started by the European Commission in 2001.

Scenario analysis and scientific assessment studies have been an important part of this CAFE programme. After the launch of the thematic strategy on air pollution, the CAFE Programme will still be in place, amongst others to prepare for the review and revision of the European National Emissions Ceilings (NEC) directive.

In this paper we will examine the role of experts and stakeholders in the formulation of the thematic strategy on air pollution and how they worked together with policy makers. In short: we will examine the so called integrated assessment process in the CAFE programme. Integrated assessment processes are intensive communication processes between scientists, policy makers and other stakeholders during which knowledge from various scientific disciplines and other knowledge sources is integrated in such a way that it provides useful information for decision making (Farrell et al., 2001). But what is it that makes this information useful? Three qualities appear to be of importance. Assessments should be of sufficient credibility (the scientific and technical credibility of the assessment), legitimacy (the political acceptability or perceived fairness to a user of that assessment) and relevance (addressing the particular concerns of the user) to multiple audiences (see Farrell and Jäger (2005) and Cash et al., 2002).

Also the division of tasks between experts, stakeholders and policy makers involved in the process plays a role. It is not self-evident from the outset who qualifies as expert, who as stakeholder and who as policy makers. In an earlier study, we concluded that one success factor in the assessment processes in the Convention on Long-range Transboundary Air Pollution of the United Nations Economic Commission for Europe (UNECE-CLRTAP) was the existence of a forum where boundaries between science and policy could be discussed (Tuinstra et al., 2006). This is in line with insights from Jasanoff (1990) about the role of expert advisory bodies. Therefore it is interesting to analyse the way how experts, stakeholders and policy-makers in the process distribute roles and tasks between them and how they work together. This process is known in the literature as “boundary work” (Jasanoff 1990, Halffman 2003).

The questions that we address in this paper are the following (1) What kind of integrated assessment process was established in preparation of the 2005 EU Thematic Strategy on Air Pollution?; (2) how did experts, stakeholders and policy-makers in the process distribute roles and tasks between them and how did they work together; and (3) to what extent and in what way did this co-operation constitute credibility, legitimacy and relevance of the assessment?

To answer these questions we will analyse the process in the CAFE Programme which led to the EU Thematic Strategy on Air Pollution (for short further referred to as the Thematic Strategy). The CAFE Programme is part of the first phase of the development of any European legislative policy proposal: the so called "expert phase". This phase is normally followed by a second phase, the negotiation phase and a third phase, the implementation phase (See Box 4.1 for an elaboration of the procedure of the development of European legislation). The expert phase is the phase during which the Commission collects information to develop a policy proposal. This is also the phase in which scientific expertise plays the most important role. For this reason we focus on the expert phase. Officially this is not yet the stage of political deliberation and negotiation, like in the negotiation phase and the implementation phase of regular legislation. Nevertheless, because we are interested in the way experts, stakeholders and policy-makers distribute roles and tasks we will also pay attention to forms of political deliberation and negotiation in the expert phase.

Box 4.1 The development of a directive or regulation in the EU under the co-decision procedure.

In the co-decision procedure under which environmental legislation in the EU resides, the European Commission has the right of initiative for new legislation proposals. In the expert phase the European Commission (in this case DG Environment) collects technical and other information needed to develop the proposal. A draft policy proposal is subsequently discussed with other Directorates (services) of the European Commission (the so-called inter-services consultation) before being published as an official proposal of the European Commission. In the next phase, the negotiation phase, the European Parliament (representing the European citizens) discusses the proposal and sends its opinion to the Commission. The Commission then sends the amended proposal to the Council of the European Union. The Council of the European Union represents the governments of the EU member states in different configurations. For example in the case of an environmental proposal, the Environment Council, existing of all Environmental Ministers of the EU Member States will discuss the proposal but the Transport and Energy Council will do so as well. If the Council agrees to the amended proposal the legislation can be adopted and the next phase, the implementation phase follows. Otherwise, the proposal will go back to Parliament and Commission for new amendments.

It should be noted that the development of the Thematic Strategy on Air Pollution follows a slightly different procedure. The strategy will not be negotiated in Council and Parliament. The Council will formulate Council conclusions and the Parliament adopt a resolution. Resulting legislative acts like a new air qualitative directive will be decided upon following the normal co-decision procedure.

Source: European Communities, 2003.

A framework for analysis

For our analysis of the science policy interface in the CAFE programme we use the integrated framework introduced by Tuinstra et al. (2006). This is a framework for the analysis of the role of boundary work in enhancing the credibility, legitimacy and relevance of scientific assessment in policy processes. This framework integrates two concepts. First, it uses the concept of effectiveness of assessment processes in terms of credibility, legitimacy and relevance[11] as described by Farrell et al. (2001) and Farrell and Jäger (2005). Second, it uses a vocabulary to describe boundary work in terms of demarcation and co-ordination between science and policy as provided by Halffman (2003).

In our framework credibility, legitimacy and relevance of an assessment are determined by the assessment characteristics themselves, the historical context of a policy issue, and the characteristics of the users. Assessments are effective only if they are sufficiently relevant, credible and legitimate according to multiple audiences simultaneously (Cash et al., 2002). Relevance, credibility and legitimacy with multiple users, can be enhanced if context and user characteristics are taken into account in the design of the assessment. Assessment characteristics are the practical result of the design, taking into account the context and user characteristics. Important design elements are 1) Initiation and Goal; 2) Participation; 3) Treatment of uncertainty; 4) Treatment of Dissent; 5) Transparency; 6) Framing; 7) Capacity; 8) Scale and 9) Quality Control. These design elements are very much determined by what happens in the science-policy interface: how science and policy demarcate and co-ordinate work. This "boundary work" is constructed throughout various stages of the communication process between science and policy within the context of a particular issue domain.

In short the framework helps to provide insight in the way how participants in the assessment process divide and co-ordinate work between science and policy; how this shapes design elements (initiation and goal, participation, treatment of uncertainty, treatment of dissent, framing and transparency) of the assessment and how this enhances credibility, legitimacy and relevance with multiple audiences.

Figure 4.1 visualises the framework for analysis. See for a more elaborate description of the framework for analysis Tuinstra et al. (2006). The framework is meant to be flexible and for the purpose of this paper we only focus on the design elements initiation and goal participation, treatment of uncertainty, treatment of dissent and transparency.

[11] Farrell et al. (2001) and Farrell and Jäger (2005) use the term "salience" instead of the term "relevance". Salience implies relevance, but also being important, noticeable, eye-catching or prominent (compare the French word *saillant*). It is thus a much richer and broader term than relevance. However, the word salience does not give most (non-native English speaking) people a first intuitive idea about what the term would mean, so I prefer to use the more common term relevance

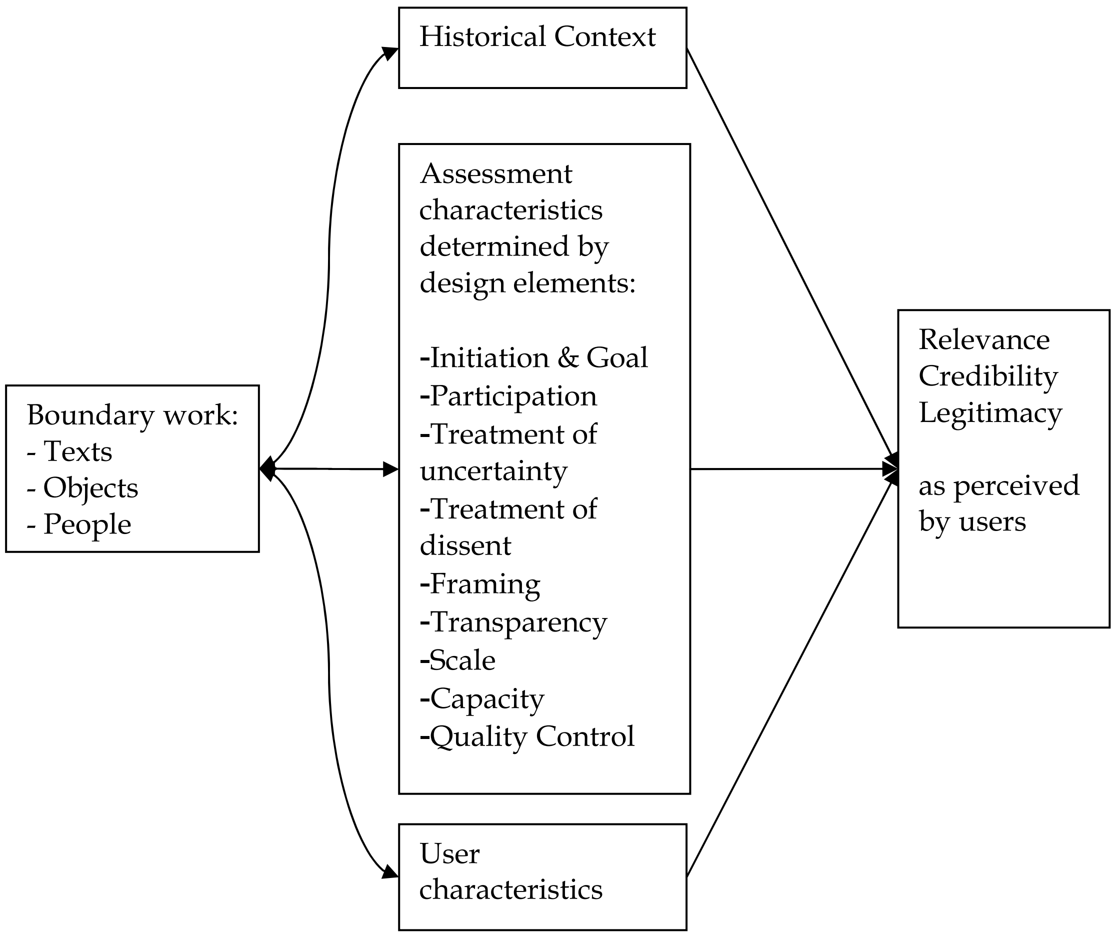

Figure 4.1 A framework relating boundary work between science and policy (in terms of texts, objects and people) to the credibility, legitimacy and relevance of assessments, taking historical context and user characteristics into account in the design (Initiation and goal, Participation, Treatment of Uncertainty, Treatment of Dissent, Framing, Transparency, Scale, Capacity and Quality control). Based on Eckley et al. (2001), Farrell and Jäger (2005), Halffman (2003) and Tuinstra et al. (2006).

The next section gives a short overview of the history of air quality policy in Europe and introduces the role of integrated assessment in the policy processes. In section 4.3 we will apply the framework to analyse the interaction between science and policy in the CAFE process and thus address the research questions 1, 2 and 3. The final section draws conclusions.

4.2 Integrated assessment in EU air pollution policy

This section gives a short overview of the history of science-policy interaction in integrated assessment work in the development of European air pollution policy, with a focus on the development of the 1997 Community Acidification Strategy, the 2001 National Emissions Ceilings (NEC) Directive and the Clean Air for Europe Programme (2001-2005). A more detailed and extensive account of the history of European air pollution policy can be found in e.g. Liefferink (1996), McCormick (1997) and Wettestad (2002).

4.2.1 EU air pollution policy in the nineties

4.2.1.1 Introduction: Two tracks in EU air pollution policy

Up to the early nineties, EU air pollution policy was fragmented. Amann and Lutz (2000) note that air pollution legislation in the European Union traditionally follows a "two track approach". One track focuses on air quality criteria which set limit values for concentration of air pollutants in ambient air (such as e.g. the 1980 Air Quality Directive). The other track focuses on the limitation of emissions of air pollutants of certain sources such as e.g. the 1988 Large Combustion Plants (LCP) Directive, standards for the emission of SO_2, NO_x and particulate matter from large combustion plants and the 1989 Car Emissions Directive. Amann and Lutz (2000) point to the fact that these two tracks of legislation have different but complementary functions. Air quality directives do not address concrete action to achieve the criteria set out but translate objectives of environmental policy as contained in the 1986 Single European Act amended by the 1997 Amsterdam Treaty, such as protection of environment and human health, in measurable criteria. Emission related directives embody key principles of the 1997 Maastricht EU Treaty such as the precautionary principle and preventive action. They are related to the means through which the objectives should be achieved but do not establish formal links to the air quality criteria. Thus, overall EU Air Pollution Policy generally has not been an integrated policy.

4.2.1.2 The Fifth Environmental Action Programme 1993 and the role of integrated assessment

Europe did not provide a more specific interpretation of environmental objectives for air pollution policy before the launch of the 1993 Fifth Environment Action Programme (1993-2000) (5EAP). The 5EAP for the first time[12] links concentration objectives to objectives related to effects. For ecosystems it sets long term objectives for acidification, eutrophication and ozone, implying no exceeding of critical loads[13] and critical levels and suggesting emission reductions for SO_2 and NO_x (Wettestad, 2002). For the protection of health the 5EAP demands the guideline values of the World Health Organization to be become mandatory (Amann and Lutz, 2000).

An increased role for integrated assessment

Up to the early nineties, legislation was mainly based on EU in-house expertise and interaction with e.g. the World Health Organization. An integrated assessment framework and process such as used in the negotiation

[12] With the exception of the 1992 EU Ozone directive which introduced health and vegetation protection thresholds for ozone based on WHO guidelines

[13] A critical load is a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge. (www.unece.org/env/wge/definitions.htm)

processes within the United Nations Economic Commission for Europe (UN-ECE) Convention on Long-range Transboundary Air Pollution (LRTAP) was not in place (see for an account of the integrated assessment process within UN-ECE LRTAP e.g. Gough et al. (1998); Tuinstra et al. (1999); Bäckstrand (2001); Castells and Ravetz (2001) and Tuinstra et al. (2006)). However, the EU participated as one of the parties in the UN-ECE LRTAP framework and could become familiar with the scenario work and data collection in this process. This led to the request of the European Commission to the International Institute for Applied Systems Analysis (IIASA) to prepare a set of emission projections in preparation of the 5EAP and to estimate the long term effects of NO_x and SO_2 with help of the RAINS model[14]. The projections indicated that, under a business-as-usual energy price scenario, critical loads for sulphur and nitrogen inputs would be exceeded over a large area of the EU by 2010 Emission reductions by 2010 of about 35 % (SO_2) and 30% (NO_x) relative to the year 1990 were indicated as necessary to reach the long-term objectives of the 5EAP. The indicated reduction targets were then adopted in the 5EAP in 1993 (Wettestad 2002, p. 72).

4.2.1.3 Strategies for combating acidification and ozone, the National Emissions Ceilings Directive and the role of integrated assessment

In March 1997, the European Commission presented a strategy for combating acidification to attain certain environmental targets in a cost-effective way by the year 2010. These environmental targets were interim targets which on the long term should lead to reach the long-term objectives of the Fifth Environmental Action Programme (5EAP). Later, a similar strategy to reduce ground-level ozone was launched. Those two strategies formed the basis for a directive setting national emissions ceilings for NO_x, SO_2, NH_3 and Volatile Organic Compounds (VOCs), the 2001 National Emissions Ceilings (NEC) directive. The acidification strategy implied furthermore the revision of the LCP-directive. The strategy further implied revising a directive on the sulphur content of liquid fuels.

The role of integrated assessment in the Acidification Strategy

An integrated strategy, connecting measures to environmental benefits, also called for an integrated assessment of the issues. In the remainder of this section we will describe the role of integrated assessment work in the development of the national emission ceilings, starting with the preparations

[14] The Regional Air pollution Information System (RAINS) model, developed and maintained by IIASA was one of the models which had supported the negotiations on the 1994 Oslo Sulphur Protocol (Tuinstra et al., 1999; Tuinstra, et al. 2006). It is a tool for an integrated assessment of multi-pollutant emission control strategies addressing multiple environmental effects including ground-level ozone, acidification and eutrophication. The model combines information on the sources of emissions (e.g., economic development, the present and future structure of emission sources, the potential and costs for controlling emissions) with scientific information about the dispersion of pollutants in the atmosphere including the ozone formation processes. It compares the resulting regional air quality with various indicators of risk at stock (e.g., population, critical loads and critical levels for vegetation, etc.) (Amann et al., 2004). See also http://www.iiasa.ac.at/rains/index.html

for the Acidification Strategy in 1995 and ending with the final work for the NEC-directive.

A first working paper (European Commission, 1995) in preparation of the 1997 Strategy was produced in 1995 by the Commission with assistance of IIASA and AEA T. This paper concluded that even within a 'strict' reduction scenario, depositions would exceed critical loads in significant parts of Europe and that comprehensive and cost-effective solutions were needed (Wettestad, 2002). Therefore, the Council asked the Commission to identify additional measures to enhance the existing policy to a coherent acidification strategy which would lead to no exceedance of critical loads (Wettestad, 2002). In a second working paper in October 1996 the Commission presented, with input from IIASA, several scenarios for SO_2, NO_x and ammonia of which one, the '50% gap closure', scenario was chosen as a basis for further analysis. This scenario aimed at reducing the area of the ecosystems not protected against acidification (i.e. were the critical loads for sulphur and nitrogen were exceeded) with 50% in 2010 compared to 1990. Subsequently IIASA analysed additional scenarios for the Commission, including sensitivity runs for the 50% gap closure scenario and scenarios that accounted for interaction of acidification with strategies to control greenhouse gas emissions, eutrophication and ground-level ozone. These scenarios, including calculations of optimised national emission ceilings were presented in a report to the Commission in December 1996 (Amann et al., 1996), which served as an input for the draft strategy which was presented early 1997.

The role of integrated assessment in the ozone strategy

IIASA also presented input for the ground level ozone strategy under development at the Commission and contributed to the Ozone Position paper developed by a group of experts from the Member States (European Commission, 1999). IIASA analysed alternative principles for defining interim targets and their implications for the distribution of national emission reduction requirements and environmental benefits (Amann et al., 1998a). The EU Ozone strategy was presented in 1999.

The role of integrated assessment in the NEC directive

As the NEC directive had to be based on both environmental targets as formulated in the Acidification Strategy and environmental and health targets as formulated in the Ozone strategy, further scenario analyses by IIASA focused on interaction between the different issues. In 1998 IIASA prepared a report containing analyses for the NEC-directive including optimised national emission ceilings for SO_2, NO_x, NH_3, and VOC (Amann et al., 1998b). These analyses were further fine-tuned in interaction with the Commission and member states and reflected also the ratification of the CLRTAP Oslo protocol by the EC and the adoption of the Directive on liquid fuel in 1998 in accordance with the Acidification Strategy. Finally, in 1999 the European Commission proposed a Directive on National Emission Ceilings (NEC) for

Certain Air Pollutants (COM(99) 125) to limit the negative environmental impacts of acidification and ground-level ozone based on the input of the findings of IIASA's analyses with RAINS. However, the NEC directive, as well as the LCP directive was only adopted in 2001, following long negotiations and debates in Council and Parliament.

4.2.2 The CAFE Programme

4.2.2.1 Introduction

Though the Ozone Strategy and the Acidification Strategy were a first step towards integrated EU legislation with regard to air pollution, still the need was felt that a bigger step should be made. In the 6th Environmental Action Programme (European Parliament and Council, 2002) the European Community voiced the ambition to have a more integrated approach to environmental legislation. Thematic Strategies on several environmental areas were to be developed for streamlining and integrating current legislation. One of those strategies was a strategy on air pollution. The main goal of this strategy was to "achieve levels of air quality that do not give rise to significant negative impacts on and risks to human health and the environment" (European Parliament and Council, 2002). According to the 6th Environmental Action Programme all environmental policy-making must be based on participation and the best available scientific knowledge.

Already in 1998 the Commission had published a discussion paper that looked ahead towards an overall clean air strategy that would include different elements of EU air pollution policy and as such enhance the development of cost-effective solutions. This strategy should be renewed in a five-year policy cycle. This paper was the starting point for the Clean Air for Europe (CAFE) programme. See box 4.2 for the objectives of the CAFE programme.

Box 4.2 Objectives of the CAFE Programme

"Clear Air For Europe will have the general aim of developing a long-term, strategic and integrated policy to protect against the effects of air pollution on human health and the environment. As required by the treaty, the policy will aim at a high level of environmental protection based on the precautionary principle, taking account of the best available scientific and technical data and the costs of benefits of action or lack of action." (European Commission, 2001a)

The specific objectives of CAFE are (CAFE- website, 2005):

1. to develop, collect and validate scientific information relating to the effects of outdoor air pollution, emission inventories, air quality assessment, emission and air quality projections, cost-effectiveness studies and integrated assessment modeling, leading to the development and updating of air quality and deposition objectives and indicators and identification of the measures required to reduce emissions;
2. to support the implementation and review the effectiveness of existing legislation, in particular the air quality daughter directives, the decision on exchange of information, and national emission ceilings as set out in recent legislation, to contribute to the review of international protocols, and to develop new proposals as and when necessary;
3. to ensure that the sector measures that will be needed to achieve air quality and deposition objectives cost-effectively are taken at the relevant level through the development of effective structural links with sectoral policies;
4. to determine an overall, integrated strategy at regular intervals which defines appropriate air quality objectives for the future and cost-effective measures for meeting those objectives;
5. to disseminate widely the technical and policy information arising from implementation of the programme.

Source: http://europa.eu.int/comm/environment/air/cafe/general/objectives.htm

The first integrated clean air strategy was planned to be adopted in 2004. This process was delayed and the Commission presented the Thematic Strategy on Air Pollution in September 2005 (European Commission, 2005).

The 2005 Thematic Strategy on Air Pollution was only the first milestone laying down interim environmental and health objectives to be reached by 2020. In order to achieve those objectives the Commission for the next step works on a proposal of revision of the NEC-directive in 2007. Other foreseen regulation includes the modification of vehicle emission limits proposed in December 2005, legislation on emissions from small-scale combustion plants, on VOC emissions from refuelling of passenger cars and on air emissions from ships (European Commission, 2005).

4.2.2.2 CAFE and the organisation of scientific input

CAFE is developed under the leadership of a permanent secretariat housed within the Directorate General Environment of the European Commission. A Steering Group composed of about 80 representatives of the Member States, the European Parliament, stakeholders and relevant international organisations meet two or three times a year (see for an overview of the members of the Steering Group Appendix A). Its mandate is to advise the Commission on the strategic direction of the programme rather than on technical issues. It does not have any formal decision making power. Nor have any of the other groups in the CAFE programme described below. The mandate of the CAFE programme is the development of policy guidance not of the policies itself. As explained above, the CAFE programme is situated in the first phase of the development of a European legislative policy proposal: the so called "expert phase". This is the phase during which the Commission collects information to develop a policy proposal.

Furthermore according to the readers guide to the CAFE work plan "the policy guidance to emerge from CAFE needs to be based on an integrated assessment of a wide range of policy alternatives, taking account of all relevant scientific, technical and political information" (European Commission, 2001b, p.4).

The CAFE programme organizes its input and integrated assessment work through a Technical Analysis Group (TAG) and a Working Group on Target Setting and Policy (WG TSP)[15].

The Technical Analysis Group (TAG) consists of members of the CAFE secretariat and consultants carrying out technical analysis under specific contracts. The group consists of about 10-20 people and meets once a year. The technical analysis in CAFE is mainly carried out under these different contracts and therefore the role of the consultants is very important. The TAG is mainly set up to enable the consultants to co-ordinate between themselves. (See for an overview of the members of the TAG Appendix A).
Contracts include (1) Development of a Baseline Scenario and an Integrated Assessment Model (International Institute for Applied Systems Analysis, Austria; Meteorological Institute, Norway; National Technical University Athens, Greece) (2) Further Development and Application of the TREMOVE Transport Model (Catholic University, Leuven, Belgium) (3) Cost-Benefit Analysis of the CAFE Programme (AEA Technology) and (4) Review of Health Effects (World Health Organisation, Geneva). The consultants present the progress of their work in the Steering Group meetings. All contractors had been involved in analysis for the European Commission already in earlier policy development processes. Besides the RAINS model, which was used for the preparation of the NEC-directive, the Acidification Strategy and the Ozone Strategy by DG Environment, the PRIMES energy model of the National Technical University Athens and the TREMOVE model had been used in earlier analyses for DG Transport and Energy.

[15] Furthermore an ad hoc Working Group on Particulate Matter was set up. Particulate Matter is one of the major issues to be dealt with under the CAFE programme. Due to the specific concerns with regard to this pollutant it was decided to establish a working group to assist the Commission with updated "solid expert information and views". CAFE also includes an ad hoc Working Group on Implementation with the task to support harmonised implementation of the air quality frame work directive, its daughter directives and the directive on national emission ceilings by Member States.

The purpose of the Working Group on Target Setting and Policy (WG TSP) was to assist the Commission in the development of air quality related targets for the protection of human health and the environment. It also gave advice on issues related to policies and measures. It advised on the Integrated Assessment Modelling work and the choice of scenarios. The WG TSP met about four times a year and according to the membership list has 18 members: 13 country representatives of Environmental Ministries or Environmental Protection Agencies, a representative of the UN-ECE and four environmental and business Non Governmental Organisations. (See for an overview of the members of the WG TSP Appendix A). This group has now closed and been succeeded by the NEC Policy Instrument group.

4.2.2.3 Divisions of roles and tasks

The integrated assessment process described in this paper took place in the "expert phase" of EU legislation development and therefore the Commission services, personified by the CAFE secretariat take the lead. The organization of the process can be seen as being top-down. The civil servants of the Commission who develop the proposal play a very important role. The role of the scientists is one of being a consultant. The role of the countries (representatives in the steering group) is to give comments[16]. In the steering group meetings there is no need to arrive at a consensus.

4.2.2.4 The development of the integrated assessment work: the CAFE Baseline

CAFE has compiled a set of baseline projections outlining the consequences of present legislation for the future development of emissions, of air quality and of health and environmental impacts up to the year 2020 (Amann et al., 2005). In further steps, the CAFE integrated assessment has explored the costs and environmental benefits associated with gradually tightened environmental quality objectives, starting from the baseline (current legislation) case up to the maximum that can be achieved through full application of all presently available technical emission control measures (the maximum technically feasible reduction case) (Amann et al., 2005).

The CAFE assessment is based on recent scientific knowledge, taking into account

- Advice received from the World Health Organization on the health impacts of air pollution,
- Information on vegetation impacts of air pollution compiled by the UN-ECE CLRTAP Working Group on Effects
- Syntheses of the understanding and modelling of the dispersion of air pollutants in the atmosphere at the regional scale developed by the Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air pollutants in Europe (EMEP)[17]

[16] Note that the role of the countries will change when the proposal is in the negotiation phase (in Council and Parliament, and also within the Commission's services)

[17] The EMEP programme provides Governments and subsidiary bodies under UN-ECE CLRTAP with

- Synthesis of the results of the so called City-Delta project[18], an open model inter-comparison exercise to explore the changes in urban air quality predicted by different atmospheric chemistry-transport dispersion models (CTMs) in response to changes in urban emissions. The range of response resulting from this model inter-comparison is to be used in the cost-effectiveness analysis of CAFE with the aim to balance Europe-wide emission controls against local measures. The model inter-comparison focuses on ambient levels of particulate matter and ozone in urban areas. It addresses health-relevant matrices of exposure (e.g., long-term concentrations) to fine and coarse particles and ozone.
- Projections of future economic activities and their implications on the evolution of energy systems and agricultural activities.

For integrating this variety of information to allow policy-relevant conclusions, CAFE has employed the RAINS model (Amann at al., 2005).

4.3 Exploring boundary work within CAFE

4.3.1 Introduction

In the introduction of this paper we raised the questions (1) what kind of integrated assessment process was established in preparation of the Thematic Strategy; (2) how scientists, policy makers and stakeholders in the CAFE process distributed roles and tasks between them; and (3) to what extent and in what way this affected credibility, legitimacy and relevance of the process. In this section we will analyse the role of boundary work in shaping each design element of the assessment process in CAFE (initiation and goal, participation, treatment of uncertainty, treatment of dissent, transparency and framing -see Figure 4.1.). Each sub-section addresses one of these design elements of the assessment process and will analyse whether and how credibility, legitimacy and relevance have been enhanced in the assessment process.

Following Halffman (2003) we distinguish three forms in which the division of labour between science and policy can be embodied: Texts, Objects and People. Boundary Texts (or language or discourse) refer to the way actors in spoken and written text distinguish between science and policy and define respective roles. Boundary Objects refer to the tools that actors use, e.g. computer models, concepts or measuring standards for knowledge production in a policy setting. Boundary People refer to networks of

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qualified scientific information to support the development and further evaluation of the international protocols on emission reductions negotiated within the Convention. See also http://www.emep.int/index_facts.html

[18] See http://rea.ei.jrc.it/netshare/thunis/citydelta/

"scientists" and "policy" makers that are formed or individual people who through their position or actions mark a boundary between science and policy. We use this distinction to analyse how boundary work shaped the assessment design. The examples chosen in this paper are meant to be illustrative and are not meant to be exhaustive.

The analysis of this chapter is based on minutes and agendas of CAFE working groups as made available by the commission on its website; assessment reports; existing literature; interviews with participants[19] in the process (consultants, country representatives, experts and other stakeholders); and participatory observation.

4.3.2 Initiation and goal

The initiation and goal of an assessment are important because the assessment is to a considerable extent shaped by the origin and initial goals of the assessments: by whom and why the assessment was set up, how the problem has been framed and what the organisational context of the assessment is (Farrell and Jäger, 2005). The integrated assessment process in the context of the CAFE programme is an initiative of the European Commission. The design of the integrated assessment work builds upon experiences with integrated assessment work in the preparation of the Acidification Strategy and NEC directive.

4.3.2.1 An early definition of effectiveness by the European Commission

In the following we consider the work plan in which the European Commission outlined the work programme in CAFE as boundary text. We look especially at the way goals are defined and how the role of "knowledge" is positioned.

Texts

Referring to the Sixth Environmental Action Programme of the European Union (6EAP) which explicitly states that all environmental policy making must be based on participation and the best available scientific knowledge, the CAFE work plan of October 2001 states that the programme "has been designed specifically with knowledge gathering and stakeholder participation in mind" (European Commission, 2001b, p. 2). With regard to knowledge gathering the work plan also states explicitly that "knowledge, if it is to be useful, must exist in the heads of people who are actually making or influencing political decisions. Knowledge that exists only on paper or in database not actively accessed by the decision-makers will not contribute to

[19] C. Ågren (Swedish NGO Secretariat on Acid Rain); M. Amann (project leader RAINS, WG TSPA); Keith Bull (UN-ECE , Geneva); R. Folkert (Steering Group, Country Representative, the Netherlands); M. Havlikova (Steering Group, Country Representative Czech Republic); P. Grennfelt (IVL, Sweden), R. Maas (WG TSPA for UN ECE); K. Wieringa (WG TSPA for European Environment Agency Topic Centre for Air and Climate Change); A. Zuber (European Commission DG Environment, CAFE secretariat)

improved policy-making." (European Commission, 2001, p. 2). Also it has to be ensured that reports "are actually read and understood by the relevant decision-makers." (European Commission, 2001b, p. 2). With regard to stakeholder participation the CAFE work plan mentions as its main advantages 1) to increase the amount of information available; 2) to help to validate the information which is available and 3) to increase the sense of ownership among those parties most affected by the policy (including the general public) (European Commission, 2001b).

From the above one can conclude that from the beginning the CAFE secretariat took great effort to make sure the work would have credibility ("best scientific knowledge", "help validate information"), legitimacy ("increase the sense of ownership") and relevance ("reports should be read and understood"). The work plan also implies an own definition of effectiveness of the assessment work: it should "contribute to improve decision making". It is supposed to do so only when "it exists in the heads of people who influence or make political decisions".

4.3.3 Participation

With participation we refer to which individuals and organisations are involved in the process and how and when they participate. This includes scientific groups, policy makers, politicians, industry groups, environmental groups and citizen groups. With regard to scientific input the Commission notes in the Communication on CAFE "Strengthening links with scientific research will be an important priority for CAFE. Policy needs to feed back more efficiently into research planning. Policy developers also need to have a clearer view of what they can expect from science: what is known, what is not known and where uncertainty cannot be reduced in the near future." (European Commission, 2001a, p.12) With regard to stakeholder involvement the Commission notes in the Communication on CAFE that this "will be crucial for the success of CAFE and of the instruments developed as a consequence, since this depends on the degree of acceptance by those involved in their implementation. Stakeholders will systematically be provided the opportunity to present evidence and comment at several stages of technical analysis and policy development." (European Commission, 2001a, p.13)

4.3.3.1 Participation in the Steering group

In the following we consider the members of the Steering Group as boundary people as they have both a policy and expert role.

<u>People</u>

The Steering Group (SG) is set up explicitly to get comments and support for the integrated assessment approach taken within CAFE. According to the Commission the Steering Group has been the main forum for "stakeholder participation" in CAFE. Participants in the Steering Group see the Steering Group as a platform to be informed about the integrated assessment work. It is a place for countries and stakeholders to give statements and to endorse or change actions by the CAFE secretariat and the consultants. The Steering Group has given comments on the work programme of CAFE, which led to the inclusion of an extra WHO study on particulate matter and to the inclusion of Common Agricultural Policy reform in the scenario modelling work. Participants see it as a way for the Commission to make countries also responsible for the work. They are asked to present their views on the process and on the data and scientific work. Also the choices for certain scenarios as a basis of the review of the NEC directive and the Air Pollution Strategy are being discussed.

The participants in the Steering Group play a boundary role in the sense that they can present the views of their countries (or member organisations) ahead of the official decision making and negotiation process. On the other hand they also have a role as an expert. Interviewees pointed out that it is difficult for them to see their role either as policy maker or as scientists. The role of the Steering Group seems contribute to both credibility and legitimacy of the work. However, as there is usually not much time in those meetings, there is not much opportunity for scientific debate. Participants see their own role rather as enhancing the legitimacy of the process than as enhancing the credibility of the process.

4.3.3.2 Participation in the Technical Analysis Group

The following discusses the boundary work performed by the Commission, industry groups and environmental NGOs in deliberations about the definition of the role of the Technical Analysis Group (TAG) and the identity of industry groups. Definitions and the interpretation of words (like "expert") are central here and laid down in minutes of the CAFE Steering Group. Therefore we consider those minutes as boundary texts.

<u>Texts</u>

Participation in the Technical Analysis Group (TAG) initially was subject to considerable debate, as becomes clear from the reports of the meeting of an advisory group, the Air Quality Steering Group[20] in preparation of CAFE and early meetings of the CAFE Steering Group (AQSG, 2001; CAFE Steering Group, 2001). The primary role of the TAG was envisaged to be co-ordination of the technical analysis projects, but also to "enhance the relationship between policy and research" and it was expected to improve the "two-way flow of information between policy and research" (AQSG, 2001).

In a meeting of the Air Quality Steering Group of 23 January 2001 industry pointed out that they would be interested to participate in the Technical Analysis Group (TAG) as stakeholders. However, the Commission doubted

[20] The Air Quality Steering Group was the predecessor of the CAFE Steering Group before the launch of the CAFE process.

that this was compatible with the stated role of the TAG to co-ordinate specific technical analysis projects. The Commission was supported in this position by an environmental NGO who stated that the TAG would not be the appropriate forum for stakeholder participation or technical input from stakeholders, and that other fora were more appropriate. On first sight, in terms of boundary work, one would say that the environmental NGO defined the TAG as being a scientific domain where stakeholders, not being part of the "scientific" community should not participate. On the other hand industry groups saw a role for themselves as experts and thus as participants in the scientific domain. When in the same Air Quality Steering Group meeting "sound science, transparency and stakeholder involvement" were discussed, industry groups repeated their request to be involved in TAG (AQSG, 2001). The Commission and several Member States then argued against this on the grounds that TAG was a "co-ordination forum and not the place to scrutinize or peer-review the science" (AQSG, 2001). The industry groups explained that they wanted to participate proactively as technical contributors to CAFE and that they expected that the Steering Group would be too reactive a forum to provide effective input. Thus we can observe that during this meeting, both the Commission and the industry groups did boundary work in trying to define the identity and role of the specific group, the TAG, and the identity and role of, in this case, industry. However, at the end of this meeting the issue was clearly not yet sorted out (AQSG, 2001).

In the second Steering Group meeting the Commission explained the distinction between "public information", "stakeholder participation" and "peer review". According to this distinction public information aims at ensuring transparency and making information available on e.g. real pollution levels. Stakeholder participation focuses on acquiring knowledge and gaining trust and acceptance from the main interested parties. Peer review investigates validity of the technical information used within CAFE. "While stakeholder involvement should help with [validity of technical information], the two (equally important) goals [of peer review and stakeholder participation] should nevertheless be clearly distinguished". The Commission emphasized in this meeting "the need for all member States and stakeholders to be able to participate in technical discussions at an early stage of the programme". With regard to the TAG it was clarified that "the group's role involved technical co-ordination, not political decision-making, but that stakeholders could be invited for discussions where they could make a technical contribution" (CAFE Steering Group, 2001).

In general we see that at the start of CAFE there was a great need for a concrete picture how the advisory procedures were organised and where and how decisions would be made. The Commission pointed out that CAFE would be a programme for technical analysis and policy development (i.e. policy advice) and not for political decision making, so there was no need for detailed arrangements concerning decision making. Apparently, quite a few organisations and member states had different views on this matter and felt that many important decisions would already be taken in this technical analysis phase before the political process in which Council and Parliament would be involved, would start. Obviously, in the industry's view the TAG would be a forum where potential important decisions would be made on which they would like to have as much influence as possible. At the same time the Commission was keen on keeping the science and the politics separate and stuck to the formal argument that in the TAG only specific projects were being coordinated[21]. Eventually, the industry groups did not become member of the TAG.

We can observe that in this early stage much boundary work took place, not only in the form of texts but also in the set up of procedures.

First, the scope of the programme itself had to be identified and established. CAFE was a programme for technical analysis and policy development, not for political decision making.

Second, the role of the Steering Group and the Technical Analysis Group (TAG) had to be established. As we have seen above, according to the Commission the TAG was a co-ordination forum and not a place to scrutinize or peer-review science. According to industry the TAG was a place to give expert input. According to others it was a possible place to co-ordinate work with CLRTAP and the Co-operation Programme for Monitoring and Evaluating of the CLRTAP (EMEP). The description of TAG in a staff working paper states that the TAG "will co-ordinate the technical analysis work carried out within CAFE… as well as helping to focus research agendas to be more policy-relevant") (European Commission Staff Working Paper SEC(2001)688 accompanying Communication COM(2001)245 on Clean Air for Europe (CAFE)).
Third, the identity of specific groups had to be established. Industry saw an expert role for itself. The Commission saw industry mainly as stakeholders and furthermore made a distinction between "experts" and "contractors".

Though the last clarification of the Commission in the second Steering Group Meeting with regard to the role of TAG cited above is quite clear, it is difficult to assess whether this was a satisfactory outcome of the boundary work for e.g. the industry groups. If not this could affect the legitimacy and also the effectiveness of the process in a negative way.

4.3.3.3 Participation of different scientific groups in relation to the use of models
Below we discuss the use of specific integrated assessment models and their role as boundary objects. On the one hand they represent scientific insights and have to adhere to scientific rules. On the other hand they have to give

[21] However, representatives of CLRTAP do participate in the TAG in order to co-ordinate work of CAFE with work under CLRTAP. So the TAG was not completely restricted to contractors of CAFE.

input to policy discussions and have to fit in to the rules of the game of policy. Furthermore they define the boundary between which scientific information is relevant and which not and which scientific groups can therefore participate meaningfully and which not.

Objects

As described above, for the technical analysis work the European Commission worked with contractors in the CAFE process: the International Institute for Applied Systems Analysis (IIASA), the Norwegian Meteorological Institute (Met.no), the National Technical University Athens (NTUA), the Catholic University Leuven (KU Leuven), AEA Technology and the World Health Organisation (WHO)). These contractors performed the main scientific analyses in the process. Input from different research groups was in theory possible through the Steering Group meetings (input from national experts) and bilateral consultations (see below). However, we note that some participants in Air Quality Steering Group (AQSG, 2001) felt that the issuing of contracts for technical analysis work should have been subject to more consultation. The question was raised why contracts had been given before the launch of CAFE. The Commission explained this by the obligation to review certain Directives for which technical analysis was needed which could not wait for the launch of CAFE (AQSG, 2001).

The Commission used the RAINS model as the central integrated assessment model. RAINS was chosen in 2002 in an open tendering process following an evaluation of objective criteria of "understanding, methodology and management". An important advantage of the RAINS model compared to others was that it was operational and had a proven track record. Furthermore, within the CAFE process also the NEC directive would eventually be reviewed. Because the NEC directive was based on analysis with RAINS, for consistency and credibility reasons, it was an advantage to perform the review with RAINS. The reasons to use RAINS as mentioned in a note for the Steering Group (Amann et al., 2001) are: "(i) RAINS is very comprehensive and well known to all air quality negotiators in both the EU and UN/ECE-CLRTAP, and (ii) its inputs have been reviewed by Member States. Further, it should be noted that the Commission is currently supporting its development (to include e.g. particulate matter)" (p4). However, according to the Commission this fact would not have excluded the choice of another model for integrated assessment modelling in its procurement procedure in 2002.

The PRIMES energy model[22] of NTUA has been developed through the support of DG Research and is used by DG Transport and Energy for energy related questions. The TREMOVE transport model[23] of the KULeuven has been used in the EU Auto-Oil II Programme. It was an advantage to use these

[22] See PRIMES at "Mathematical Models" at http://www.e3mlab.ntua.gr/

[23] See http://www.tremove.org/download/index.htm

models as well to ensure credibility and relevance with DG Transport and Energy.

A consequence of this choice for certain models was that input data, the kind of information needed as well as the framing of the problem became predefined as well. This made participation in the process for some scientific groups more evident than for others. This could have consequences for both the credibility and the legitimacy of the process.

4.3.3.4 Stakeholder meetings and bilateral consultations on scenarios[24]

Below we discuss a special feature with regard to participation in the CAFE process namely the organisation of bilateral consultations with member states and other stakeholders. We consider this procedure in terms of a boundary object, because it entails a special procedure in which knowledge is transferred and roles are defined.

Objects

The bilateral consultations were held to enable country experts to review the inputs in RAINS (country data in the databases and scenarios) for their own country. In addition to the bilateral consultations (which took place at IIASA) four stakeholder meetings were held in Brussels.

Some bilateral consultations had taken place in the preparations for NEC, but these were not as elaborated and systematic as in CAFE. The CAFE secretariat had at first planned to have only multilateral stakeholder meetings, but the International Institute for Applied Systems Analysis (IIASA) suggested that bilateral consultations would be much more effective.

The process was mostly organised in such a way that one person from the environment ministry visited IIASA together with two experts from national Environment Protection Agencies. They came well prepared to the meetings with the modellers of the RAINS model. Interestingly, especially countries which had not felt very much involved in the preparations for the NEC Directive and the Acidification Strategy and had not had good experiences with that were very well prepared.

Also business NGOs participated in the bilateral consultations. Their goal was to receive information. In the WG TSPA (WGTSPA, 2004; UNICE, 2004) industry made a statement that they found it important to base CAFE on a cost-effectiveness evaluation. A cost-effective approach is useful for industry because 1) policy has to be rational, and predictable to be able to base strategies on; 2) the approach is supposed to enhance a fair distribution among sectors, and 3) it is easier to defend a strategy based on “logic” then one based on “vague strategies”.

[24] This section relies heavily on an interview with Markus Amann, 22 December 2004

A complication in the consultation was that many countries had comments on the input from the PRIMES model of NTUA into RAINS, but that there was no separate consultation with the PRIMES modellers. Countries had other data, but also other ideas about e.g. growth of the Gross Domestic Product. However, the RAINS team noticed that countries were often inconsistent in themselves as well. For example, they deliver different energy projections in the context of the Kyoto protocol than for CAFE.

For the RAINS modelling team the consultations were useful because they helped much to improve data base development on e.g. VOC data and grouping of sectors.

These bilateral consultations contributed to (1) credibility because they enable country experts to verify the data and inspect the model structure, (2) legitimacy because all countries were invited to provide data: it was their own responsibility, (3) relevance, because after review the data used would be more in line with data from the countries themselves. According to various interviewed country representatives and members of the RAINS team, the consultations were generally seen as a success.

4.3.4 Treatment of Uncertainties

Treatment of uncertainty refers to how uncertainty is being managed in the process. In the Communication on CAFE the Commission notes that “Given that scientific advice inevitably contains several elements of uncertainty, a balance will need to be drawn within CAFE, as in all policy areas, between a strict precautionary approach and the need to compile a convincing scientific case before taking action. (…) The level of robustness of the evidence required will depend upon the seriousness of the suspected effects as well as on the costs of the action envisaged. Scientific uncertainty must not be used as an argument against taking due precaution against possible long-term damaging effects. Moreover, endless discussions on the science can suffer from a law of diminishing returns: after a certain level of scientific debate, policy conclusions must be drawn and policy made on the base of the best available evidence.” (European Commission, 2001a, p.12).

4.3.4.1 “Sound science” and Peer review

Below we consider the definition and use of the terms “sound science” and “peer review” and what they mean in the CAFE context as boundary texts

<u>Texts</u>

The Air Quality Steering Group (AQSG) discussed the use of the term “sound science” as used by the Commission. Participants in the meeting emphasised that uncertainty is inherent to science. It was suggested to use the concept “uncertainty management” instead. It was also stated that a discussion was needed on the “levels of evidence” needed for precautionary policy measures, referring to an upcoming WHO report on uncertainty (AQSG, 2001). In this context the AQSG also discussed the possibility of an external group to conduct peer-review. The Commission stated in the AQSG meeting that "the starting point should be a clear identification of what kind of validation and peer review is needed to the scientific advice used by policy makers". (AQSG, 2001). This shows that in the view of the Commission a specific kind of peer review and validation is needed for "scientific advice used by policy makers". In the second SG meeting it was agreed that "publication of peer-review articles on technical work carried out for CAFE should be encouraged but should not be a prior requirement for the results to be used. Communication between modellers (e.g. through model comparison) was seen as important and it was emphasised that full advantage should be made of stakeholder experts." (CAFE Steering Group, 2001)

Both the discussions on "sound science" and peer review are important for the final credibility and legitimacy of the analyses performed. These discussions help to make explicit what is accepted as being "credible" and "legitimate".

4.3.4.2 Perceptions of uncertainty management

Below we discuss how participants perceived the extent to which uncertainty was being dealt with in the CAFE process. We consider this as boundary text because the Commission and some participants have different views on how dealing with uncertainties should look like.

Texts

According to some participants, uncertainties are not explicitly dealt with in the CAFE process. At the same time it should be noted, that in the case of the RAINS model this is not to say that national experts and policymakers do not have the opportunity to inform themselves or give input for the uncertainty management. The RAINS team has been publishing regularly about uncertainties in the model and data bases used (e.g. Alcamo and Bartnicki, 1990; Altman et al., 1996; Syri et al., 2000; Suutari et al, 2001; Amann et al., 2004, Schöpp et al., 2005). Also in 2003 a workshop on uncertainty analysis about the RAINS model was held at IIASA to which various participants in both the CAFE and CLRTAP processes were invited. However, in the course of the CAFE process itself uncertainty did not get a lot of explicit attention according to participants. The development and use of two different scenarios seemed to be the only approach to uncertainty. According to interviewees at the Commission indeed the approach to uncertainty is rather one of sensitivity analysis. They furthermore point to the analysis of the risk of taking the wrong decision as part of the Cost-Benefit Analysis exercise within CAFE. However, some participants miss a comprehensive sensitivity analysis. According to those participants it does not become clear in presentations what the weakest part in the chain is and what would be the policy consequences of that. According to the RAINS review (see below) presentations about uncertainties in the results have not been very detailed and have primarily focused on statistical variance due to limitations in input data and parameterisations. Furthermore the RAINS reviewers find that other sources of uncertainty, such as the lack of scientific understanding, the use of assumptions or simplifications, and the inability to predict future socio-economic developments, have been less characterized or communicated (Grennfelt et al., 2004).

4.3.4.3 RAINS review

Below we discuss the review of the RAINS model in terms of a boundary text. The review is at the same time meant to establish the model's scientific credibility and to determine its fitness for policy analysis. It therefore both has to answer to scientific standards and policy standards and the resulting report is a boundary text.

Texts

In 2004, the RAINS model has undergone extensive review in order to establish its scientific credibility and determine its fitness for the purpose of policy analysis in the context of the CAFE programme and the envisaged revision of the Gothenburg Protocol of the Convention on Long-range Transboundary Air Pollution.
The review was conducted in three different ways: (1) A scientific peer review of the concept of the RAINS model and its implementation (Grennfelt et al., 2004); (2) bilateral consultations with experts from the EU-25 Member States and industrial stakeholders to review all input data (see above); and (3) scientific peer reviews of the disciplinary models and assessments on which the RAINS model is based. These include the EMEP Eulerian dispersion model, the assessment of the World Health Organization of the health impacts of air pollutants and the impact assessment of the UN-ECE Working Group on Effects.[25]

In the report which the reviewers presented to the European Commission they concluded that the RAINS model was sufficiently credible to be used as a tool in policy making (Grennfelt et al., 2004). The reviewers furthermore concluded that "the communication between IIASA and the scientific community, the Member States, and other stakeholders is fundamental to the legitimacy of the RAINS model. The IIASA 'openness' policy is commendable and should be encouraged. The success of RAINS is as much due the versatility of the IIASA team and their active engagement with the scientific community as it is to do with the model itself. The process of model development and verification by bilateral dialogue with interested parties and the scientific community is effective." (Grennfelt et al., 2004).

Though the use of various models in CAFE was suggested in the first meeting of the WG TSPA to enhance sensitivity and uncertainty analysis, in fact the

[25] See for documentation on the review http://www.iiasa.ac.at/rains/review/index.html?sb=10

only Integrated Assessment model used in the CAFE process is the RAINS model. Only in a note of 2001 to the SG (Amann et al., 2001) two other models are mentioned: ASAM[26](ApSimon et al. 1994, ApSimon and Warren, 1999, Warren and ApSimon, 2000) and Merlin[27] (Stuttgart University, 2004). They played no significant role in the process, however. Most interviewees see the RAINS review as an important strategic step to enhance credibility of the model. However, the same participants point to the fact that for them the bilateral consultations were more important to enhance, if not credibility, in any case legitimacy of the model, the data and the analyses.

4.3.5 Treatment of Dissent

Treatment of dissent refers to how different and opposing insights are dealt with. Partly this relates to dealing with uncertainties and lack of information: in CAFE e.g. how to deal with health thresholds for ozone or how to deal with the value of statistical life years lost. Also different views exist about future energy developments the European wide projections by PRIMES differ from what the countries project themselves.

4.3.5.1 Room for dissent in the Steering Group?

Below we consider as boundary text the way the commission determines 1) when to discuss points of disagreement and 2) what is science and what is policy.

Texts

According to various interviewees, there is not much time in the Steering Group meetings to discuss conflicting (scientific) ideas. The way the meetings are organised does not provide much room for that. First there is a round of questions for clarification that does not normally leave much time for comments. According to the CAFE secretariat, if a considerable number of countries raises the same issue then it will be dealt with. Otherwise, countries which do not agree should bring this up once the strategy is discussed in the Council or Parliament. This way of treating dissent can be seen as boundary work by the CAFE secretariat: demarcating what is the appropriate timing and forum for certain discussions, but also whether the topic is a scientific or a political one. Whether this enhances legitimacy and credibility of the process with the Steering Group participants depends on their own experiences in the process.

4.3.6 Transparency

Transparency means that interested observers can readily see into an assessment process and judge for themselves the data, methods, and decisions used in the process. In practice, this means making a significant amount of

[26] See also http://www.huxley.ic.ac.uk/emma/IAU.htm
[27] See also http://www.merlin-project.info/

information available and explaining decisions based on this information. Transparency is an important way of establishing legitimacy and credibility (Farrell and Jäger, 2005).

4.3.6.1 Transparency with regard to the analyses in CAFE

Below we consider internet as a boundary object. The CAFE secretariat uses internet to make available all information around the process, including data, scenarios and models for the interested user. Internet serves as an interface and leaves room for different interpretations of the data and procedures presented.

Objects

The CAFE secretariat took great efforts to make the CAFE process transparent: all agendas, meeting notes, inputs and participants lists of all meetings are publicly available on the website. The same holds for reports of the modelling work and the documentation of scenarios. Through the IIASA website databases on e.g. activity data, emission factors, cost-information and cost curves are available and an online version of the RAINS model can be viewed and used. Thus a lot of information is open for the user to make an own judgement which is important for credibility and legitimacy. On the other hand, according to some interviewees there is overkill in information.

Interestingly, the Union of Industrial Employers' Confederations of Europe (UNICE), states in a letter to European Commission president Barroso in June 2005, sent after the circulation of the draft Strategy that they believe strongly that decisions about new targets should be based on robust scientific and economic assessment. They state that the model used by CAFE is very complex and that transparency concerning input assumptions and the uncertainties of the results thus generated is distinctly lacking. Also they state that "Member States and industries were not able to evaluate the results of the model runs" (UNICE, 2005). Still, the scientific underpinning of the policy advice was discussed several times in the CAFE working groups and the SG. The development of the policy proposal – the draft Strategy and the new air quality legislation - took place when IIASA had made its policy options runs in early 2005. The main elements of the Strategy and draft legislation were presented to and consulted with the CAFE SG in May 2005 as two "non-papers" and the Commission thereafter finalised its drafts for interservice consultation within the Commission. At the same time it should be noted that there was not much time to react for Member States and other stakeholders. However, given the fact that so much effort in the CAFE process went into stakeholder consultation and making sure that the process would be transparent, still the statement of UNICE is remarkable. In a letter to Barroso in reaction to the UNICE letter the European Environmental Bureau (EEB) states that "this is simply untrue". And "As compared to other EU policy processes the CAFE process has been a model of transparency both in terms of actual stakeholder meetings (opportunity for involvement) as well as in terms of explanatory documentation provided to stakeholders and Member States"(EEB, 2005).

The UNICE letter had quite some consequences, as it made Barroso postpone the Thematic Strategy on Air Pollution (ENSD, 2005) and to have an "orientation debate" (which took place in July 2005) about all the upcoming strategies due under the 5th EAP. Apparently transparency alone is no recipe for credibility and legitimacy.

4.3.6.2 Transparency with regard to the decision making process

Below we discuss how participants perceived the extent to which it was clear in the CAFE process where and at what time the real decisions were taken and what roles different groups and people had at different points in time.

People

It is not transparent to all participants in the CAFE process in what part of the legislation and policy process the knowledge will play a role. The CAFE Steering Group is a group on the level of civil servants of the ministries. Though the input of knowledge plays an important role here, decisions are officially not taken in the Steering Group. The first official decisions are taken in the Commission itself. The Commissioners have to agree among each other. It is difficult to discern what role knowledge as produced in the integrated assessment process has been playing in these discussions. The next steps after the expert phase are the negotiations in the Council and the European Parliament when legislative acts like the air quality directive will be decided upon. Different knowledge sources can play a role here. Countries can again involve their own experts. In this phase it is difficult to get a good picture of the role and relevance of the knowledge as produced in the integrated assessment process for the Thematic Strategy in the expert phase. Note that the Strategy itself will not be negotiated in Council and EP as it is the Strategy of the Commission. The Council and the EP will formulate Council conclusions and resolutions respectively to the Strategy.

4.4 Conclusions and Discussion

Our first question in this paper was what the integrated assessment process looked like in the establishment of the Thematic Strategy on Air Pollution. In section 4.2 we compared the CAFE process with the science-policy interaction processes in preparation of the 1997 Acidification Strategy and National Emissions Ceilings (NEC) directive. We conclude that while the CAFE process builds further on these experiences, the CAFE process is explicitly organized as a much more open and transparent process. The scientific assessment process has been extensive, a mechanism for stakeholder involvement was in place, data provided from Member States have been used and scenario inputs from DGs other than DG Environment (through the PRIMES and TREMOVE models) have been applied. Data, scenario outputs, results of analyses and reports of meetings all have been made available through the internet.

The second question of addressed in this paper was how experts, stakeholders and policy-makers in the process distributed roles and tasks between them and how have they been working together in this process. We see that especially in the beginning of the process i.e. in the preparatory meetings of the Air Quality Steering Group and the first few meetings of the CAFE Steering Group, boundary work took place in the negotiation on roles and identities of "experts" and "stakeholders" and the scope of certain groups. From the analysis in section 4.3 we conclude that this happened not only in the form of texts but also in the set up of procedures. Firstly, in identifying and establishing the scope of the programme itself: CAFE was set up as a programme for technical analysis and policy development, not for political decision making. Secondly in e.g. the definition of the role of the Steering Group and the Technical Analysis Group (TAG): interpretations on the role of the TAG ranged from a co-ordination forum of work under contract, to a place to give expert input. Thirdly, in the definition of identity of specific groups: industry saw an expert role for itself while the Commission saw industry mainly as stakeholders and furthermore made a distinction between "experts" and "contractors". The results also indicated that for industry the boundary work was in a way "not completed". Industry was not satisfied with its role and appointed identity as stakeholder instead of expert. This would also explain why UNICE could keep insisting that the process and inputs were not transparent, while in fact and in the eyes of most participants the Commission and the experts involved went out of their way in providing information and giving opportunity for comments.

In contrast with this generally as transparent perceived set up of the information exchange, not very transparent in the CAFE process seems the actual decision making process. In section 4.3 we have seen that there was a great need for a concrete picture how the advisory procedures were organised and where and how decisions would be made. As the European Commission saw CAFE as a programme for technical analysis and policy development (i.e. policy advice) and not for political decision making, they saw no need for detailed arrangements for decision making. Apparently, quite a few organisations and member states had different views on this matter and felt that many important decisions would already be taken in this technical analysis phase before the political process, in which Council and Parliament would be involved, would start. This can also have influenced some participants' opinion with regard to treatment of uncertainties and the possibilities to discuss dissenting views. This could happen because conflicting views existed about the right forum for the discussion of certain issues and the participants entitled to give input in this discussion.

With regard to the third question of this paper "To what extent and in what way did co-operation between scientists, stakeholders and policy makers constitute credibility, legitimacy and relevance of the assessment?" we conclude that on the one hand the CAFE process indeed established credibility, legitimacy and relevance with the majority of the actors involved. The bilateral consultations, the review of the RAINS model and other models involved, and the transparency and documentation of the integrated assessment work played an important role in enhancing this for the member States. On the other hand, also with regard to the place and time of actual decisions as mentioned above we conclude that the last step in the expert phase is the least transparent. This last step is the negotiation between the different services of the European Commission before the launch of the Thematic Strategy. It is not easy to follow for e.g. Member States what happens in that process behind the closed doors of the European Commission's Directorates General.

While drawing our conclusions we need to realize that we are dealing with a situation in which actors change roles. Representatives of Members States play a role of "expert" in the expert phase and play a role as policy maker once proposals for legislation gets to the European Parliament. Also, in the expert phase, DG Environment plays partly the role of "policy maker", but when it comes to real decisions it is dependent on the other Commission services and negotiations in the European Parliament and in the European Council.

While the analysis in this paper did not focus on the inter-services consultation at the Commission, it would be interesting to analyse further if indeed the assessment design of CAFE also took into account this part of the process or whether it is dealt with as a completely separate process. How credible, legitimate and relevant has the CAFE process been in the eyes of the other Commission services? In a context where apparently important final decisions in the expert phase are taken at the level of commission services it might be not enough to pay attention only to (for example) member state involvement. This is in contrast with an international negotiation context like CLRTAP in which the member states are viewed as the most important stakeholders. The above suggests that in the setting of an expert phase in an EU legislation procedure more boundaries are important than only the boundary between policy makers and appointed experts.

Annex A Participants lists of the CAFE Steering Group, the Working Group on Target Setting and Policy Analysis, the Technical Analysis Group, Stakeholder Consultations and Dissemination Workshop

CAFE Steering Group

Countries

Austria
Belgium
Czech Republic
Cyprus
Denmark
Estonia
Finland
France
Germany
Hungary
Ireland
Italy
Latvia
Lithuania
Luxembourg
Poland
Portugal
Slovakia
Slovenia
Spain
Sweden
The Netherlands
United Kingdom
Bulgaria
Iceland
Norway
Switzerland

NGOs

European Free Trade Organization (EFTA)
European Environmental Bureau (EEB)
Swedish NGO Secretariat on Acid rain
European Association of car makers (ACEA)
Oil Companies' European Organization for Environmental and Health Protection (CONCAWE)
Association of the electricity industry in Europe (EURELECTRIC)
European Confederation of Oil and Steel Industries (EUROFER)
European Association of Metal Industries (EUROMETEAUX)
European government affairs organisation of the oil refining and marketing industry (EUROPIA)
Federatie Chemische Industrie België (FEDICHEM)
Union of Industrial and Employers' Confederations of Europe (UNICE)
European Chemical Industry Council (CEFIC)
European Solvent Industry Group (ESIG)
European Solvents VOC Co-ordination Group (ESVOC)
Renault
BMW
European Community Shipowners' Associations (ECSA)
Bundesverband der Deutschen Industrie (BDI)
European Cement Industry Association (CEMBUREAU)
European Association of Internal Combustion Engine Manufacturers (EUROMOT)

Research Organisations

International Institute for Applied Systems Analysis (IIASA)
Network of major European Cities (EUROCITIES)
European Environment Agency (EEA)
World Health Organization (WHO)
Landesumweltamt Nordrhein-Westfalen, Germany
EMEP/MSC-W
Swedish Environmental Research Institute (IVL)
United Nationions Economic Commission for Europe (UN-ECE)
Swiss Agency for the Environment, Forest and Landscape (BUWAL)
Netherlands Organisation for Applied Scientific Research (TNO)
AEA Technology, UK
Department for Environment, Food and Rural Affairs (DEFRA), UK
National Physical Laboratory, UK
City of Munich

Commission

DG Enterprise and Industry
DG Taxation and Customs Union
Joint Research Centre, Sevilla
Joint Research Centre, Ispra
DG Environment (CAFE secretariat)

Working Group on Target Setting and Policy Analysis WG TSPA		
Countries	*NGOs*	*Invited experts*
Austria	European Environmental Bureau (EEB)	International Institute for Applied Systems Analysis (IIASA)
Belgium	The Swedish NGO Secretariat on Acid rain	Netherlands Organisation for Applied Scientific Research (TNO)
Denmark	Union of Industrial and Employers' Confederations of Europe (UNICE)	European Environment Agency (EEA)
Finland		
France	Electricité de France (EDF)	*Others*
Germany		UN-ECE Task Force on Integrated Assessment Modelling
Italy		DG Environment (CAFE secretariat)
Latvia		Chair Working Group on Particultae Matter
Slovenia		
Spain		
Sweden		
The Netherlands		
United Kingdom		

Technical Analysis Group (TAG)	
Contractors	*Commission*
International Institute for Applied Systems Analysis (IIASA)	DG Environment
Catholic University Leuven	DG Joint Research Centre
Transport and Mobility Leuven	
EcoMetrics Research and Consulting (EMRC), Reading	
Institute of Occupational Medicine, Edinburgh	
AEA Technology, Culham	
Meteorological Institute MET.NO, Oslo	
National Technical University of Athens	
Environmental and Engineering Consultancy, ENTEC, London	
Netherlands Organisation for Applied Scientific Research (TNO)	
World Health Organization (WHO)	

Stakeholder Consultations

Countries	*NGOs*	*Research organisations*
Austria	Association for Emissions Control by Catalyst (AECC)	International Institute for Applied Systems Analysis (IIASA)
Belgium	European Chemical Industry Council (CEFIC)	Catholic University Leuven
Cyprus	European paper Industry (CEPI)	European Environment Agency (EEA)
Czech Republic	Oil Companies' European Organization for Environmental and Health Protection (CONCAWE)	European Fertilizer Manufacturers Association (EFMA)
Denmark	Association of the electricity industry in Europe (EURELECTRIC)	University of Bonn
Finland	European government affairs organisation of the oil refining and marketing industry (EUROPIA)	National Technical University of Athens
France	European Environmental Bureau (EEB)	
Germany		*Commission*
Ireland		DG Environment
Lithuania		Other services of the commission
Netherlands		
Poland		
Slovakia		
Slovenia		
Spain		
Sweden		
UK		

Dissemination workshop

Countries	*NGOs and other organisations*	*Research organisations*
Austria	Swedish NGO Secretariat on Acid rain	International Institute for Applied Systems Analysis (IIASA)
Belgium	European Association of car makers (ACEA)	European Environment Agency (EEA)
Czech Republic	Oil Companies' European Organization for Environmental and Health Protection (CONCAWE)	Landesumweltamt NRW, Germany
Denmark	Association of the electricity industry in Europe (EURELECTRIC)	EMEP/MSC-W
Finland	European Confederation of Oil and Steel Industries (EUROFER)	AEA Technology, UK
Germany	European government affairs organisation of the oil refining and marketing industry (EUROPIA)	Department for Environment, Food and Rural Affairs (DEFRA), UK
Hungary	Union of Industrial and Employers' Confederations of Europe (UNICE)	
Slovenia	European Chemical Industry Council (CEFIC)	*Commission*
Spain	European Solvent Industry Group (ESIG)	DG Enterprise
Sweden	Port of Rotterdam	DG Environment
The Netherlands	Greater London Authority	CAFE secretariat
United Kingdom	BASF AG	
Norway	RWE power	
	Asociacion Espanola de la Industria Electrica (UNESA), Spain	
	National Technical University of Athens	
	Josef Stefan institute, Slovenia	
	Shell Europe Oil Productions	
	EBEA, Italy	
	Administratie Milieu-, Natuur-, Land- en Waterbeheer, Belgium	
	German Advisory Council	
	Stahlinstitut, Germany	
	L'Institut National de l'environnement industriel et des risques (INERIS), France	
	Brussels Environment (IBGE)	
	EnergieNed the Netherlands	
	General Motors	
	UK association of environmental protection specialists (NSCA)	

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Chapter 5 European Air Pollution Assessments: Co-production of Science and Policy

Willemijn Tuinstra

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Abstract
This paper examines the question whether the scientific knowledge framework produced in the context of one policy arena can keep its credibility, legitimacy and relevance when used in a different policy arena. For example, the European Commission (EC) of the European Union is using knowledge produced in the context of the Convention on Long-range Transboundary Air Pollution (CLRTAP) to develop its own air quality strategies. This paper examines how the roles and division of tasks between scientists and policy makers differ among these two policy arenas and whether this influences the way credibility, legitimacy and relevance of the scientific assessments are established. To this end, the paper combines an analytical framework to approach effectiveness of scientific assessment in policy making with the notion of boundary work and co-production of science and policy. The process within the EC differs from CLRTAP in that it hires consultants and will result in binding targets, whereas the CLRTAP process works with voluntary networks of country experts and does not have a strong compliance mechanism. At the same time the work of the EC and of CLRTAP are much intertwined and dependent on each other. The EC in the process rather focuses on building legitimacy, whereas it builds its credibility on the credibility established in the work of CLRTAP. An important feature in the EC process both for legitimacy and credibility is the use of bilateral consultations between countries and scientific consultants.

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5.1 Introduction

Policy making in the field of Air Pollution on a European level takes place in two different arenas. Already since 1979 negotiations on reducing emissions of pollutants are going on in the context of the United Nations European Commission for Europe Convention on Long-range Transboundary Air Pollution (UN-ECE CLRTAP). Of a later date, but evolving in a rapid manner is the development of European Union (EU) legislation on air pollution. In 2005 the European Commission launched an integrated Thematic Strategy on Air Pollution.

The two policy arenas UN-ECE CLRTAP and the EU are linked in many different ways. Several authors have examined those policy linkages. Wettestad (2002) elaborates on the intensive interplay between the development of the so called CLRTAP multi-pollutant/multi-effect protocol signed in 1999 in Gothenburg and the development of the EU National Emission Ceilings directive adopted in 2001. Wettestad notes that policy development in the 1990s within the CLRTAP context has strengthened the position of EU policy makers in the field of air pollution. He also finds that CLRTAP experience and expertise had a major impact on the way of working and thinking within the Commission (Wettestad 2002 p.157). Selin and VanDeveer (2003) discern a multitude of governance linkages and actor linkages between the two arenas. Governance linkages refer to e.g. similar policy objectives, harmonized activities and overlapping geographical areas. For example the UN-ECE geographical area includes all EU-25 countries and in addition the United States of America (USA), Canada, the Balkan countries, Russia, Ukraine and other parts of the former Soviet Union. With actor linkages, Selin and VanDeveer (2003) point to the role of organisational actors, such as member organisations and non member organisations and individual actors in creating and utilising linkages. Furthermore Selin and VanDeveer (2003) note that CLRTAP and the EU share problem and solution frames exemplified by the use of terms like 'critical loads', country based emission ceilings and the use of Best Available Techniques and emissions limit values standards for specific emission sources. Common rules include also specific emission reductions requirements.

Acknowledging the importance of the governance and actor linkages as outlined by Selin and VanDeveer (2003) this paper adds to this by adding empirical material and further elaborating the differences and linkages between the two policy processes from a slightly different angle, viz. with regard to *the role of scientific advice and assessment in policy making.* It focuses on the division of roles and tasks between scientists and policy makers in integrated assessment processes in the context of UN-ECE CLRTAP and in the EU Clean Air for Europe Programme (CAFE) respectively. The CAFE Programme was launched in 2001 as a programme of technical analysis and policy development. In 2005 CAFE has led to the formulation of the EU Thematic Strategy on Air Pollution. The CAFE programme partly builds on the scientific knowledge framework that has been developed within the context of UN-ECE CLRTAP. This scientific knowledge framework encompasses not only the scientific knowledge base itself but also the problem framing and the scientific networks that constitute the knowledge base.

The scientific assessment process within CLRTAP is generally seen as having been successful in generating, synthesising, and disseminating scientific knowledge (e.g. see Hordijk 1991; Levy 1993; Gough et al. 1998; Grünfeld 1999; Castells and Ravetz 2001; Sundqvist et al. 2002; Farrell and Keating 2005). Within the context of CLRTAP there has been a successful division and co-ordination of work between science and policy. CLRTAP provided a forum which simultaneously co-produced a scientific knowledge framework and a framework for policy making (Tuinstra et al. 2006). An example of this co-production is the development of the concept of 'critical loads'[28]. The introduction of the concept formed the platform for the development of the effects based cost-efficient approach, which formed the basis for further European air pollution control strategies (Grennfelt and Hov 2005). Grennfelt and Hov (2005, p 4) note that "the formation of a concept like critical load has had a strong influence not only on policy development itself, but also on the development of science".

Taking this co-production as a starting point, the paper examines how the roles and division of tasks between scientists and policy makers differ among the UN-ECE and the EU air pollution policy processes and whether these differences influence the way credibility, legitimacy and relevance of the assessment are established. It compares the science-policy communication process in CAFE with the science-policy communication process within CLRTAP and examines how the two are intertwined. For this purpose a framework is used for the analysis of the role of boundary work in enhancing the credibility, legitimacy and relevance of scientific assessment in policy processes.

The next section presents the framework for analysis. Section 5.3 shortly summarises conclusions of two earlier analyses of the science-policy interaction in CLRTAP and CAFE separately. Section 5.4 analyses differences and linkages between the two policy arenas. Section 5.5 concludes the paper with a discussion.

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[28] A critical load is a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge (www.unece.org/env/wge/definitions.htm).

5.2 Effective boundary work? A framework for analysis.

Tuinstra et al. (2006) introduce a framework for the analysis of the role of boundary work in enhancing the credibility, legitimacy and relevance of scientific assessment in policy processes. This framework integrates two concepts. First, it uses the concept of effectiveness of assessment processes in terms of credibility, legitimacy and relevance as described by Farrell et al. (2001) and Farrell and Jäger (2005). Second, it uses a way to describe boundary work in terms of demarcation and co-ordination between science and policy as provided by Halffman (2003). This integrated framework will help us to focus on what happens at the science-policy interface.

Starting point for the integrated framework are two observations. First, it is not easy to define effectiveness of assessment processes and factors that influence this effectiveness. Second, it is not easy to draw a sharp line between scientific and policy making activities in an assessment process. Neither can scientists' nor policy makers' roles as actors in such processes always precisely be defined (Tuinstra et al. 2006).

Effectiveness

With regard to the first observation, as mentioned above the framework builds upon the concept of effectiveness as described by Farrell et al. (2001) and Farrell and Jäger (2005). This concept considers effectiveness as an emerging property based on three qualities that participants and users attribute to an assessment: credibility, legitimacy and relevance. These qualities are co-determined by the characteristics of the assessment itself, the characteristics of the users of the assessment and the context in which the assessment takes place.

Boundary work

The second observation refers to an important aspect of science-policy communication in assessment processes, viz. the negotiation of the division of labour between science and policy. Negotiation takes place about the identity of practices (e.g. 'science' and 'policy') and actors (e.g. 'scientists' and 'policy makers') and their collaboration. This practice of maintaining and withdrawing boundaries between science and policy, shaping and reshaping the science-policy interface has been referred to as 'boundary work' (cf. Jasanoff 1990; Gieryn 1995; Halffman 2003). The boundary between science and policy is constructed throughout various stages of the communication process between science and policy within the context of a particular issue domain. In the science-policy interface, knowledge is produced, and simultaneously the social structures to produce this knowledge are being organised and the scene is being set for the framing of the policy problem and the organization of dealing with the problem. Within the field of science studies, the term co-production is used to refer to processes that connect the production of knowledge with the organization of policy-making (Shackley and Wynne 1995; Jasanoff 1996; Miller 2001; Jasanoff 2004). Boundary work, the division of labour between science and policy, is part of this process

Relevance, credibility and legitimacy can be different with different users. Relevance, credibility and legitimacy of an assessment with multiple users, can be enhanced if context and user characteristics are taken into account in the *design* of the assessment. Assessment characteristics are the practical result of the design, taking into account the context and user characteristics (Tuinstra et al., 2006).

Important design elements are 1) Initiation and Goal; 2) Participation; 3) Treatment of uncertainty; 4) Treatment of Dissent; 5) Transparency; 6) Framing; 7) Capacity; 8) Scale and 9) Quality Control. These design elements are much determined by what happens in the science-policy interface through boundary work: how science and policy demarcate and co-ordinate work.

In short, the integrated framework helps to provide insight in the way *participants in the assessment process divide and co-ordinate work between science and policy; how this shapes design elements (initiation and goal, participation, treatment of uncertainty, treatment of dissent, transparency) of the assessment and how this enhances credibility, legitimacy and relevance with multiple audiences*

Figure 5.1 visualises the framework for analysis. See for a more elaborate description of the framework for analysis Tuinstra et al. (2006). The framework is flexible and for the purpose of the current study the paper only focuses on the design elements *initiation and goal participation, treatment of uncertainty, treatment of dissent* and *transparency.*

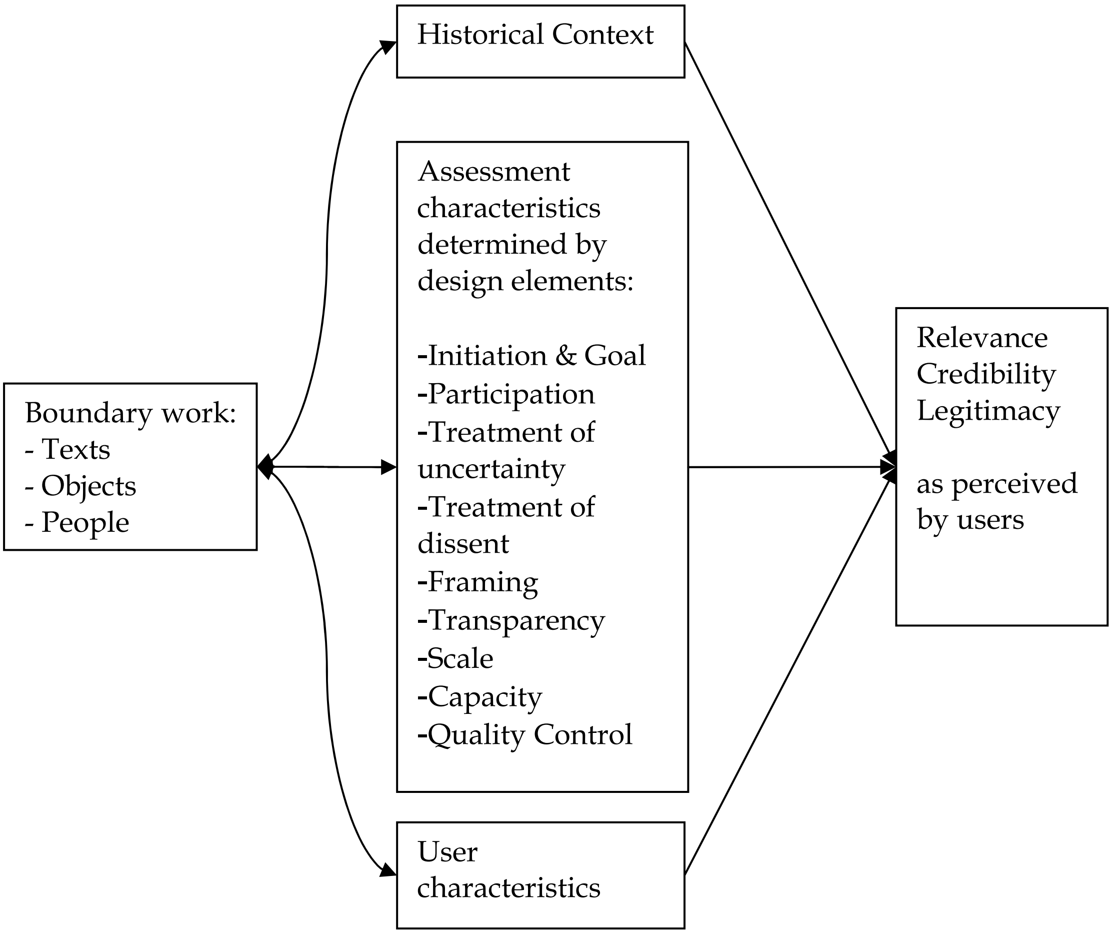

Figure 5.1 A framework relating boundary work between science and policy to the credibility, legitimacy and relevance of assessments, taking historical context and user characteristics into account in the design (Initiation & goal, Participation, Treatment of Uncertainty, Treatment of Dissent, Framing, Transparency, Scale, Capacity and Quality control). Based on Eckley et al. (2001), Farrell and Jäger (2005), Halffman (2003) and Tuinstra et al. (2006).

5.3 Boundary work in CLRTAP and CAFE

In two recent papers we have analysed the science-policy interaction in the two different arenas separately (Tuinstra et al. 2006; Tuinstra 2006). The conclusions of the two papers are summarised below in the Boxes 5.1 and 5.2.

Box 5.1 Summary of conclusions rearding boundary work in CLRTAP (Tuistra et al. 2006)

Our analysis of *initiation and goal* of the CLRTAP and the *participation* in CLRTAP showed that what is considered to be credible, legitimate and relevant is established already in an early stage of the development of the assessment framework. It is therefore important for actors to be involved in boundary work in an early stage of the communication process.

For example members of the RAINS modelling team of International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria, were very early participants in boundary work. The features of the RAINS model currently match quite well with what is considered relevant in the CLRTAP community. The knowledge frame of RAINS developed in parallel with policy development within CLRTAP and the set up of the data collection structure, and partly influenced the course of these developments. RAINS clearly participated in setting the scene and could therefore enhance its own relevance. An example of this is the development of the use of the concept of Critical Loads, which could not have been operationalised without integrated assessment models such as RAINS and the other models used.

With regard to dealing with *uncertainties* we also see that this requires careful boundary work balancing between credibility and legitimacy eventually leading to operational structures and effective assessment procedures. The example of the use of models and monitoring which could be managed and applied in all countries ('lowest common denominator standard') shows that this balance is of crucial importance for continuation of e.g. the monitoring programme without which this programme never could have been effective for policy making. The context determines what kind and degree of uncertainty is being accepted.

With regard to dealing with *dissent* we see that the consensus structure of CLRTAP, offers ample room for boundary work. We showed this in the example of the production of consensus reports but also in the creation of the 'gap-closure' concept which was inspired by the necessity to come to consensus in the policy debate. The concept served a boundary role by being relevant through its ample timing and in fitting both to the policy concerns and the framing of the scientific debate at that stage. In its context it was both politically legitimate because of its equity dimension, and scientifically credible because of its connection to effects, and therefore contributed to the effectiveness of the complete assessment process.

Box 5.2: Summary of conclusions regarding boundary work in CAFE (Tuinstra, 2006)

Especially in the beginning of the process (the preparatory meetings of the Air Quality Steering Group, the first meetings of the CAFE Steering Group) boundary work has been taking place in the sense that roles and identities of 'experts' and 'stakeholders' and the scope of certain groups have been negotiated. However, our analysis suggests that the boundary work was not completed in the sense that not all actors were satisfied with their roles and appointed identities. This can also have influenced the fact that not all participants were convinced that uncertainties were treated satisfactorily and that there was enough space available to discuss dissenting views. This could happen because conflicting views existed about what the right forum for the discussion of certain issues was and who were the ones entitled to give input in this discussion. This would also explain why certain groups could keep insisting that the process and inputs were not transparent, while in fact and in the eyes of most participants the Commission and the experts involved went out of their way in providing information and giving opportunity for comments. Especially for the Member States an important role in enhancing credibility, legitimacy and relevance were bilateral consultations between modellers and Member States, the review of the RAINS model and other models involved and, still, the transparency and documentation of the integrated assessment work e.g. on the internet.

5.4. Exploring differences and linkages between science-policy interaction in CLRTAP and in CAFE

5.4.1 Introduction

This section analyses differences and linkages between science policy interaction in CLRTAP and in CAFE. Each sub-section addresses one of the design elements of the assessment process and will analyse how credibility, legitimacy and relevance have been enhanced in the assessment process. The analysis of this section is based on interviews with participants in the process (consultants, country representatives, experts and other stakeholders); minutes and agendas of CLRTAP and CAFE meetings and working groups; assessment reports; existing literature and participatory observation. (See Tuinstra et al. (2006) and Tuinstra (2006) for details).

5.4.2 Initiation and goal

An important feature of CLRTAP is that all initiatives and decisions are taken by the parties (countries) themselves. In contrast in the context of the EU, instead of the member states the European Commission (e.g. DG Environment) has the initiative[29]. Related to this is the fact that participation in e.g. monitoring or inventory efforts within LRTAP is on a voluntary basis

[29] That is, with regard to organize the scientific information process in the expert phase of the preparations of a commission proposal for legislation. With regard to putting an issue on the political agenda the member states in the EU also have to play their role.

and that e.g. compliance mechanisms are not very strong. Also decision procedures are quite slow. Funding of scientific work is coming from the parties themselves on a voluntary basis. Within CAFE all member states are supposed to participate and to deliver data. The EU has the possibility to enforce compliance. Because of the 'top down' oriented process, decisions can be taken quicker and it is easier to provide funds if the CAFE secretariat decides that e.g. certain scientific analyses are needed.

A strong feature of a 'bottom up' process is that it will enhance legitimacy of an assessment with various participants[30]. A 'top down'-like approach will enhance relevance of assessments for the process itself, because it can fine tune the assessment directly to the needs of the process.

5.4.3 Participation

CLRTAP has been setting up a data information structure, on e.g. emissions of air pollutants, sensitivity of ecosystems (critical loads) and measurements of air quality, to which all parties have the possibility to contribute.[31] Scientific work to underpin negotiations is carried out in collaboration with a broad network of scientists and national experts that contribute to the systematic collection, analysis and reporting of emission data, measurement data, critical loads and integrated assessment results. All countries can send experts to task force and working group meetings. Because all countries have the possibility to participate in the process, in principle there is the possibility for a common development of knowledge. The possibility of broad participation of the different countries in the data collection in principle enhances legitimacy of the information in the process. However, because of the voluntary nature, some countries play a more active role than others. Front-runner countries like Sweden, Germany and the Netherlands have more power and resources to contribute. In practice the legitimacy of the information will thus be higher in those countries which indeed have the capacity to participate meaningfully.

The European Commission works in a different way. The main scientific work, like e.g. integrated assessment modelling, scenario analysis and cost-benefit analysis to support policy proposals is carried out by contractors who are hired by the commission. In the CAFE process Member States are being consulted additionally and invited to give comments to presentations made by the contractors. The main analyses, however, are carried out by the contractors on whom the commission relies heavily. Through a tendering process the European Commission selects the best equipped scientific groups. This means that in principle there are only a few scientific groups directly

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[30] It should be noted that while in principle the organization of CLRTAP can be viewed as being bottom up, it have been particular countries who have been taking the lead. It is a small set of powerful countries which is the most active within the scientific and political process within CLRTAP. See e.g. Castells and Nijkamp (1998), Botcheva-Andonova (2001) and VanDeveer (2005)

[31] See e.g. http://www.emep.int/index_facts.html, and http://www.unece.org/env/lrtap/welcome.html

involved while other experts can only comment if they are a delegate for their own Member State. The possibility exists that development of knowledge capacity does not take place in all countries. Thus, hiring consultants on the one hand enhances the relevance of the work for the commission. On the other hand, Member States could feel not so much involved and attribute less relevance, credibility and legitimacy to the information produced. However, because all Member states are obliged to participate in the consultation, all member states are at least involved in one way or another.

In practice the contractors in the CAFE process also are important players in CLRTAP. Furthermore the CAFE process currently builds on the knowledge development within CLRTAP. Thus indirectly input from various experts from various countries also can become included into the CAFE process. CLRTAP plays an important role to keep all countries involved in CAFE. In this way CAFE builds on the credibility and legitimacy of the work in CLRTAP. Furthermore, funding of the contractors by CAFE is essential also for e.g. model development in CLRTAP.

5.4.4 Treatment of uncertainties

Over the years the importance of the issue of uncertainties has increased within CLRTAP. Being first only an issue for the scientific community, in recent years, policy interest in uncertainties also increased. This is partly an effect of the development of the air pollution issue. For certain pollutants current air quality levels and deposition levels are almost at the level of targets and critical loads. The last step to actually reach those targets takes a large effort, while the effect is small. Therefore, uncertainties become more significant. Though initially uncertainty management played a less important role, in the early 90s three integrated assessment models were available for scenario analysis in CLRTAP. The use of the three models was a form of uncertainty management and increased the credibility of the process. Later the RAINS[32] model of the International Institute for Applied Systems Analysis (IIASA) became the central model (Tuinstra et al. 1999, Maas et al. 2004).

In the preparations of the set up of the CAFE process the use of the term 'sound science' was discussed (AQSG 2001). Participants in the Air Quality Steering Group (AQSG, the predecessor of the CAFE Steering group) emphasised that uncertainty of science was inherent. It was suggested to use the concept 'uncertainty management' instead. It was also stated that a

[32] The Regional Air pollution Information System (RAINS) model is a tool for an integrated assessment of multi-pollutant emission control strategies addressing multiple environmental effects including ground-level ozone, acidification and eutrophication. The model combines information on the sources of emissions (e.g., economic development, the present and future structure of emission sources, the potential and costs for controlling emissions) with scientific information about the dispersion of pollutants in the atmosphere including the ozone formation processes. It compares the resulting regional air quality with various indicators of risk at stock e.g., population, critical loads and critical levels for vegetation, etc. (Amann et al. 1999). See also http://www.iiasa.ac.at/rains/index.html

discussion was needed on the 'levels of evidence' needed for precautionary policy measures. In this context also the possibility of an external group to conduct peer-review was discussed. The commission stated in the AQSG meeting that "the starting point should be a clear identification of what kind of validation and peer review is needed to the scientific advice used by policy makers" (AQSG 2001). This is an interesting remark, because it shows that in the view of the commission a specific kind of peer review and validation is needed for "scientific advice used by policy makers". In the second CAFE Steering Group meeting it was agreed that "publication of peer-review articles on technical work carried out for CAFE should be encouraged but should not be a prior requirement for the results to be used. Communication between modellers (e.g. through model inter comparison) was seen as important and it was emphasised that full advantage should be made of stakeholder experts." (CAFE Steering Group 2001). Both the discussions on 'sound science' and peer review are important for the final credibility and legitimacy of the analyses performed. These discussions help to make explicit what is accepted as being 'credible' and 'legitimate' within the CAFE process.

Though the use of various models is suggested in CAFE (AQSG 2001) to enhance sensitivity and uncertainty analysis, in fact the only integrated assessment model used in the CAFE process is the RAINS model. Only in a note of 2001 to the CAFE Steering Group (Amann et al. 2001) two other models are mentioned: ASAM[33] and Merlin[34]. They played no significant role in the rest of the process however.

In practice, currently the way the CLRTAP and CAFE processes deal with uncertainties is not fundamentally different, mainly because most CAFE work builds upon the work within CLRTAP. In the course of time both within CLRTAP and CAFE the focus of uncertainty analysis shifted from statistical analysis to the detection of biases and to sensitivity analysis. A peer review of the RAINS model performed in 2004 under contract of the commission to establish the credibility of the RAINS model (Grennfelt et al. 2004) also re-enforced the credibility of the RAINS model within CLRTAP. National experts and policymakers in both policy arenas have the opportunity to inform themselves or give input with regard to uncertainty management. The RAINS team has been publishing regularly about uncertainties in the model and data bases used (e.g. Alcamo and Bartnicki 1990; Altman et al. 1996; Syri et al. 2000; Suutari et al. 2001; Amann et al. 2004; Schöpp et al. 2005). Furthermore in 2002 there has been a workshop on uncertainty analysis and RAINS at IIASA to which various participants in both the CAFE and CLRTAP

[33] The UK Abatement Strategies Assessment Model (ASAM) (ApSimon et al. 1994; ApSimon and Warren 1999; Warren and ApSimon 2000). See also http://www.huxley.ic.ac.uk/emma/IAU.htm

[34] A model developed through the DG Research 5th Framework Programme research project MERLIN (Multi-Pollutant Multi-Effect Modeling of European AiR Pollution ControL Strategies - an INtegrated Approach). See also http://www.merlin-project.info/

processes were invited[35]. However, according to participants in the course of CAFE process itself uncertainty did not get a lot of explicit attention.

5.4.5 Treatment of dissent

By tradition CLRTAP works by consensus. This means discussions are geared towards reaching a compromise. Sometimes this takes a long time. Reports of meetings also play the role of 'consensus documents' and constitute the collective memory of CLRTAP thereby ensuring credibility and legitimacy of the work.

Within CAFE the commission takes the decisions and the final policy proposal is the responsibility of the commission. Member States and stakeholders are consulted during the process. Though the Commission takes the comments seriously, there is no need for consensus.

According to participants who are involved in both processes those different principles of working also lead to a different starting point for countries. While in CLRTAP countries are more working together towards a common goal, within CAFE countries tend to protect their own stakes more. This also has consequences for the relevance and credibility they attribute to the assessments in the process.

5.4.6 Transparency

Transparency means that interested observers can readily see into an assessment process and judge for themselves the data, methods, and decisions used in the process (Farrell and Jäger 2005). In this sense the CLRTAP process has not been very transparent up to the second half of the 90s. Though information within CLRTAP (on e.g. data and models) was in principle open and reports were available and scientific meetings have been open as well, for just an 'interested observer' it was not so easy to get to know how to access this information. According to participants however, everything always has been transparent once you took part in the process. Still, according to participants who only recently joined the CLRTAP process it takes a while to become familiar with the procedures, though once you know them, they are clear. From the late 90s on transparency also to the outside world is improving rapidly. Reports and agendas of meetings as well as data and documentation on models and methods used are accessible through internet.

The CAFE secretariat took great efforts to make the CAFE process transparent: all agendas, meeting notes, inputs and participants lists of all meetings from the beginning have been made available on the internet. The same holds for reports of the modelling work and the documentation of

[35] See http://www.iiasa.ac.at/rains/meetings/Uncertainty-Jan2002/announcement.html

scenarios. Through the IIASA website all databases are available and the RAINS model can be viewed and used online[36]. Thus all inputs are open for the users to make their own judgement, which is important for credibility and legitimacy. Also the RAINS team regularly organises workshops to inform country and stakeholder experts on the principles of the model[37]. On the other hand, according to some participants the information load is difficult to handle. According to participants, the 'bilateral consultations' organised by the RAINS team at IIASA have been important for the transparency of the modelling and scenario work. The bilateral consultations were held to enable country experts to review the inputs in RAINS (country data in the databases and scenarios) for their own country. It was mostly organised in such a way that a delegate from an environment ministry visited IIASA together with a few experts from national Environment Protection Agencies. These bilateral consultations contributed to (1) *credibility* because they enabled country experts to verify the data and inspect the model structure, (2) *legitimacy* because all countries were involved to provide data: it was their own responsibility (3) *relevance*, because after review the data used would be more in line with data from the countries themselves. Through the bilateral consultations country experts could increase their own knowledge about the model and scenario work.

In practice the transparency of the assessment work in CAFE has re-enforced the transparency of the work in CLRTAP. Participants in the CLRTAP processes note that workshops, reviews, bilateral consultations organised in the context of CAFE also are also useful for CLRTAP.

According to participants, in the CAFE process it is not so transparent at what moment and how policy decisions are taken. It is not clear to participants in what part of the whole legislation and policy process the scientific knowledge will play a role. Officially neither the CAFE Steering Group nor any other group under the CAFE programme has the mandate to take decisions. The final proposal for the Thematic Strategy has been made by DG Environment which has been further discussed between the different services of the Commission before officially being launched as Commission proposal. According to participants, it is not transparent what the role of the scientific knowledge and integrated assessment at that moment is in that part of the process. See for more details of this process Tuinstra (2006).

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[36] See e.g. http://www.iiasa.ac.at/rains/Rains-online.html?sb=8

[37] See e.g. http://www.iiasa.ac.at/rains/meetings/methodology/announcement.html

5.5 Discussion: interdependency of CAFE and CLRTAP

The central question of this paper was how the roles and division of tasks between scientists and policy makers differ between the UN-ECE and the EU air pollution policy processes and whether these differences influence the way credibility, legitimacy and relevance of the assessment are established. Can a scientific knowledge framework produced in the context of one policy arena be as effective when applied in a different policy arena? What about the parallel development or co-production of knowledge and policy?

User characteristics and the historical context are to a certain extent similar in CLRTAP and CAFE, although these are different policy arenas. Participants in the two processes partially overlap and the two processes tackle to a certain extent the same policy problem. However, there are also differences. First, the UN-ECE includes more countries then only EU countries (e.g. Russian Federation and USA as well). Second, while the focus of CLRTAP is naturally on 'Long-range transboundary air pollution' the EU is also concerned with urban air pollution. Third, while within UN-ECE the policy process is one of international negotiation, within in the EU it is a matter of legislation and binding targets. And as we have seen in the preceding sections, there are differences in the design of the assessment processes in terms of e.g. initiation, participation and treatment of dissent.

With regard to the issue of co-production, we conclude that also on the EU level co-production of knowledge and policy takes place, and in such a way that it influences developments in CLRTAP. As VanDeveer (2004) notes, the centre of air pollution politics in Europe moved from CLRTAP to the EU. "LRTAP's knowledge producing bodies are now increasingly interwoven with EU-policy processes. […] The focus of scientific and technical research and advice has changed. Researchers and modellers at IIASA, whose RAINS model has been used by LRTAP negotiators for years, now design their models in response to feedback from staff at the EU Commission in Brussels. Air pollution knowledge is being reframed consistent with European integration and EU policy." (VanDeveer 2004, p. 322).

Despite the differences between the two different policy arenas the use in CAFE of the scientific knowledge framework (both the scientific knowledge base and the network that constitutes this knowledge base) as developed within CLRTAP can be effective and maintain credibility, legitimacy and relevance. However this can only be effective under certain conditions. One of those conditions is the effective functioning of CLRTAP as the CAFE assessment process is highly dependent on the CLRTAP process. We elaborate this further below.

First, the data collection and mapping efforts in the context of CLRTAP form also the basis for the analyses within CAFE. Second, within CLRTAP the possibility of participation in building up scientific knowledge in each country is important, both for the legitimacy of the process and for the capacity building within the countries. An own scientific basis in a country is needed for parallel development of scientific and policy understanding in that country. With regard to both points there are risks involved. First, when the EU policy process becomes dominant over the CLRTAP process, countries could shift their attention to the requirements of the EU. Then there is a risk that there are no funds or capacity available anymore in the countries to maintain the data collection infrastructure for CLRTAP. This would at a certain moment backfire on the EU process as well. Second, if only a few scientific groups under contract would perform analyses for the EU and no broadly embedded scientific basis would exist as now provided and facilitated by CLRTAP, there is the risk that other countries cannot follow or relate to the analyses anymore which would undermine credibility, legitimacy and relevance of the assessment process in the EU for several countries.

In turn, for CLRTAP it is important to stay alert on the "reframing of air pollution knowledge consistent with European integration and EU policy" (VanDeveer 2004, p 322) as the UN-ECE encompasses more than the EU only. Also non-EU countries have to remain able to follow the process and the analyses as well as to subscribe to them. Also it would be a good strategy to keep room for negotiations and consensus. If the process for the EU countries within the UN-ECE develops isolated from the other countries, little room for manoeuvre remains and there is the risk that those UN-ECE countries that are not involved in the EU process do not feel involved anymore. A broad basis for consensus still is needed within CLRTAP and therefore both knowledge and policy development in CLRTAP should ideally develop in parallel with the developments in the EU. Parallel development is also desirable in order to avoid double work and to create work-flows that are as efficient as possible.

Remaining alert and encouraging parallel development in the two policy arenas offers lots of opportunities to enhance effectiveness as we have seen in our analysis. CAFE has build on the credibility of the CLRTAP knowledge framework and in turn re-enforced credibility and legitimacy of CLRTAP work e.g. through the RAINS review and bilateral consultations. Furthermore funds for CAFE work also favour developments in CLRTAP. Furthermore, regional air pollution problems can not be solved without the non-EU countries (see also Grennfelt and Hov 2005). And because of the stronger compliances mechanism CAFE plays an important role in attaining environmental targets both set by the EU and the UN-ECE. Both policy processes serve their own goal and will remain having their own important tasks. The geographical broad participation of countries in UN-ECE CLRTAP will be key to facilitate meaningful negotiation about hemispheric air pollution and the linkages between climate change and air pollution. It will be important also for the EU to keep taking full advantage of the scientific network built up during more than 25 years scientific collaboration within UN-ECE CLRTAP.

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Chapter 6 Conclusions and discussion

6.1 Introduction

The main objectives of this thesis were (1) to contribute to the understanding of the processes at the interface between science and policy in shaping assessment frameworks and assessment processes in the field of air quality policy making in Europe; and (2) to contribute to the understanding of the role of boundary work in enhancing credibility, legitimacy and relevance of assessments.

The theoretical basis was the literature on the impacts and effectiveness of scientific assessment in environmental policy and literature on boundary work between science and policy. The empirical basis for this research was formed by the assessment processes within the United Nations-Economic Commission for Europe Convention on Long-range Transboundary Air Pollution (UN-ECE CLRTAP) and the Clean Air for Europe (CAFE) process in the European Union (EU). A framework for the analysis of the interactions between science and policy in assessment processes was developed. This framework was used to address three research questions:

1. How do participants in different settings of air quality policy making in Europe divide and co-ordinate work between science and policy?
2. How does this division of work shape the design of these assessment processes and enhance credibility, legitimacy and relevance of the assessments?
3. How do the roles and division of tasks between scientists and policy makers differ between different settings of air quality policy making in Europe and how do these differences influence the way credibility, legitimacy and relevance of the assessments are established?

In the following, section 6.2 draws conclusions regarding the three research questions for both cases CLRTAP and CAFE and the overall objectives of this study. Section 6.3 reflects on the findings and limitations of the study and discusses recommendations for policy and research.

6.2 Conclusions

6.2.1 Division and co-ordination of work between science and policy (Research Question 1)

How do participants in different settings of air quality policy making in Europe divide and co-ordinate work between science and policy? Based on chapter 3 we conclude that already from the beginning CLRTAP established a dual framework of scientific assessment and political interaction, which gradually changed over time and is still functioning. The first protocol within CLRTAP (establishing the financing of the monitoring network EMEP) was a protocol which explicitly addressed scientific co-operation and organized scientific input for the Convention. The critical loads concept became a driving force for scientific research and policy development, and provided a "common concept" for science and policy. It has served as an important tool for connecting scientific knowledge to policy-making and has different meanings for the involved actors, which include heterogeneous views on the boundary between science and policy (Sundqvist et al., 2002).

The application of the critical loads concept and of the cost-effectiveness principle went together with a major coordinated effort of data collection by the parties to the Convention in the fields of energy, emissions, technology, control costs, atmospheric dispersion and mapping of critical loads. In all parties to the Convention national focal centres were established to provide these data. A number of Working Groups and Task Forces regularly review this information. The outcome of this scientific assessment process is submitted to the Working Group on Strategies, whose members are civil servants, representing governments of parties to the Convention, which uses this information to assist its negotiations on further emission control agreements.

Based on chapter 4 we conclude that while the CAFE program builds further on the experiences from the 1997 Acidification Strategy and National Emissions Ceilings (NEC) directive, it is explicitly organized as a more open and transparent process. In the science-policy interaction processes in preparation of the 1997 Acidification Strategy and National Emissions Ceilings (NEC) directive only a few scientific consultants had been involved. Within the CAFE process which led to the 2005 EU Thematic Strategy on Air Pollution a mechanism for stakeholder involvement was in place. Furthermore, data provided from Member States have been used and scenario inputs from Directorate Generals of the European Commission other than DG Environment have been applied. Data, scenario outputs, results of analyses and reports of meetings all have been made available through the internet.

According to the 6th Environmental Action Programme of the EU, of which the Thematic Strategy on Air Pollution is a result, all environmental policy-making must be based on participation and the best available scientific knowledge. Within the CAFE integrated assessment process the Commission services, personified by the CAFE secretariat, take the lead. The role of the scientists is one of being a consultant and the role of the Member States (representatives in the Steering Group) is to give comments.

We conclude that especially in the beginning of the process, boundary work took place in the negotiation on roles and identities of "experts" and "stakeholders" and the scope of various working groups in CAFE. First by identifying and establishing the scope of the programme itself: CAFE was set up as a programme for technical analysis and policy development, not for political decision making. Secondly in the definition of the role of the Steering Group and the Technical Analysis Group (TAG): interpretations on the role of the TAG ranged from a co-ordination forum of work under contract to a place to give expert input. Thirdly, in the definition of the identity of specific groups: industry saw an expert role for itself while the Commission saw industry mainly as stakeholders and furthermore made a distinction between "experts" and "contractors". We also conclude that for industry the boundary work was in a way "not completed". Industry was not satisfied with its role as stakeholder instead of expert.

6.2.2 Shaping the assessment design and the impacts on credibility, legitimacy and relevance of assessments (Research Question 2)

How does the division of work between science and policy shape the design of the assessment processes and enhance credibility, legitimacy and relevance of the assessments? Based on chapter 3 we conclude that the assessment process in CLRTAP has been sufficiently credible, legitimate and relevant in the eyes of various significant audiences. The science-policy interaction which took place within CLRTAP generally has been described as a success story both by policy makers, scientists and analysts. Factors mentioned in this success are the direct link between relevant science and policy preparation, strong personal networks and a science-policy network with a strong memory. Other factors are the important role of the framework offered for countries to provide their own data, the ability to adapt scientific and policy frameworks to developments in science and policy and trust in the decision making processes within which the assessments were conducted.

Credibility, legitimacy and relevance with many audiences were enhanced by boundary work in an early stage of the process. For example members of the RAINS team were very early participants in boundary work. RAINS, the policy development within CLRTAP and the set up of the data collection structure, partly influenced the course of each others developments.

The example of the use of models and monitoring which could be managed and applied in all countries ("lowest common denominator standard") shows that careful boundary work balancing between scientific standards and meeting policy needs, led to uncertainty management approaches which enhanced credibility and legitimacy of this assessment procedure. The context determined what kind and which degree of uncertainty was acceptable.

Similar boundary work can be observed in the creation of the "gap-closure" concept which was inspired by the necessity to come to consensus in the policy debate. The concept fitted both the policy concerns and the framing of the scientific debate in the final stage of the negotiations for the 1994 Oslo protocol and since then has been a commonly applied concept both in

CLRTAP and EU policy making. In its context it was both to multiple audiences politically legitimate because of its equity dimension, and scientifically credible because of its connection to environmental effects.
In short, boundary work in the assessment processes in CLRTAP has been enhanced because a forum was provided, where boundaries between science and policy could be discussed. This enabled a successful division and co-ordination of work between science and policy which made the boundaries in the CLRTAP process to remain quite stable through the years.

Based on chapter 4 we conclude that on the one hand the CAFE process indeed established credibility, legitimacy and relevance with the majority of the actors involved. The bilateral consultations, the review of the RAINS model and other models involved, and the transparency and documentation of the integrated assessment work played an important role in enhancing this for the Member States.

The bilateral consultations contributed to credibility because they enabled Member State experts to verify the data and inspect the model structure; to legitimacy because all Member States were involved to provide data; and to relevance, because after review the data used would be more in line with data from the Member States themselves. With regard to the review of the RAINS model we saw that the international review team concluded that the RAINS model was sufficiently credible to be used as a tool in policy Participants in the CAFE Steering Group regarded the review as an strategic step to enhance credibility of the model while at the same time to them the bilateral consultations were more important to enhance, if not credibility, in any case legitimacy of the model, the data and the analyses.

On the other hand we have seen that in the CAFE process conflicting views existed about the right forum for the discussion of certain issues and the participants entitled to give input in this discussion. For example the UNICE letter to European Commission president Barroso suggests that industry was not satisfied with its role and appointed identity as stakeholder instead of expert. UNICE complained that the process and inputs were not transparent and that member states and industries were not able to evaluate the results of model runs. Though other stakeholders disagreed with this statement we have seen that it made Barroso postpone the Thematic Strategy on Air Pollution.

6.2.3 Establishing credibility, legitimacy and relevance in CLRTAP and CAFE: differences and linkages (Research Question 3)

How do the roles and division of tasks between scientists and policy makers vary between different settings of air quality policy making in Europe and how do these differences influence the way credibility, legitimacy and relevance of the assessments are established? Based on chapter 5 we conclude that the CLRTAP process differs from the CAFE process in that it in principle uses a 'bottom up' approach of organising scientific input and works with voluntary networks of country experts, whereas the European Commission uses a more 'top-down' approach and hires consultants.

With regard to the policy process itself, the UN-ECE policy process is one of international negotiation, while within in the EU it is a matter of legislation. Furthermore, the UN-ECE does not have a strong compliance mechanism while the EU legislation will result in binding targets.

With regard to the setting, the UN-ECE includes more countries than only EU countries (e.g. Russian Federation and USA as well). This has consequences for the focus of both the policy and the scientific work, as for example the UN-ECE becomes a natural site to deal with issues like e.g. hemispheric air pollution and the linkages between climate change and air pollution. Second, while the focus of CLRTAP is naturally on 'Long-range transboundary air pollution' the EU is also concerned with urban air pollution. This has consequences for the applicability of models. Models designed to tackle transboundary air pollution are not necessarily well equipped to perform assessments of local air pollution problems.

Despite the differences between the two policy settings, user characteristics and the historical context are to a certain extent similar in CLRTAP and CAFE and participants in the two processes partially overlap and tackle the same policy problem. Also we have seen that CAFE and CLRTAP are much intertwined and dependent on each other. With regard to establishing credibility, legitimacy and relevance we conclude that CAFE in its assessments process rather focuses on building legitimacy, whereas it builds its credibility on the credibility established in the work of CLRTAP.

The scientific knowledge framework as developed within CLRTAP can maintain credibility, legitimacy and relevance when it is used in CAFE. However, certain conditions have to be fulfilled.

First, based on chapter 3 we conclude that new boundary work is needed when knowledge produced in the context of CLRTAP is used in other policy contexts or when new participants enter the arena. It could be argued that this need in CAFE would be less than in the case of 'a start from scratch', because of for instance the established networks and credibility. Nevertheless, the need is still significant because new participants have new perceptions of the problem and also need to establish their own roles. With regard to relevance, the issue of local air pollution in CAFE shows that also new scientific knowledge has to be developed in order to be able to deal with the relevant questions.

Second, another condition is the effective functioning of CLRTAP, because the CAFE assessment process remains also dependent on the CLRTAP process. One of the reasons is that the data collection and mapping efforts in the context of CLRTAP form also the basis for the analyses within CAFE. Another condition is that a broadly embedded scientific basis remains in the countries, as now provided and facilitated by CLRTAP. If only a few scientific groups under contract would perform analyses for the EU, without a scientific basis in other countries, there is the risk that those countries cannot follow or relate to the analyses anymore. This would undermine credibility, legitimacy and relevance of the assessment process in the EU for several countries.

6.2.4 Overall Conclusions

With respect to the main objectives of this thesis, i.e. contributing to the understanding of (1) the processes at the interface between science and policy in shaping assessment frameworks and assessment processes in the field of air quality policy making in Europe; and (2) the role of boundary work in enhancing credibility, legitimacy and relevance of assessments, we conclude the following:

(1) The field of air quality policy making in Europe provides a clear picture of how science and policy influence each other and develop together. Iterations between scientists and policy makers in CLRTAP for example furthered the development of measuring methods, data collection procedures and the development of models. Simultaneously the availability of scientific tools inspired the set up of expert bodies within the framework of CLRTAP. Furthermore the air pollution problem was framed through the concepts, tools and data available e.g. conceptualising air pollution as a transboundary air pollution problem with a focus on the relation between emissions and effects in terms of critical loads.

Ideas about what counts as credible, legitimate and relevant can be quite stable. We showed this with the example of the RAINS review which judged the model fit for policy both in the context of CLRTAP and CAFE. The stability of the framing of the problem of air pollution in Europe also means that the issues that are supposed to be relevant, the “language” spoken in the policy process and the scientific disciplines judged to be relevant have remained stable. This counts both for CAFE and CLRTAP.

As we saw from the CAFE case ideas about what should be the tasks of science and policy differ for ‘newcomers’ in the process, because they have not been involved in the early boundary work which set the boundaries. Thus they have a different view on credibility and legitimacy because they have different expectations of scientific and policy actors. Newcomers also have a different view on relevance, because they have a different problem frame. New boundary work is therefore needed when different structures for interactions between scientists, policy makers and stakeholders are set up. The dispute about the role of industry as an expert or stakeholder in the CAFE process which caused problems for credibility and legitimacy of the process illustrates this. An example of an innovation in the CAFE process with regard to the division of roles of different experts and the role of member states are the bilateral consultations, which enhanced credibility and legitimacy of the models used.

(2) Though this study focused on the specific issue of air pollution in Europe, several insights are also valuable in other policy areas and on other levels of policy making. Demands on the communication process between scientists and policy makers in order to create assessments that indeed provide useful information to decision making, vary in different contexts. A recipe thus cannot be given. However, we learned that the division of roles between science and policy can be fixed already in early stages of an assessment process. For a while this can provide a situation in which the division of roles between science and policy are clear and in which a common view exists on what kind of information and what kind of behaviour is credible, legitimate and relevant. At a certain point this can change again: when the context changes or when participants change. New rules for credibility, legitimacy and relevance have then to be established. Note that this implies that there is no straight forward answer to the questions when assessments are considered useful or how scientists can maintain their credibility when they engage in policy issues. This depends on the context and is determined by boundary work.

Boundary work takes always place, but in what cases will it be successful in the sense that it leads to meaningful interaction between science and policy? Awareness that negotiations on roles and tasks of science and policy implicitly take place is a first step. In the introduction we mentioned the Global Energy Assessment which is currently being set up. What should the organisers pay attention to? Taking the framework for analysis as developed in this study as a starting point, one could argue that a careful assessment of the context and user characteristics is needed. Then the goals have to be specified. Why do we do this in the first place? Do the different participants and users have different needs? Who participate anyway? In dealing with these questions the actors involved have to be aware that boundary work has implicitly started. In defining the goals, in defining the participants, in defining the users: roles will already be defined and tasks divided. In this early phase it is important to know who needs to be involved in this boundary work (or who is going to be involved no matter whether you like it or not). While this process is going on, step by step also the ways to deal with uncertainties and dissent will be established, the framing and the scale of the problem will be articulated, and capacity needs and needs for quality control will be formulated. In all these activities boundary work will be involved. Thus, it is not a matter of just copying the example of the Intergovernmental

Panel Climate Change or the Millennium Ecosystem Assessment, but taking into account the difference in audience, context and time.

6.3 Discussion

6.3.1 Discussion and recommendations for further research

This thesis has added to the existing literature by analysing and comparing science policy interaction processes both in the UN-ECE CLRTAP and the EU CAFE process, applying a new framework for analysis that enabled a focus on the science policy interface.

The combined framework for analysing credibility, legitimacy and relevance and for analysing boundary work developed for this study turned out to be helpful in describing the processes at the science-policy interface. The use of the concepts ‘credibility’, ‘legitimacy’ and ‘relevance’ helped to assess the ‘usefulness’ of assessments in terms that took into account both scientific and policy needs and requirements. It also provided a means to deal with the many meanings of ‘effectiveness’ of assessments, depending on goals and audiences. The combination with the concept of boundary work made it possible to examine the dynamic relationships between science and policy. We have shown that these dynamics themselves influence the design and the design aspects of the assessment.

It would be useful to apply the framework also systematically to other cases in order to further investigate its strengths. Not all aspects of the framework did get equal attention in this study: the design elements scale, quality control and capacity have not been further applied in the cases in this study. Furthermore the specific role of boundary texts, boundary objects and boundary people offers room for more detailed investigation. This could be part of future research.

The focus of the research also implied limitations. While focussing on science-policy interactions at a European scale, e.g. at the interaction between the European Commission, member states, representatives of European stakeholder groups and experts directly under contract with the commission, this study has not paid attention to science-policy interaction at the national levels. Experts advising delegations of member states within e.g. the CAFE Steering Group have been playing a different role than experts advising the Commission. It would be interesting to investigate their role, not only during the expert-phase in which proposals were developed within the European Commission, but also during negotiations between Member States in the European Council and in the European Parliament. Also a more detailed analysis of the role of national experts and national civil servants involved both in national policy making and European policy making would be valuable.

Because the focus of this study has been on assessment processes in which scientific information has been integrated on a general level, it has not paid attention to the deliberations involved in specific studies like the cost-benefit analysis within CAFE (Holland et al., 2005) or the science-policy interaction processes which have led to the set up of e.g. limit values of specific pollutants. Interesting cases for further research would be the science-policy interaction processes which have led to the determination of e.g. limit values for Particulate Matter (PM10 and PM2.5) and for nitrogen oxides (NO_x). Further research into this area would be relevant in the light of recent debates such as in e.g. the Netherlands about exceedance of limit values and involved uncertainties both with regard to health effects and with regard to measurements.

Another important issue which was beyond the scope of this study, but is of significance for credibility, legitimacy and relevance of assessments is the issue of participation of stakeholders and citizens. Though this study signalled the role of certain groups of stakeholders in e.g. the CAFE Steering Group it did not go into the knowledge and knowledge needs of specific groups like e.g. patients with lung diseases. What would be the relevance for this group of the scientific knowledge generated within the CAFE or the LRTAP processes? What kind of policy relevant information could these groups themselves have been contributing? How does European air pollution policy relate to local air pollution policy, and what could be the role of local knowledge and situated knowledge in generating understanding of air pollution issues? Further research in these areas could build on valuable work of Bailey et al. (1999), Yearly (2000) and Yearly et al. (2001) who investigated the way in which the public use and understand information from models and the inclusion of non-specialist, spatially referenced information in policy. Possible further research in this area could also meaningfully connect to the framing of air pollution problems in relation to relevance of the information produced.

Compared to other studies which conducted similar research on science-policy interactions in LRTAP, this study has paid little attention to the issue of “power”. For example Bäckstrand (2001) and VanDeveer (2004; 2005) show the dominance of North-West European Countries over Eastern European countries in pushing the framing of the air pollution issue in LRTAP. This study did not go into this because the focus was not on international relations but rather on boundaries between science and policy. Nevertheless, the power issue is of significance because it is related to the issue of relevance and legitimacy of assessments.

6.3.2 Implications for policy and practice

The insights from this study imply that not only there is no recipe for science; there is also no recipe for policy, other than taking the context into account. The importance of boundary work and the continuous negotiation about roles, tasks and rules for co-operation between science and policy show that no standard rules can be given for dealing with uncertainties and scientific standards.

A recommendation to policy makers would therefore be to be careful with the use of labels like "correct" or "incorrect" for measurements or "dangerous" or "safe" for limit values". Also important is awareness that the framing of the problem implies what kind of science and what kind of data apply as relevant. If frames are not clearly articulated also misunderstandings and disagreements can rise about what information or which actor is relevant to the problem. Indicators or solutions from one frame may not be recognised as being relevant in another frame. Possibly this is one of the reasons that it is so difficult to link EU priorities to local priorities with regard to air pollution. It is important to acknowledge differences in perception or framing of air pollution issues to be able to understand different priorities. This will improve the communication between the various groups in the science-policy interface.

With respect to other environmental and sustainability issues like the issues of climate change or energy use the relationships between policy priorities, scientific knowledge and stakes of different groups are even more complex. Linkages between different scales of policy exist, as do various sources of scientific knowledge exist and various framings of the issue. On the various scales different models apply and different data are relevant. Boundary work in this case takes place on many levels, and it is a challenge to establish credibility, legitimacy with multiple audiences. A starting point for both scientists and policymakers taking up assessments in these areas, is to be aware of which boundaries play a role in their particular cases.

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Summary

In the field of air quality policy making in Europe a long tradition exists in using scientific information to support negotiations and decisions. This tradition is characterised by an intensive communication process between scientists and policy makers in so called integrated assessment processes. Knowledge from different scientific disciplines such as economy, soil-science, ecology, meteorology and other knowledge sources is integrated to serve as a basis for decision making. A relevant issue in this respect is what demands have to be made on the communication process between scientists and policy makers in order to create assessments that indeed provide useful information to decision making. Also questions like how scientists maintain their credibility when they engage in policy issues are of interest. And can a straightforward answer be given on these questions at all?

This thesis explores the communication process between science and policy actors in assessment processes in the field of air quality policy in Europe. It focuses on the boundaries between science and policy and on the processes that shape assessments. It uses a concept of effectiveness of scientific assessments in policy processes in terms of credibility, legitimacy and relevance, in combination with the concept of "boundary work". Credibility is the scientific and technical credibility of the assessment to a user of the assessment. Legitimacy is the political acceptability or perceived fairness to a user. Relevance refers to the extent to which an assessment and its results address the particular concerns of the user. Boundary work is the practice of maintaining and withdrawing boundaries between science and policy, shaping and reshaping the science-policy interface.

The objectives of this thesis are (1) to contribute to the understanding of the processes at the interface between science and policy in shaping assessment frameworks and assessment processes in the field of air quality policy making in Europe and (2) to contribute to the understanding of the role of "boundary work" between science and policy in enhancing credibility, legitimacy and relevance of assessments. To this end the following research questions are addressed: (1) How do participants in different settings of air quality policy making in Europe divide and co-ordinate work between science and policy?; (2) How does this division of work shape the design of these assessment processes and enhance credibility, legitimacy and relevance of the assessments?; and (3) How do the roles and division of tasks between scientists and policy makers differ between different settings of air quality policy making in Europe and how do these differences influence the way credibility, legitimacy and relevance of the assessments are established?

In order to answer the research questions first a framework for the analysis of the interactions between science and policy in assessment processes is

developed. This framework builds further upon the concept of effectiveness as developed in the Global Environmental Assessment (GEA) project. This concept considers effectiveness as an emerging property from credibility, legitimacy and relevance. The framework developed in this thesis combines the features of the GEA framework with the notion of "boundary work" between science and policy. Starting point for the framework is that it is not easy to draw a sharp line between scientific and policy making activities in an assessment process. Neither can scientists' or policy makers' roles as actors in such processes always be precisely defined. Negotiation takes place about the identity of practices (such as "science" and "policy") and actors (such as "scientists" and "policy makers") and their collaboration. The combined framework adds to the literature because it has a special focus on the science-policy interface. This helps us to improve our understanding of co-production of science and policy: the simultaneous development of the problem framing, division of labour between science and policy, the assessment framework and the policy framework.

Subsequently the framework for analysis is applied to two cases referring to different policy settings in air quality policy making in Europe. One is set in the framework of the Convention on Long-range Transboundary Air Pollution (CLRTAP) of the United Nations- Economic Commission for Europe (UN-ECE which includes EU and non-EU countries). The other is set in the context of the work of the European Commission within the EU and discusses the preparatory work for the Thematic Strategy on Air Pollution, the Clean Air for Europe Programme (CAFE). Data for the analysis of the cases are derived from (1) the study of official documents and reports of meetings of various bodies operating in the science-policy interface as well as of informal documents; (2) interviews with delegates and scientists involved in the processes, as well as interviews with those not directly involved; and (3) observations in official meetings as well as observations of working processes and informal meetings.

The analysis of the CLRTAP case shows that already from the beginning in the mid-seventies CLRTAP established a dual framework of scientific assessment and political interaction, which gradually changed and still functions. The critical loads concept, an effects-based approach to base pollution abatement strategies on, became a driving force for scientific research and policy development. It provided a "common concept" for science and policy. The application of the critical loads concept and of the cost-effectiveness principle went together with a major coordinated effort of data collection by the parties to the Convention. Careful boundary work balanced between scientific standards and standards meeting policy needs. This led to uncertainty management approaches which enhanced credibility and legitimacy of assessment procedures. The context determined what kind and degree of uncertainty in scientific information was being accepted. Knowledge produced within the CLRTAP process and the institutional setting in which this knowledge production takes place cannot be separated from each other: they are co-produced. Furthermore, in the CLRTAP-case, credibility, legitimacy and relevance were to a large extent determined by boundary work in an early stage of the process. At the same time boundary work has to take place continuously in order keep the assessment process credible, legitimate and relevant for new audiences.

The analysis of the CAFE case shows that the European Commission from the preparations in the late nineties and the beginning in 2001 took great effort to organise a transparent assessment process based on scientific knowledge and with extensive involvement of stakeholders and Member States. Bilateral consultations, review of integrated assessment models, and transparency and documentation of integrated assessment work played an important role in enhancing credibility, legitimacy and relevance for the Member States. Especially in the beginning of the process boundary work can be discerned in the negotiation on roles and identities of "experts" and "stakeholders" and the scope of certain groups. In the CAFE process conflicting views existed about the right forum for the discussion of certain issues and the participants entitled to give input in this discussion. Some industry groups were not satisfied with their role as stakeholders instead of experts. Also the real place and time where decisions took place (and thus where the integrated assessment work is relevant) have not been transparent in the process, according to certain participants.

Subsequently the CLRTAP case and the CAFE case are compared in this thesis. Taking co-production of science and policy as a starting point the question is addressed whether the scientific knowledge framework produced in the context of one policy arena can keep its credibility, legitimacy and relevance when used in a different policy arena. The analysis of the comparison of the CLRTAP and the CAFE case shows that the European Commission is using knowledge produced in the context of CLRTAP to develop its own air quality strategies. The process within the European Commission differs from CLRTAP in that it hires consultants and will result in binding targets, whereas the CLRTAP process works with voluntary networks of country experts and does not have a strong compliance mechanism. At the same time the work of the European Commission and of CLRTAP are much intertwined and dependent on each other. The European Commission in the process rather focuses on building legitimacy, whereas it builds its credibility on the credibility established in the work of CLRTAP. The analysis shows that the scientific knowledge framework as developed within CLRTAP can maintain credibility, legitimacy and relevance when it is used in CAFE. However, certain conditions have to be fulfilled. One condition is the effective functioning of CLRTAP, because the CAFE assessment process remains also dependent on the CLRTAP process. The data collection and mapping efforts in the context of CLRTAP form also the basis for the analyses within CAFE. Another condition is that a broadly embedded scientific basis remains in the countries, as now provided and facilitated by CLRTAP. If only a few scientific groups under contract would perform analyses for the EU, without a scientific basis in other countries, there is the risk that those countries cannot follow or relate to the analyses anymore. This would undermine credibility, legitimacy and relevance of the assessment process in the EU for several countries. At the same the EU is financing models and data collection which are used in CLRTAP as well.

The field of air quality policy making in Europe provides a clear picture of how science and policy influence each other and develop together. Iterations between scientists and policy makers in CLRTAP, for example, furthered the development of measuring methods, data collection procedures and the development of models. Simultaneously the possibilities of integrated assessment models inspired the set up of expert bodies such as the Task Force on Integrated Assessment Modelling within the framework of CLRTAP. Furthermore the air pollution problem was framed through the concepts, tools and data available e.g. conceptualising air pollution as a transboundary air pollution problem with a focus on the relation between emissions and effects in terms of critical loads.

Ideas about what counts as credible, legitimate and relevant can be quite stable. This becomes clear in this thesis from the presented example of the 2004 RAINS review which judged the model fit for policy both in the context of CLRTAP and CAFE. The stability of the framing of the problem also means that the issues judged to be relevant, the “language” spoken in the policy process and the scientific disciplines supposed to be relevant have remained stable.

As has been shown in the CAFE case, ideas about what should be the tasks of science and policy differ for ‘newcomers’ in the process, because they have not been involved in the early boundary work which set the boundaries. Thus they have a different view on credibility and legitimacy because they have different expectations of scientific and policy actors. Newcomers also have a different view on relevance, because they have a different problem frame. New boundary work is therefore needed when different structures for interactions between scientists, policy makers and stakeholders are set up. The dispute about the role of industry as an expert or stakeholder in the CAFE process illustrates this.

Though this thesis focused on the specific issue of air pollution in Europe, several insights are also valuable in other policy areas and on other levels of policy making. Demands on the communication process between scientists and policy makers in order to create assessments that indeed provide useful information to decision making, vary in different contexts. A recipe thus cannot be given. However, the division of roles between science and policy can be fixed already in early stages of an assessment process. For a while this can provide a situation in which the division of roles between science and policy are clear and in which a common view exists on what kind of information and what kind of behaviour is credible, legitimate and relevant. At a certain point this can change again: when the context changes or when participants change. New rules for credibility, legitimacy and relevance have then to be established. This implies that there is no straight forward answer on the questions of when assessments are considered useful or how scientists can maintain their credibility when they engage in policy issues. This will depend on the context and be determined by boundary work.

The continuous negotiation about roles, tasks and rules for co-operation between science and policy implies that no standard rules can be given for dealing with uncertainties and scientific standards. Careful use of labels like "correct" or "incorrect" for measurements or "dangerous" or "safe" for limit values is therefore recommended. The framing of the problem implies what kind of science and what kind of data apply as relevant. If frames are not clearly articulated also misunderstandings and disagreements can rise about what information or which actor is relevant to the problem. Indicators or solutions from one frame may not be recognised as being relevant in another frame. This is one of the reasons why it is so difficult to link EU priorities with regard to air pollution to local priorities. It is important to acknowledge differences in perception or framing of air pollution issues to be able to understand different priorities. This will improve the communication between the different groups in the science-policy interface and enhance the mitigation of air pollution in Europe.

Samenvatting

Het gebruik van wetenschappelijke informatie om onderhandelingen en beleidsbeslissingen over het terugdringen van luchtverontreiniging te ondersteunen kent in Europa een lange traditie. Er is sprake van een intensief communicatieproces tussen onderzoekers en beleidsmakers. Kennis van verschillende wetenschappelijke disciplines zoals economie, bodemkunde, ecologie, meteorologie en andere kennisbronnen wordt geïntegreerd om beleidsbeslissingen te ondersteunen. Dit proces wordt in jargon een *assessment*proces genoemd. Welke eisen moeten worden gesteld aan het communicatieproces tussen onderzoekers en beleidsmakers om ervoor te zorgen dat *assessments* effectief zijn en inderdaad bruikbare informatie opleveren in een beleidscontext? Hoe kunnen onderzoekers hun wetenschappelijke geloofwaardigheid waarborgen als ze intensief betrokken raken bij beleidszaken? En kan op dergelijke vragen wel een eenduidig antwoord worden gegeven?

Dit proefschrift verkent het communicatieproces tussen onderzoekers en beleidsmakers in assessmentprocessen ter ondersteuning van de ontwikkeling van luchtkwaliteitbeleid in Europa. Het richt zich met name op de grenzen tussen wetenschap en beleid en de processen waardoor assessments tot stand gebracht worden. Dit proefschrift beschrijft effectiviteit van assessments in termen van geloofwaardigheid, legitimiteit en relevantie en combineert dit met het begrip “grenzenwerk”. Geloofwaardigheid is de mate waarin de wetenschappelijke en technische kwaliteit van een assessment gewaardeerd wordt. Legitimiteit is de mate waarin de assessment maatschappelijk en politiek geaccepteerd wordt. Relevantie verwijst naar de maatschappelijke relevantie van assessments. “Grenzenwerk” kan worden gezien als het definiëren en onderhouden van grenzen tussen wetenschap en beleid, waardoor het grensvlak van wetenschap en beleid steeds opnieuw wordt vormgegeven.

De doelstellingen van dit proefschrift zijn (1) bij te dragen aan kennis over de processen op het grensvlak van wetenschap en beleid in het vormgeven van assessmentprocessen in luchtkwaliteitbeleid in Europa en (2) bij te dragen aan kennis over de rol die “grenzenwerk” tussen wetenschap en beleid speelt in het bevorderen van geloofwaardigheid, legitimiteit en relevantie van assessments. Daartoe wordt ingegaan op de volgende onderzoeksvragen: (1) Hoe verdelen en coördineren deelnemers in verschillende beleidssituaties op het gebied van luchtkwaliteitbeleid in Europa rollen tussen wetenschap en beleid?; (2) Hoe geeft deze werkverdeling vorm aan de betreffende assessmentprocessen en hoe bevordert deze geloofwaardigheid, legitimiteit en relevantie van de assessments?; en (3) Hoe verschillen de rollen en taakverdelingen tussen wetenschappers en beleidsmakers in de verschillende beleidssituaties en hoe beïnvloeden deze de manier waarop geloofwaardigheid, legitimiteit en relevantie van de assessment tot stand worden gebracht?

Om deze onderzoeksvragen te beantwoorden wordt eerst een kader voor de analyse van de interacties tussen wetenschap en beleid in assessmentprocessen ontwikkeld. Dit analysekader bouwt voort op het begrip effectiviteit zoals dat is ontwikkeld in het Global Environmental Assessment (GEA) project van de universiteit van Harvard. Volgens dit begrip is de effectiviteit van een assessment een eigenschap die voortkomt uit de geloofwaardigheid, legitimiteit en relevantie van de assessment. Het analysekader in dit proefschrift combineert het GEA-kader met het begrip "grenzenwerk". Uitgangspunt voor het analysekader is dat in een assessmentproces geen eenduidige lijn te trekken is tussen wetenschappelijke activiteiten en beleidsactiviteiten. Ook kunnen rollen van wetenschappers en beleidsmakers als actoren in het proces niet precies worden gedefinieerd. Onderhandelingen vinden noodzakelijkerwijs plaats om werkvelden (wat geldt als het domein van "de wetenschap" en wat als het domein van "beleid") en actoren (wie gelden als de "wetenschappers" en wie als de "beleidsmakers") te identificeren en hun manier van samenwerken te bepalen. Het gecombineerde analysekader in dit proefschrift richt zich met name op het grensvlak van wetenschap en beleid. Daarmee geeft het inzicht in de gezamenlijke ontwikkeling of coproductie van wetenschap en beleid. Deze coproductie betreft de gelijktijdige ontwikkeling van probleemformulering, onderzoekskaders, beleidskaders en de verdeling van taken tussen wetenschap en beleid.

Vervolgens wordt in dit proefschrift het analysekader toegepast op twee casussen die betrekking hebben op twee verschillende beleidssituaties in Europees luchtkwaliteitbeleid. De eerste betreft de Conventie aangaande grensoverschrijdende luchtverontreiniging (CLRTAP) van de Economische Commissie voor Europa van de Verenigde Naties (UN-ECE, waarin zowel EU als niet-EU landen participeren). De andere betreft het werk van de Europese Commissie voor het opstellen van het beleidsdocument dat de Thematische Strategie Luchtverontreiniging voor de EU beschrijft. Dit werk wordt uitgevoerd in het kader van het Clean Air for Europe (CAFE) programma. Gegevens voor de analyse van de casussen zijn verkregen via (1) officiële documenten en rapporten van verschillende organen die op het grensvlak van wetenschap en beleid opereren en via informele documenten; (2) interviews zowel met delegaties en onderzoekers betrokken bij het proces, als met personen die niet direct betrokken waren; en (3) waarnemingen bij officiële bijeenkomsten en in werkbijeenkomsten en informele bijeenkomsten en werkvoorbereidingen.

De analyse van de CLRTAP-casus in dit proefschrift laat zien dat al vanaf het begin in het midden van de jaren zeventig, CLRTAP een tweeledig kader van wetenschappelijke assessment en van beleidsontwikkeling instelde. Dit kader evolueerde geleidelijk en functioneert nog steeds. Het "critical loads concept", een concept dat betrekking heeft op de effecten van luchtverontreiniging, werd een sturende kracht in het ontwikkelen van wetenschap en beleid. Het voorzag in een gezamenlijk concept voor wetenschap en beleid. De toepassing van het critical loads concept en van het kosteneffectiviteitprincipe ging gepaard met een grootscheepse inspanning van de betrokken landen om data te verzamelen. Zorgvuldig grenzenwerk bewaarde het evenwicht tussen wetenschappelijke standaarden en standaarden die voldeden aan beleidseisen. Dit leidde bijvoorbeeld tot een aanpak van onzekerheid in wetenschappelijke gegevens die de geloofwaardigheid en legitimiteit van assessmentprocedures bevorderde. De context bepaalde in dit geval welke mate van onzekerheid in de informatie acceptabel was. Daarom kan de kennis die in het CLRTAP-proces is ontwikkeld niet los gezien worden van de institutionele setting waarin dit gebeurde. Beide zijn gezamenlijk ontwikkeld. Verder zijn de geloofwaardigheid, legitimiteit en relevantie voor een belangrijk deel bepaald door grenzenwerk in een vroeg stadium van het proces. Tegelijkertijd blijft grenzenwerk voortdurend nodig om het assessment proces geloofwaardig, legitiem en relevant te houden.

De analyse van de CAFE-casus in dit proefschrift laat zien dat de Europese Commissie vanaf de voorbereidingen in de jaren negentig en in het begin van 2001 zich grote moeite getroostte om een transparant assesssmentproces te organiseren, gebaseerd op wetenschappelijke kennis en met intensieve betrokkenheid van lidstaten en "stakeholders" (belanghebbenden, zoals maatschappelijke groeperingen en vertegenwoordigers uit het bedrijfsleven). Bilaterale wetenschappelijke bijeenkomsten, review van geïntegreerde assessmentmodellen en de transparantie en documentatie van assessment modellen speelden een belangrijke rol in het bevorderen van geloofwaardigheid, legitimiteit en relevantie van het werk in de ogen van de lidstaten. Vooral in het begin was er intensief grenzenwerk rond de rollen en identiteit van "experts" en "stakeholders" en het werkveld van bepaalde werkgroepen. In het CAFE-proces bestonden tegenstrijdige inzichten over het juiste forum voor discussie voor bepaalde onderwerpen en over de deelnemers die gerechtigd waren een bijdrage te leveren aan deze discussies. Ook de werkelijke plaats en tijd waar echte beslissingen werden genomen (en waarvoor het assessmentwerk dus relevant zou moeten zijn) zijn niet geheel transparant geweest in de ogen van sommige deelnemers.

Vervolgens zijn in dit proefschrift de CLRTAP-casus en CAFE-casus met elkaar vergeleken. Met coproductie van wetenschap en beleid als uitgangspunt werd ingegaan op de vraag of een wetenschappelijk kader dat is ontwikkeld in een bepaalde beleidscontext zijn geloofwaardigheid, legitimiteit en relevantie kan behouden in een andere beleidscontext. De vergelijking van de twee casussen laat zien dat de Europese Commissie voor de ontwikkeling van haar eigen beleidsstrategieën kennis gebruikt die is ontwikkeld in de context van het CLRTAP-proces. Het proces van de

Europese Commissie verschilt met dat van CLRTAP op diverse punten. Onder andere huurt de Commissie consultants in terwijl in het CLRTAP-proces sprake is van vrijwillige wetenschappelijke netwerken. Verder resulteert het proces van de Europese Commissie in bindende regelgeving terwijl CLRTAP geen sterk handhavingmechanisme kent. Tegelijkertijd zijn het werk van de Europese Commissie en CLRTAP sterk met elkaar verbonden en afhankelijk van elkaar. De Europese Commissie richt zich in het proces op het verkrijgen van legitimiteit terwijl de wetenschappelijke geloofwaardigheid van het werk voortbouwt op geloofwaardigheid die binnen CLRTAP-kader is opgebouwd. De analyse laat zien dat het wetenschappelijke kader ontwikkeld binnen CLRTAP inderdaad geloofwaardig, legitiem en relevant kan zijn binnen CAFE. Echter, er moet aan bepaalde voorwaarden worden voldaan. Een voorwaarde is het goed blijven functioneren van de netwerken binnen CLRTAP. Data verzameld in de context van CLRTAP worden ook gebruikt als basis voor analyse in CAFE. Aan de andere kant is de Europese Commissie een belangrijke financier voor de ontwikkeling van modellen die ook in CLRTAP-kader worden gebruikt. Een andere voorwaarde is dat de wetenschappelijke basis stevig verankerd blijft in alle betrokken landen. Als alleen bepaalde wetenschappelijke groepen in een beperkt aantal landen onderzoek zouden doen voor de Commissie, zonder dat er een basis is in andere landen (zoals nu gefaciliteerd door CLRTAP), dan bestaat het risico dat andere landen de analyses niet meer kunnen volgen of zichzelf ermee kunnen identificeren. Dit zou de geloofwaardigheid, legitimiteit en relevantie van het assessment proces van de EU in verschillende landen kunnen ondermijnen.

Het luchtkwaliteitbeleidsterrein in Europa geeft een goed beeld van de manier waarop wetenschap en beleid elkaar beïnvloeden en gezamenlijk een ontwikkeling doormaken. Dit blijkt bijvoorbeeld uit de iteraties tussen onderzoekers en onderhandelaars in CLRTAP die de ontwikkeling van meetmethoden, procedures voor dataverzameling, en de ontwikkeling van modellen bevorderden. Tegelijkertijd inspireerden de mogelijkheden van geïntegreerde assessment modellen het instellen van werkgroepen zoals de Task Force on Integrated Assessment Modelling binnen het CLRTAP-kader. Ook werd het luchtverontreigingsprobleem geformuleerd in termen van de concepten, tools en data die beschikbaar waren.

Ideeën over wat telt als geloofwaardig, legitiem en relevant kunnen vrij stabiel blijven. Dit blijkt bijvoorbeeld uit het gepresenteerde voorbeeld van de review van het RAINS model in 2004. Deze bepaalde dat het model bruikbaar was voor beleidsdoeleinden zowel in CAFE als CLRTAP context. Verder betekent de stabiliteit van de formulering van het probleem dat de onderwerpen die als relevant gezien worden, de "taal" die gesproken wordt in het beleidsproces en de wetenschappelijke disciplines die relevant geacht worden ook stabiel gebleven zijn.

Uit de CAFE-case blijkt dat ideeën over wat de taken zijn van de wetenschap en welke die van beleid anders zijn voor "nieuwkomers" in het proces dan voor diegenen die al langer bij het proces betrokken zijn. Dat komt doordat de nieuwkomers niet betrokken zijn geweest in het vroege grenzenwerk waarbij de grenzen tussen wetenschap en beleid getrokken werden. Daarom hebben ze een andere kijk op geloofwaardigheid en legitimiteit omdat ze andere verwachtingen hebben van onderzoekers en beleidsactoren. Nieuw grenzenwerk is dus nodig als nieuwe structuren voor interacties tussen onderzoekers, beleidsmakers en stakeholders worden opgezet. Dit wordt bijvoorbeeld geïllustreerd in dit proefschrift door het dispuut over de rol van de industrie als expert danwel als stakeholder in het CAFE-proces.

Hoewel dit proefschrift specifiek gericht was op luchtkwaliteitbeleid in Europa zijn een aantal van de verkregen inzichten ook relevant voor andere beleidsterreinen en andere schalen van beleidsontwikkeling. De eisen die gesteld moeten worden aan de communicatieprocessen tussen wetenschap en beleid, willen assessments effectief zijn, zijn afhankelijk van de context en kunnen dus variëren. Er bestaat niet één recept. Een belangrijk inzicht is echter dat de rolverdeling tussen wetenschap en beleid al in een vroeg stadium van een assessment proces vastgelegd kan worden. Gedurende een bepaalde tijd kan de rolverdeling tussen wetenschap en beleid dan vastliggen waarbij een gezamenlijke kijk bestaat op wat geloofwaardig, legitiem en relevant is. Op een bepaald moment kan dit weer veranderen, bijvoorbeeld als de context verandert of als deelnemers wijzigen. Nieuwe regels voor geloofwaardigheid, legitimiteit en relevantie moeten dan worden opgesteld. Dit betekent dat er geen eenduidig antwoord bestaat op de vraag wanneer assessments bruikbaar geacht worden en hoe onderzoekers hun wetenschappelijke geloofwaardigheid kunnen behouden. Dit hangt af van de context en wordt bepaald door grenzenwerk.

Noodzakelijkerwijs vinden voortdurend onderhandelingen over rollen, taken en regels voor de samenwerking tussen wetenschap en beleid plaats. Daarom zijn er geen standaardregels voor bijvoorbeeld het omgaan met wetenschappelijke onzekerheden te geven. Daarom kunnen meetgegevens of grenswaarden voor atmosferische concentraties van luchtverontreiniging niet zonder meer als "goed" of "fout" respectievelijk als "gevaarlijk" of "veilig" bestempeld worden. De formulering van het probleem impliceert wat voor soort kennis en welke data relevant zijn. Als deze zogenaamde "problem frames" niet duidelijk zijn gearticuleerd kunnen misverstanden en onenigheid ontstaan over welke informatie relevant is en welke actoren relevant zijn. Het is ook mogelijk dat indicatoren en oplossingen die relevant zijn binnen een bepaalde probleemformulering niet als zodanig erkend worden binnen een andere probleemformulering. Dit is een van de redenen waarom het zo moeilijk is prioriteiten in luchtbeleid op EU-niveau te koppelen aan prioriteiten op lokaal niveau. Om deze verschillen in prioriteiten te kunnen begrijpen is het onderkennen van het bestaan van verschillende percepties of probleemformuleringen van luchtverontreiniging van belang. Dit zal de communicatie tussen de verschillende groepen op het grensvlak van wetenschap en beleid en de aanpak van problemen bevorderen.

Dankwoord

Met de afronding van dit proefschrift is ook een bijzondere periode van vier jaar afgrond. In die periode heb ik met veel plezier mijn werk bij het Milieu- en Natuurplanbureau (MNP) gecombineerd met reflectie op de rol van kennis in beleidsvorming. Dat die combinatie altijd inspirerend en niet belastend is geweest heb ik aan een aantal mensen te danken.

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Lieve Frans-Willem, bedankt voor je liefde en zonnige lach, en tenslotte kleine Jan: het is dankzij jou dat dit proefschrift nu al af is!

Curriculum Vitae

Willemijn Tuinstra werd geboren te Leiden op 19 november 1971. In 1990 behaalde ze het diploma Gymnasium-ß aan het Rijnlands Lyceum te Wassenaar. Een muzikaal jaar volgde waarin ze het conservatorium in Utrecht bezocht en stages liep bij koorscholen in Wales en Oostenrijk. Daarna lokte de wetenschap en vanaf 1991 studeerde ze Agrosysteemkunde aan Wageningen Universiteit met als afstudeerrichting Systeem- en Bestuurskunde. Ze specialiseerde zich in het gebruik van geïntegreerde computersimulatiemodellen in internationale milieuvraagstukken. Voor het afstudeervak milieusysteemanalyse deed ze bij het International Institute for Applied Systems Analysis (IIASA) in Laxenburg in Oostenrijk onderzoek naar het gebruik van het RAINS-model in internationale onderhandelingen over het terugdringen van zure regen. Voor het afstudeervak informatica werkte ze bij het Nederlands Instituut voor Onderzoek der Zee (NIOZ) op Texel aan een simulatiemodel voor planktongroei in de Noordzee onder invloed van strenge en zachte winters. Daarnaast liep ze stage bij het Rijksinstituut voor Volksgezondheid en Milieu (RIVM) in Bilthoven en droeg bij aan het ontwikkelen van landbouwscenario's voor het IMAGE-model, een model dat klimaatverandering en klimaatbeleid simuleert. In 1996 studeerde ze cum laude af.

Een VSB-beurs gaf Willemijn de gelegenheid zich in 1996-1997 bij het IIASA verder te verdiepen in het gebruik van wetenschappelijke kennis in internationale milieuvraagstukken. Hierdoor raakte ze betrokken bij het ULYSSES-project, een project dat de rol van burgers en het gebruik van computermodellen in klimaatbeleid bestudeerde. Ook raakte ze betrokken bij het Global Environmental Assessment (GEA)-project, een onderzoek van de universiteit van Harvard naar de effectiviteit van mondiale milieu-assessments. Van 1997 tot 2001 werkte ze bij de leerstoelgroep Milieusysteemanalyse aan Wageningen Universiteit als projectcoördinator van het Climate OptiOns for the Long term (COOL)- project. Dit project bracht in samenwerking met vertegenwoordigers uit de transport-, bouw-, industrie/energie- en landbouwsector mogelijkheden voor lange termijn klimaatbeleid in kaart. Vanaf 2002 werkt Willemijn bij het Milieu- en Natuurplanbureau (MNP). Ze deed o.a. onderzoek in opdracht van het Europees Milieuagentschap te Kopenhagen en op dit moment maakt ze deel uit van een team dat de overheid adviseert over Europese milieuwetgeving en duurzaamheidbeleid. Van het MNP kreeg ze de gelegenheid een dag van de week aan promotiewerk te besteden. Daarvan is dit proefschrift het resultaat.

The SENSE Research School declares that Ms. Willemijn Tuinstra has successfully fulfilled all requirements of the Educational PhD Programme of SENSE with a work load of 33 ECTS, including the following activities:

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Presentations

- SENSE Summer Symposium, June 2005, Ede, The Netherlands
- SWOME Marktdag April 2005, The Hague, The Netherlands
- Berlin Conference on the Human Dimensions of Global Environmental Change, December 2005, Potsdam, Germany

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