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Transboundary Air Pollution Policy in Transition

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Climate change, *transboundary air pollution*, *urban air quality*, *greenhouse gases*, *sulfur dioxides*, and *fine particles*—a cluster of related words is circulating in news reports, political discussions, and public debates. These words describe the importance of clean air for human health, a livable society, and a sustainable environment. But what is clean air, or, rather, what makes air polluted? And when pollutants are traced and explored, what kinds of actions should then be taken? How can the air be rendered governable? To what extent and in what way is it possible to steer society, regulate activities, abate pollution, and control emissions? And what authorities have the capacities to exert control in a globalized and fragmented world?

Simple expressions such as *transboundary air pollution*, *ozone depletion*, and *climate change* raise a range of issues that concern the understanding of air pollution and society. This book's point of departure is that governing the air entails a process in which boundaries between society, science, and nature are intermingled and constantly renegotiated. Earlier demarcations are transgressed, and new ones configured. Changes in scientific understandings and political organizations influence each other and often do so in unforeseeable ways.

The book's empirical focus is transboundary air pollution. This environmental problem has a fairly long regulatory history, not least in Europe, where a United Nations (UN) convention, the Convention on Long-Range Transboundary Air Pollution (CLRTAP), was established in the late 1970s. Many commentators consider this convention to have been very successful. As such, it has been of great interest to social scientists, international relations (IR) scholars in particular, seeking to understand and explain what has been achieved and why. However, this success story of air pollution regulation currently faces a number of challenges. The organizational context has recently changed due to the

European Union's (EU) strengthened political role and its development of an air policy for all its member states. Scientific advances have led to a more complex and dynamic view of ecosystems. There has also been a gradual shift in focus from aquatic and terrestrial ecosystems to human health; this shift means that epistemic networks, established concepts, and developed models may become obsolete—or at least less relevant.

The 1980s were the heyday of transboundary air pollution as a public issue, and the term *acid rain* was on everyone's lips. Since the mid-1990s, however, this environmental problem has gradually been eclipsed by climate change. Nevertheless, because both transboundary air pollution and climate change concern atmospheric processes and substances emitted by the burning of fossil fuels, activities are under way to connect the two regulatory frameworks to achieve synergetic effects (Pleijel and Grennfelt 2007). Underlying these activities is the belief that the regulation of transboundary air pollution can gain a new mission by transferring its experience of success to the context of a less successful international regime.

Air pollution policy is in transition and can develop in various directions. It is therefore useful to assess critically how various actors have developed strategies to make the governing of the air more socially robust, politically viable, and environmentally effective. This book's focus is not confined to the limited area of air pollution. Current debate in this field provides ample opportunity to analyze the relationships among science, policy, and the public in international environmental governance in general, making a theoretical contribution to the academic field of IR. As in many other environmental areas—not least that of climate change—science and expertise are given a pivotal role in developing effective abatement strategies.

This book has two objectives: first, to evaluate international air pollution policy critically and, second, to improve the theoretical understanding of the dynamics among science, policy, and citizens. To achieve the first objective, it is necessary to place the regulation of air pollution in its political and scientific contexts, explain its historical development, and relate it to other relevant environmental issues. The empirical focus is primarily air pollution in Europe, but regulatory efforts in other parts of the world are also considered. The second objective aims to deepen our understanding of the links among science, policy, and citizens in international environmental governance. By discussing and combining approaches and findings from the academic fields of IR and science and technology studies (STS), we deepen our understanding of science–

policy–citizen relationships and consequently of what makes an environmental regime effective. This book is based on the belief that the new political complexity, new scientific understandings, and recent theoretical developments in social science concerning international environmental governance need to be exploited. This book aims to cross-fertilize the fields of IR and STS in light of the new complexity in European air policy, based on 40 years of practical regulatory work and 30 years of social scientific studies of the experience gained.

The chapters in this volume approach these objectives from various angles: reviewing earlier findings, analyzing the current situation, and discussing future development paths. Instead of subordinating all the chapters to a single theoretical approach, this book uses various theoretical perspectives with the explicit aims of more deeply analyzing the underlying drivers of the development of international air pollution policies and improving our theoretical understanding.

The book is structured around three related themes: policy and institutions, expertise and learning, and citizens and involvement. As demonstrated in the chapters, it is misleading to regard these themes as discrete categories. Institutions obviously have to do with knowledge and learning as well as with public participation, and the use of expertise and public participation is related to policy. In fact, a guiding theme here is that processes in disparate fields greatly influence each other. At the same time, these three themes highlight some crucial aspects of the current understanding of environmental problems in general and of transboundary problems in particular.

Before turning to the individual chapters, we elaborate on the current context of air pollution policy—in particular on changes in scientific understanding, policy development, and social science insights.

Transboundary Pollution and Spatial Effects

Today, climate change is at the top of the environmental agenda. Media reports attribute current weather conditions to climate change; scientists develop tools for projecting future consequences; and political representatives ponder how this problem can be made politically manageable—that is, how space can be created for concerted political action. A fundamental belief of those involved in combating climate change is that the biosphere does not recognize political boundaries, so international cooperation is indispensible. This understanding is in no way restricted to the climate-change issue. Most environmental problems rest on the

understanding that pollutants cross boundaries and that previous ways of distinguishing between spatial scales—local, national, regional, and global—have been superseded. Local emissions may have global consequences; global activities may have local consequences; and emissions from a nation-state may mainly affect other nation-states.

What now seems a commonplace notion—that many environmental problems have a transboundary nature—is not given by nature but something that has been historically established. However, the paradigmatic example is neither today's discussion of climate change nor the long-range transport of sulfur dioxides discovered in the late 1960s. It was earlier, in the wake of the Second World War, that the transboundary nature of pollutants was first placed at the center of international political concern.

The atomic bombing of Hiroshima and Nagasaki in 1945 and the atmospheric nuclear bomb testing in the 1950s made radiation a key matter of international concern and regulation. Radioactivity was eventually found to have genetic effects that transcend the temporal aspects of a single human life. More important, however, the effects of nuclear bombs were not restricted to the targets in that radioactive fallout was spread far and wide by winds. The notion of the "mist of death" or "death dust" encompassed the understanding that a nuclear bomb and even bomb testing can kill at a distance, far from the immediate circle of destruction, creating a worldwide "A-bomb disease" (Weart 1988, 199; Sundqvist 2002, 54). Since that time, the atmosphere has been understood as both a global commons and a carrier of air pollution; a forceful reminder was given with the Chernobyl disaster, which spread radioactivity over most of Europe in 1986.

Since the Second World War, the fear of radioactivity has been a key driver of the development of our understanding of the long-term transportation of pollutants. Meteorology and atmospheric chemistry became important scientific disciplines, and researchers specialized in measuring small amounts of invisible pollutants, tracing them from their sources to their eventual disposition via atmospheric transportation over long distances. Today, this understanding of pollutant patterns is widespread in society, and it is generally accepted that environmental degradation and human health effects are caused at least in part by emissions from sources far away. Pollutants travel in land, water, and air; however, these flows do not have uniform effects, and pollutants are deposited at various places around the globe. The consequences of this deposition are also differentiated: ecosystems differ in their sensitivity to pollutant uptake,

and societies differ in how they are affected and have different capacities for resilience.

Many environmental problems have both transboundary and spatial characteristics, and the consequences of long-range air pollution are spatially distributed in an uneven way. Some nation-states are net exporters of airborne pollutants, whereas others are net importers, and some will be more severely hurt by a changing regional or global atmosphere. The discovery of long-range air pollution did not result in the dissolution of spatial boundaries, though. Instead, it meant the transgression of earlier demarcations between local, national, and international environmental problems and the establishment of new ones. A new political geography of winners and losers was created, and new and different incentives for international cooperation were established.

The Discovery of Transboundary Pollution

In the late 1960s, the long-distance travel of sulfur dioxides from local sources, together with its transnational effects, was discovered. Acidification of freshwater and its effects on fish stocks were connected to airborne pollutants that traveled from the United Kingdom and continental Europe to Scandinavian rivers, lakes, and forests (Lundgren 1998). Europe was suffering not only from a Cold War, but from tacit, creeping, and unintentional chemical warfare with a new political geography—not between the North Atlantic Treaty Organization (NATO) and the Warsaw Pact, but between net exporters and net importers of air pollutants.

Although the emergent understanding of radioactive dust had already paved the way, new insights into the transboundary character of airborne pollutants resulted in a shift in the understanding of the environment. This shift became visible in science, environmental consciousness, and political cooperation. Scientific investigations began to focus on detecting airborne pollutants, following them from source to effect, and on learning about chemical transformations in the atmosphere.

There were initially some decades of naive hope that pollutants would be diluted to harmlessness in the atmosphere after release through tall smokestacks. Environmental consciousness slowly became established, however, encompassing an understanding that the effects of local sources have a new temporal–spatial pattern: delayed in time and extensively spread out in space. Due to the spatial characteristics of long-range air pollution, initiatives for multilateral political cooperation were undertaken. In Europe, it was discovered that transboundary air pollutants

constituted a threat to a common European atmosphere (Letell 2002, 25–27; VanDeveer 2004, 313; Sundqvist, chap. 7 in this volume). The transboundary nature of air pollution supported cooperation, but it also engendered competition and conflict between nation-states.

At the first international political meeting on environmental issues, the UN Conference on the Human Environment in Stockholm in 1972, a declaration was agreed upon. One of its best-known principles says, "States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and 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" (UN 1973, Principle 21).

The transboundary nature of many emissions into water and air implies the violation of this principle and indicates that no nation-state has complete sovereign rule over its territory. The adoption of this principle placed the transboundary nature of air pollution at center stage, and the task it indicated was how to regulate this kind of pollution. But this task is not easy to complete. Whereas the victim countries—those that are ecologically vulnerable to specific problems—are obviously motivated to foster international agreements to reduce the emissions at their sources, the main producers of the pollutants are less motivated. There seems to be a paradox that the stronger the need for concerted action, the harder it appears to be to achieve it; when mutual action is most needed, the mutual benefits are not obvious. It is important to note, however, that this apparent paradox seems not to be generally applicable. In the case of efforts to deal with transboundary air pollution beginning in the 1970s, it was possible to see beyond short-term winners and losers and to develop concerted actions and effective abatement strategies. But how was this cooperation accomplished?

Regulating Transboundary Air Pollution

In the late 1960s, Scandinavian researchers argued, contrary to earlier beliefs, that air pollutants can travel several thousand kilometers before deposition and damage occurred. This assertion made the burning of fossil fuels for transportation, heating, and electricity production not only a local problem, but also an international one. Even though there was little doubt as to the acid output from power plants based on fossil fuels, the idea of long-range air pollution was highly controversial among both researchers and politicians in Europe in the early 1970s. However,

this situation changed, and in a process involving scientific development and political initiatives an international UN convention was adopted in 1979: the CLRTAP. This convention's aim was and is to reduce emissions of airborne cross-boundary pollutants within the UN Economic Commission for Europe (UNECE) region. Thirty-two parties—29 European nation-states, the United States, Canada, and the European Community—signed the convention, which was the first multilateral instrument addressing atmospheric environmental issues (Munton, Sooros, Nikitina, et al. 1999, 167). The CLRTAP was later followed by protocols regulating specific substances (see table 1.1). Today, 51 parties have ratified the convention.

CLRTAP is one of the oldest international environmental conventions, and several researchers have analyzed its formation and development. Their descriptions differ somewhat in emphasis but agree in positively assessing the convention, which, compared with other environmental regimes, is considered a success. The historical account given in these studies unanimously emphasizes the role of science in developing the convention (Sooros 1993; Hajer 1995a; Munton, Sooros, Nikitina, et al.

Table 1.1
CLRTAP, Its Protocols, and Where They Were Signed (Year of Entering into Force)

1979	Convention on Long-Range Transboundary Air Pollution (1988)
1984	Protocol on Long-Term Financing of the Cooperative Program for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (EMEP Protocol), Geneva (1988)
1985	Protocol on the Reduction of Sulfur Emissions or Their Transboundary Fluxes by at Least 30 Percent (Sulfur Protocol), Helsinki (1987)
1988	Protocol Concerning the Control of Nitrogen Oxides or Their Transboundary Fluxes (NO_x Protocol), Sofia (1991)
1991	Protocol Concerning the Control of Emissions of Volatile Organic Compounds or Their Transboundary Fluxes (VOCs Protocol), Geneva (1997)
1994	Protocol on Further Reduction of Sulfur Emissions (Second Sulfur Protocol), Oslo (1998)
1998	Protocol on Heavy Metals, Århus (1998)
1998	Protocol on Persistent Organic Pollutants (POPs Protocol), Århus (2003)
1999	Protocol to Abate Acidification, Eutrophication, and Ground-Level Ozone, Gothenburg (2005)

1999; Wettestad 1999; Underdal and Hanf 2000; Tuinstra, Hordijk, and Kroeze 2006).

The CLRTAP has become more complicated over time. Abatement strategies were initially negotiated based on the flat-rate reduction of emissions of pollutants (i.e., sulfur dioxides and nitrogen oxides), meaning the same emission cuts for all countries. These strategies were later called the "first-generation protocols." In the 1990s, the development of a second generation of protocols started, resulting in the Protocol on Further Reduction of Sulfur Emissions (Second Sulfur Protocol, 1994) and the Protocol to Abate Acidification, Eutrophication, and Ground-Level Ozone (multipollutant/multieffect protocol, 1999). These protocols focused on varying national reduction rates based on the approach of critical loads—that is, effects in relation to what nature can withstand—and cost effectiveness. They also covered more substances. The multipollutant/multieffect protocol was signed in Gothenburg in November 1999 and regulates four types of compounds (i.e., sulfur dioxide, nitrogen oxides, ammonia, and volatile organic compounds) that affect human health, natural ecosystems, materials, and crops through acidification, eutrophication, and ground-level ozone (UNECE 1999, Article 2). The signatories have called it "a smart protocol," one of the most sophisticated and most scientifically based protocols ever signed (Thompson 1999).

However, the negotiation processes connected with the protocols have not run completely smoothly. Several diverging standpoints and conflicting interests became apparent, not least in the former Federal Republic of Germany and the United Kingdom (Boehmer-Christiansen 2000; Sprinz and Wahl 2000). Of note, in describing this process, researchers have regarded the overcoming of these conflicts as a token of CLRTAP's success. Consensual science is often singled out as the key factor in reaching agreements; for example, international scientific work is said to have been crucial in persuading British decision makers of the need for further international control measures (Hajer 1995b; Hanf 2000). Thus, from the late 1960s to the early 1980s acid rain was transformed from an esoteric branch of scientific research in certain specialized fields of atmospheric chemistry and ecology into a household word. Science played a decisive role in both developing the regulatory regime and making it feasible.

However, not only science but also East–West diplomacy was important for the establishment of CLRTAP. In fact, diplomacy accounts for

the important role given to science within the regime (Lidskog and Sundqvist 2002). Politicians tried to mitigate the East–West conflict by proposing cooperation in the field of environmental protection. The context of CLRTAP's creation was the stalemate between the NATO states and the Warsaw Pact in Europe. The Soviet Union, despite its earlier boycott of the UN Conference on the Human Environment in Stockholm in 1972, initiated discussions of international cooperation on environmental issues at the Helsinki Conference on Security and Cooperation in Europe in 1975. Air pollution was soon chosen as the specific area of cooperation, and CLRTAP became an important common social project for European states across the Iron Curtain, acknowledging long-range transport of air pollutants as a serious environmental problem. The politicians' search for politically less controversial issues on which to cooperate was an important factor in explaining the scientific nature of the regime. This emphasis has meant the scientization of the European air pollution problem. Policymakers demanded scientific cooperation and saw it as a key factor in the establishment of the CLRTAP regime, and scientists accepted an expanded role for science in environmental governance, which gave them considerable room for technocratic maneuvering.

As a concrete result of the political support for scientific cooperation, several monitoring stations were set up in European countries in the 1970s, and emission data were exchanged. In 1977, the European Monitoring and Evaluation Programme (EMEP, officially the Cooperative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe) was established. EMEP enabled the development, support, and coordination of national monitoring programs, thereby facilitating the evaluation of the emission-reduction protocols.

EMEP was integrated into CLRTAP and became a mechanism for producing, distributing, and exchanging information on pollution flows, effects, and mitigation options. EMEP started in the 1970s, and the first protocol under the CLRTAP, signed in 1984, concerned maintaining financial support for EMEP. Today, EMEP encompasses some 100 stations in Europe, monitoring sulfur dioxide, nitrogen dioxides, ground-level ozone, and other substances. A channel for exchanging standardized scientific information and empirical data was established, enabling the growth and spread of a common knowledge base concerning both the seriousness of the acid rain issue and ecosystem mechanisms.

Current Situation: Growing Political and Scientific Complexity

Since the mid-1990s, the political organization of air regulation has changed in Europe, largely due to initiatives taken by an expanded EU via the European Council and the European Parliament. The EU has adopted the Air Quality Framework Directive (1996); presented an acidification strategy (1997); issued the National Emission Ceilings Directive (2001); launched a process for developing a thematic strategy for air quality, Clean Air for Europe (CAFE) (2001); and adopted a new thematic strategy on air pollution (2005).

The EU's thematic strategy on air pollution and the UN's CLRTAP share a number of similarities in how they conceptualize the problem. They also differ in a number of ways, not least concerning organizational structure, geographical scope, and ways of organizing the science–policy relationship (Selin and VanDeveer, chap. 3 in this volume). This means that various political organizations are managing the same problems; linkages and overlaps exist but are not often made explicit or critically discussed. Furthermore, air quality and climate change are becoming increasingly interlinked, and policies developed for abating one problem will influence the other.

As a political body, the EU is much stronger than CLRTAP. The EU's established directives on air quality standards for several pollutants are legally binding on all its member states. In contrast, CLRTAP relies on initiatives from participating countries and has no authority to determine binding regulations or to use sanctions should any party fail to honor the commitments. In this situation, science has served as an important policy support in the development of agreed-on abatement strategies. Scientific networks were formed and gradually became formally adopted as integral parts of the CLRTAP organization.

The scientific understanding has also changed. It is not ecological damage but human health that is today considered the most urgent problem connected with transboundary air pollution (Sliggers 2004; Pleijel and Grennfelt 2007). Studies indicate that air pollution contributes significantly to a wide range of acute and chronic health problems (Kunzli and Tager 1999). The most severe effects relate to an increased risk of premature death, expressed by the estimated 3.6 million life years lost through some 348,000 annual deaths attributable to current particulate matter exposure in the EU (WHO 2006, 95). Air pollution also results in a number of less severe health consequences. Exposure to particulate matter, for example, results in 100,000 hospital admissions per year in the EU due to respiratory and cardiac emergencies (WHO 2006, 95).

When people's own health is at stake, they become more motivated to take action and support further abatement strategies. The EU Air Quality Framework Directive explicitly focuses on air quality in big cities, and "problem cities" such as Athens and London are singled out (Nikolaou 2003; EC 2008). Dying fish stocks and acid lakes, located in rural areas in peripheral Scandinavian countries, are no longer a strong driving force of citizen and politician engagement in continental Europe to combat air pollution.

The European Commission's focus on air quality can also be understood in conjunction with the project of European integration (Sundqvist and Letell 2005). What is more of a shared resource than the air we breathe? Air quality can be identified not only as a local/urban problem but also as a pan-European problem, which makes it an ideal integrative project. From being an issue located on the boundary between East and West during the Cold War era and politically supported as a possible communicator over that boundary, air pollution is today once again part of the macropolitical project to support European integration. This time, however, the political context is not two political blocs locked in a cold war, but nation-states and citizens reluctant to embrace the EU's integrative ambitions. European regulatory efforts to control air pollution are in a formative phase, and the interactions among science, policy, and citizens seem pivotal in determining how they will develop.

Science, Policy, and Citizens

The new political geography caused by transboundary air pollution is not inherent in nature but has been constructed through social processes (Beck 1995; Yearley 1996; Lidskog 2004). Some actors may try to advance claims about the transboundary nature of the problem, thus changing the opportunity structure for political action. Others may try to prevent an issue from being perceived as global or regional, or they may try to weaken the resolve to address an issue that is already on the international agenda. These attempts are made because the regulation of certain environmental problems goes right to the heart of domestic policies concerning, for example, energy, transport, and employment. There may be reasons other than environmental or scientific ones for wishing to see certain environmental issues treated either as matters of international priority or as matters solely within the scope of domestic policymaking.

As in all political areas, it is not the object per se, but those who speak for it or claim to represent it who are the driving causal agents in the political process. Hence, there is a need for a social scientific explanation of why biodiversity conservation and climate change are framed as global issues, acidification and marine pollution as regional issues, and freshwater quality and household wastes as local issues (cf. Martello and Jasanoff 2004).

By negotiating and constructing boundaries among the global, regional, national, and local levels, an identity is shaped between a specific environmental problem and a specific spatial level (Lidskog, Soneryd, and Uggla 2009). An image of a geographical location at risk is constructed and becomes the object of action. An important task for social science is to analyze the configuration of a problem as a socially and politically shaped process of image building. But what actors have the power to identify environmental issues, construct their spatiality, and thereby propose the kinds of measures and cooperation that are important to agree on? And what institutions limit and enable these actors' maneuvering room?

Three Approaches: Institutions, Networks, and Co-production

The most common way to understand international environmental governance from a social science perspective is the *institutional approach*. This approach is based on rationalistic assumptions rooted in exchange theory, which says that when interest-based nation-states see opportunities for mutual benefit, international cooperation will occur. International institutions are therefore created and shaped by the tension between expectations of political benefit and the costs of achieving them (Keohane 1988). International cooperation is a possible result of nation-states' negotiations of benefits and costs. When costs are low and benefits high, cooperation can be expected to happen.

In general, an institution is understood as a "set of rules, decision-making procedures, and programs that define social practices, assign roles to the participants in these practices, and guide interactions among the occupants of individual roles. . . . Institutions that deal explicitly with environmental or resource issues are commonly known as environmental or resource regimes" (Young 2002, 5). An international regime refers to "sets of implicit and explicit principles, norms, rules, and decision-making procedures around which actor expectations converge in a given area of international relations" (Krasner 1983, 2). Such institutions or regimes result from negotiations between interest-driven parties

and create consensus and cooperation that go beyond the involved parties' interests.

This means that the institutional approach studies regimes, which in this context are certain kinds of institutions that deal with environmental issues. According to Oran Young (2002), a leading proponent of the institutional approach, a regime can be studied as "thin" or "thick"—that is, as rules on paper or as rules in application. The distinction is between what is formal and what is informal, explicit and implicit. In the institutional approach, the three most crucial questions are, according to Young (2002, 11–12): (1) How important is a specific regime for the condition of a specific natural resource, and what difference does it make? (2) How effective is the regime in relation to determined criteria, such as sustainability, efficiency, or equity? and (3) How can regimes be designed or redesigned to improve the environment? Young argues that the approach is still very heterogeneous, that results from studies of specific environmental issues are difficult to compare, and that the cumulative aspect of the tradition—its progress—could be much better.

Whereas the institutional approach has traditionally emphasized the role of the interest-driven nation-state, assuming that its preferences and interests are stable and given, the *epistemic-community approach*, which provides a foundation for understanding international negotiations and cooperation, places a greater emphasis on science. According to Peter M. Haas, the leading proponent of the latter approach, environmental regimes are driven not only "by state power, but by the application of scientific understanding about ecological systems to the management of environmental policy issues with which decision makers are unfamiliar" (1997, 200). Therefore, knowledge—consensual and trusted—is a requirement for successful environmental cooperation.

The concept of the "epistemic community" has been introduced as an analytical tool for investigating the role of science in the formation and development of regimes. An epistemic community is a knowledge-based transnational network of professionals holding political power through cognitive authority (Haas 1992, 3). Members of an epistemic community can come from various disciplines but share a body of basic knowledge according to which they interpret phenomena in a similar way. They also share values and policies—that is, convictions concerning how to enhance human welfare.

The epistemic-community approach is also based on a rational and interest-based foundation, but, instead of exchanging and competing nation-states, we find epistemic communities that work on a consensual

basis. According to this approach, epistemic communities are strong vehicles for achieving international cooperation and establishing institutions that go beyond nation-states' interests. As in the institutional approach, the results from this approach are international institutions designed for governing specific environmental problems.

Experts' extensive involvement has contributed to the notion that regimes serve as institutions for learning that in turn produce convergent state policies (Haas 1989, 377; cf. Social Learning Group 2001). This expert influence is strengthened by the transnational nature of epistemic communities: scientists, through the power of their network, are able to resist political temptations to subordinate their advice to existing national concerns. What explains international cooperation is not political benefits but adaptation to scientific understanding.

Whereas the epistemic-community approach focuses strongly on international networks of scientific experts and on scientific consensus as a necessary condition for political and practical achievements, the STS approach directs attention to the preliminary character of knowledge and the fact that knowledge is always locally embedded.

The *STS approach* forcefully argues against a linear model of the relationship between science and policy, in which the role of science is that of "speaking truth to power" (Haas and Stevens, chap. 5 in this volume). Instead of assuming a strong separation between science and policy, STS scholars advocate a view in which scientific knowledge and political order are seen as two sides of the same coin: science and policy are co-produced (Wynne 1996; Jasanoff 1996a, 2004b; Jasanoff and Wynne 1998).

In contrast to the first two approaches, the STS approach was not developed in the IR research field. However, it has gradually gained a foothold in this field, not least due to its sophisticated way of understanding expert knowledge and its connections to political power. Some IR studies are influenced by findings from STS, and some STS studies focus on the international regulation of environmental problems (e.g., Jasanoff 1996b; Social Learning Group 2001; Lidskog and Sundqvist 2002). The STS approach's potential is still underexploited in IR research, in partly because researchers in this field are unaware of it and in part because STS researchers have not in any deeper sense taken advantage of most knowledge developed in the IR field.

The STS approach is more relativistic, sociological, and actor oriented, questioning some basic assumptions of the institutional and epistemic-community approaches—for example, that interests and

preferences are inherent, that international cooperation is the result of interest-based negotiations among nation-states, and that scientific knowledge is consensual. On the contrary, STS argues that preferences, interests, and knowledge are unstable and changing. Science is often uncertain, controversial, and interpreted differently by different actors (Sundqvist, chap. 7 in this volume). Knowledge and interests are not factors that explain social institutions, but phenomena that need to be explained. Moreover, actors' various strategies and learning processes lead to changes in preferences, interests, and knowledge; therefore, these latter phenomena cannot provide a strong foundation for explaining international cooperation.

The STS approach focuses on knowledge as something contingent and on science and policy as co-produced. However, compared with both the institutional and the epistemic-community approaches, it provides a less coherent framework and is therefore less capable of evaluating the development of international cooperation. The co-production thesis, however, might be a starting point for developing a stronger STS-inspired theoretical position in the field of IR research. Co-production means that policy influences the production and stabilization of knowledge and that knowledge simultaneously supports and justifies policy; actors may therefore accept a particular knowledge claim because it supports their policy strategies. A specific understanding of nature can be used to solve social problems, and new social orders can create new understandings of nature. In this way, causes and effects become functionally interrelated—that is, knowledge production is also policy production, and vice versa. Co-production means that uncertain or contested science can grow stronger if the policy context is "right," or a weak policy context can become stronger through the support of science (Jasanoff 2004b).

The STS approach emphasizes the role social conditions play in enabling science to acquire the power to influence and shape policy. Science and policy are always interdependent, which implies that science can shape regimes if social conditions are favorable (cf. Haas and Stevens, chap. 5 in this volume). Because of the interdependence of science and policy, the role of science in environmental policy can never be prescribed but is instead open to investigation. There is no other way to understand how transboundary air pollution functions in society than to investigate various actors' articulations, strategies, and practices.

Some important conclusions can be drawn from the STS approach; for example, scientific knowledge is not an independent, fixed entity entering political negotiations from the outside but should be understood

as dependent on political processes. As Sheila Jasanoff puts it, "Scientific development is tied to society at all points" (2004a, 16). Nor is the boundary between science and policy fixed: it changes and is negotiated among actors. However, in everyday understanding the boundary between science and policy is often considered stable. Therefore, an important objective for STS scholars is to make visible what is invisible—the fluid and changing pattern of the interdependence of science and policy. To do this, they have to identify the political connections of scientific knowledge.

Converging Approaches?

All three approaches have drawn criticism. The institutional approach has been criticized for its strong focus on interest-oriented nation-states and for not giving science a distinct role in international negotiations; the epistemic-community approach has been criticized for ascribing too much power to science, giving a pivotal role to consensual knowledge; and the STS approach has been criticized for focusing primarily on the microlevel of the scientific enterprise and neglecting everything but actors. The existence of all three approaches, all trying to understand the same object, creates good opportunities for theoretical development, and both controversies and cross-fertilization can be noted between them (Social Learning Group 2001; Lidskog and Sundqvist 2002; Haas 2004; Young 2004). This debate obviously has modified the positions of proponents of the three approaches, leading to convergence in certain respects or at least to overlapping emphases.

Today, all three approaches suggest that improving our understanding of international environmental governance calls for closer scrutiny of the roles of expertise and learning, citizens and stakeholders, and institutions. All three stress that international regimes can stimulate processes of social learning, affecting social identities and changing discourses. This means that regimes not only change a nation-state's external environment but also facilitate learning and define roles for actors. A specific regime may foster new ways of perceiving a problem and its effects and of successfully coping with it (Young 1999; 2008). This is a more dynamic view of how to understand the internal mechanisms of international regimes than was first developed by the institutional approach, which argued that international regimes' performance can be reduced to the interests of nation-states. The dynamic perspective is an important distinctive mark of STS but is now taken into account in all three approaches.

Furthermore, the three approaches focus on knowledge and on the interplay between science and policy, which is considered crucial in international environmental governance. Their emphasis is on the interaction between science and policy, with causal powers not being attached exclusively and a priori to either of them, even though the institutional approach tends to focus on the importance of policy and the epistemic-community approach on science. All three approaches are interested in assessing factors that make transboundary environmental problems governable and want to investigate such questions as: How are scientific integrity and political involvement balanced, and how does this balance affect the credibility of science and the legitimacy of political decisions? What configurations of science–policy relationships have developed and with what results? Do differences between international organizations in terms of their political and expert cultures significantly influence abatement strategies' effectiveness and legitimacy? We firmly believe that, when exploring these questions, more pertinent answers can be achieved if perspectives and findings from all three approaches are considered.

The Missing Link: Citizen Involvement

Alongside the focus on the relationship between science and policy in international environmental governance, there is growing emphasis on the relationships between science and the public. This emphasis is most energetically cultivated by the STS approach (Irwin and Michael 2003; Jasanoff and Martello 2004; Jasanoff 2005; Yearley 2006), though it is still underdeveloped. A broader, critical focus on citizen involvement in science-based issues is a strong trend more generally in today's social science, supported by the work of scholars such as Ulrich Beck, the governance approach, and neo-Foucauldian work on governmentality. This trend has exerted an important influence, leading to new understandings of environmental policymaking—for example, as governance (Hempel 1996; Haas 2008), "subpolitics" (Beck 1992, chap. 8), or advanced liberal steering mechanisms (Barry, Osborne, and Rose 1996; Rose 1999).

Both policy and science have recently claimed that public inclusion is a requirement for creating policies that are socially robust, politically legitimate, and trustworthy in the eyes of the public (see, e.g., EC 2001; Nowotny, Scott, and Gibbons 2001; Renn 2008). Although citizens' role in environmental governance has been described for some years now, the meaning and implications of public inclusion remain scantily researched and poorly understood (Gouldson, Lidskog, and Wester-Herber 2007),

in part because public involvement in regulating complex issues such as biotechnology, climate change, and transboundary air pollution has not yet been widely adopted (Yearley, chap. 9 in this volume). Many decision makers still ponder how to reconcile the growing complexity of an issue with the need for public awareness, inclusion, and engagement.

So how should citizen involvement be integrated into international environmental governance? Some see citizens as contributing agents, whereas others see them as passive accepters of reached agreements who provide the agreements with posteriori legitimacy. Many argue that citizens interpret issues based on preferences, interests, and knowledge that differ from those of scientific experts and political representatives (Jasanoff and Martello 2004; Corell and Sundqvist 2005; Leach, Scoones, and Wynne 2005).

At the same time that the complexity of many environmental issues is increasing, there is a growing need to garner public support for proposed courses of action. The European Commission views this situation as indicating a crisis in the credibility of expertise and public unease with science. The commission's white paper on governance argues that the credibility of expertise must be high; otherwise, regulation will be in serious trouble (EC 2001). Because regulatory policymaking is considered an important feature of European integration as such, the whole EU project might lose its legitimacy if the credibility of expertise is considered too low (Sundqvist 2003). The commission has set up an expert group of STS scholars on science and governance to provide advice on the process of increasing transparency and expert credibility (Wynne and Felt 2007). The solution, according to the commission, is to increase transparency in expert work, which it hopes will lead to increased public trust. By means of "democratized expertise," including increased transparency, the quality and credibility of expertise will be restored. The commission is aware of the need to restore public trust in science, but its concern still amounts more to words than deeds, and few concrete initiatives have been taken to bring citizens and science closer to each other (Irwin 2006).

A starting point for this urgent task is to reconsider the old one-way communication process, from experts to laypeople, and to focus on more symmetrical processes of mutual learning. IR scholars usually take learning to mean the recognition and acceptance of new information that can change involved actors' motives and behavior (Young 1999, 25). Whereas some studies restrict their focus to learning mechanisms operative between scientific experts and political representatives, others pay

attention to the wider community of stakeholders (Fischer 2004; Held and Koenig-Archibugi 2005). The regulation of transboundary air pollution has implied largely an emphasis on the former case, in which networks between scientists and policymakers have developed and become extensively institutionalized and formalized through the development of organizational structures of interaction. However, the current focus on the need for public support implies an additional emphasis on the relationship between science and society and on the development of a broader understanding of the air pollution problem. Researchers in science communication and risk management have strongly emphasized that public involvement cannot be fostered simply by means of one-way information campaigns, going from science and policy to the public. On the contrary, communication is needed in which citizens are welcome to take part as active subjects having experience, knowledge, and perspectives that are important for making regulation more robust, effective, and trusted (Wynne 2001; Löfstedt 2005; Renn 2008).

In general, bringing science closer to society entails cultivating both scientific citizenship and socially sensitive expertise (Elam and Bertilsson 2003; Lidskog 2008). Creating socially robust regulation implies merging science with democracy, which means that citizens and scientists together are mobilized in shaping policy. The public understanding of an issue must be included when seeking that public's support for a policy; we must ask not only what is true regarding a policy, but also what that policy is about and what its social purpose is (Wynne 2003, 405).

A Successful Regime?

CLRTAP is one of the most studied international environmental regimes, and most policy evaluators have deemed it a success. As a comparative study of regime effectiveness states, "Indeed, CLRTAP's success in enhancing cooperation, bestowing authority, and facilitating learning is perhaps unique among international environmental regimes" (Munton, Sooros, Nikitina, et al. 1999, 235). The close interaction between scientific experts and policymakers in CLRTAP has been emphasized as the key explanatory factor for this success.

The shift from uniform emission cuts (the same for all parties) to effect-oriented strategies based on the critical-load concept in the early 1990s has been described as "a revolution in the management of transborder pollutants" (Levy 1993, 100; Ishii, chap. 6, and Sundqvist, chap. 7, in this volume). Combining the critical-load concept and the Regional Acidification Information System (RAINS) model allowed

negotiators to justify nonuniform sulfur emission cuts as politically neutral, scientifically sound, and a smart alternative to arbitrary fixed-percentage reductions (Patt 1998, 10). Adopting the critical-load concept changed the cooperative atmosphere, shifting the dynamic from singling out "bad guys and dirtbags" to determining specific regions' vulnerability. The debate became more "sophisticated and relaxed" in both the scientific and the political contexts (Wettestad 1999, 101). Decisive for science-based regulation was the multilateral trust fund for the long-term financing of EMEP, considered the backbone of efforts to reach further agreements on emission reductions (Wettestad 1997, 245).

Scientists initially complained about uncertainties and oversimplification in relation to both critical loads and the RAINS model. However, policymakers, bureaucrats, and scientific experts eventually succeeded in defending the concept and the model as a productive way forward, considering the uncertainties as gaps in knowledge that could be bridged by further research (Tuinstra, Hordijk, and Amann 1999, 38). Critical loads and RAINS became tools of communication between scientific expertise, on one hand, and negotiations and political decisions, on the other. A "buffer body" was thus established between science and policy (Wettestad 1999, 33), enabling coordination of work and stabilizing the roles and boundaries in the CLRTAP process (Tuinstra, Hordijk, and Amann 1999, 35). However, this effort involved many questions: Would the scientific community in the long run accept this way of doing science? And would policymakers within the CLRTAP regime be ready to accept such a complicated foundation for abatement solutions?

After the success of the multipollutant/multieffect protocol signed in Gothenburg in 1999, some experts began worrying about the increased complexity of abatement strategies based on the critical-load concept, which regulates several compounds and effects in a single protocol. They argued that protocols should not be so "smart" that only a few experts can understand their mechanisms for distributing the signatories' commitments (Sundqvist 2003, 66). Some argued that the protocol might mark the end of the road for abatement strategies based on the critical-load concept (Tuinstra, Hordijk, and Amann 1999). Since 1999, no more protocols have been determined under CLRTAP; instead, a revision of the multipollutant/multieffect protocol has been started (Selin and VanDeveer, chap. 3 in this volume). The protocol's great complexity has not only made air pollution work more complicated, but also made it much harder to communicate the reasoning underlying the determined

abatement strategies to those not involved in the work (Pleijel and Grennfelt 2007, 51).

The CLRTAP regime's success, which politicians, involved scientific experts, and social science analysts often cite, has also been questioned. The problems that CLRTAP deals with are far from being solved, and some of the most important emission cuts, primarily those of sulfur dioxides, have been caused by factors exogenous to the international regulation (e.g., economic restructuring, as in the case of the British electricity and coal industries, and technical developments, such as the introduction of low-sulfur fossil fuels and desulfurization equipment for coal-burning plants). The extent to which CLRTAP should be seen as a success—in terms of being the main cause of emissions cuts—is not uncontested, as some of the chapters in this volume discuss (chaps. 2 and 3). The development of parallel and partly overlapping regulatory regimes in Europe also merits investigation (chapters 3 and 4). Furthermore, the shift in the problem formulation—from a perspective emphasizing ecosystem effects to one emphasizing urban air quality and human health—implies that new groups of experts are being mobilized and enrolled in the regulatory work (chap. 8). Established relationships between policymakers and scientific experts within the CLRTAP organization are thereby being challenged, and opportunities for new types of coproduction between science and policy may arise that are different from those that have previously characterized CLRTAP (chap. 7). Earlier ways of mobilizing knowledge may change, giving rise to new opportunities for learning (chaps. 5 and 6).

Taken together, the current situation—marked by changes in political organizations, expert involvement, and science–policy dynamics—suggests an uncertain future direction for international cooperation on transboundary air pollution. Moreover, the issue of public trust has become a central concern of regulatory work. Without public legitimacy, decision makers and experts may not succeed in implementing further abatement strategies, and today there are serious concerns that the earlier one-way information flow will remain in effect. Various forms of public inclusion and citizen involvement are being proposed as a general strategy for creating public acceptance and support. Thus far, the issue of citizen involvement has to some extent been a blind spot in international studies of air policy work. This book helps remedy this lack, including both practical examples of citizen involvement in air pollution work and theoretical contributions regarding how to understand the role of citizens in developing the regulation of transboundary air pollution (chaps. 9,

10, and 11). As emphasized in the last chapter, two important tasks are to develop research into citizen involvement and to foster a broader and deeper understanding of science–policy–citizen dynamics in international environmental governance.

This Book: Science, Policy, and Citizens

The regulation of transboundary air pollution results from a combination of social order, political negotiations, and scientific practices. This book aims to contribute to new understandings of international environmental governance that take into consideration changes in political organization, scientific understanding, and civil society. Policy and institutions, expertise and learning, and citizens and involvement are accordingly three key areas to take into account when considering how the regulation of transboundary air pollution can be configured to be trustworthy, effective, and relevant.

In the volume, prominent social scientists specializing in international environmental governance make substantial contributions to the study of air pollution governance. They all share an emphasis on the need to assess previous experience if we are to understand the current situation, and they all suggest possible future directions for research, concerning both theoretical understandings and practical work.

Part I, "Policy and Institutions," focuses on the institutional dimensions of international efforts to combat air pollution. The three chapters in this section employ mainly an institutional approach, focusing on regime effectiveness, institutional linkages, and institutional design of the interface between science and policy. Chapter 2 focuses on the effectiveness of CLRTAP, and chapters 3 and 4 are devoted to the new political complexity, in which two organizations—the CLRTAP and the EU—compete and cooperate regarding how to regulate European air pollution.

In "The Improving Effectiveness of CLRTAP: Due to a Clever Design?" Jørgen Wettestad questions the regime's effectiveness and asks whether CLRTAP is in fact a cleverly designed regime. After discussing two ways to define effectiveness, as "relative improvement" or as "distance to optimum," and compiling his own top-five list of obstacles to effectiveness, he gives the answer that CLRTAP is a moderately effective regime. He views the regime in this light because the problem it addresses is malign and not easy to deal with and therefore has not yet been solved. At the same time, it should be noted that the regime's problem-solving

capacity has improved over time. One of Wettestad's top-five obstacles to regime effectiveness is "differences regarding the perception of the problem," and he suggests that the way past this obstacle is via international knowledge-improvement efforts. Though Wettestad does not explicitly state it, he comes close to the epistemic-community approach when arguing that the CLRTAP regime is a good example of the establishment of this kind of knowledge capacity. He also focuses on the flexible organization of the science–policy relationship, citing, for example, how the CLRTAP Working Group on Strategies has functioned as a flexible arena for negotiation between science and policy, building consensus on both scientific and political matters. Wettestad's chapter is a good example of bridge building between theoretical approaches because it is grounded in the institutional approach but simultaneously includes perspectives from other approaches.

In "Institutional Linkages and European Air Pollution Politics," Henrik Selin and Stacy VanDeveer focus on political complexity in studying cooperation and conflict between the CLRTAP and the EU in European air pollution regulation. They aim to present a conceptual framework for studying institutional linkages in international environmental policy formation and implementation that comprises multiple theoretical approaches but is still grounded in a focus on institutions. The background for their discussion is the growing number of international institutions that deal with environmental governance, the overlaps and linkages between which are not yet well understood or studied. Selin and VanDeveer argue that a recent development in one institution cannot be fully understood if the linkages to other institutions are not taken into account. After making basic distinctions between vertical and horizontal linkages as well as between governance (institutional) and actor linkages, they state that linkages can have either synergetic or disruptive effects. Of great interest in their study of the CLRTAP and EU linkages are the horizontal linkages between two institutions acting on the same level, located in the same geographical area, and regulating the same kinds of problems. The CLRTAP–EU horizontal linkages are numerous, and there is reason to ask whether there really is a need for two European institutions for air regulation. Selin and VanDeveer conclude, however, that the similarities and overlaps have been more synergetic than disruptive, meaning that cooperation has led to more ambitious targets for both institutions.

The first part ends with the chapter "Transboundary Science for Transnational Air Pollution Policies in Europe." Bernd Siebenhüner

follows up on the comparison of the CLRTAP and the EU by closely examining the interface between scientific knowledge and political decision making in these two institutional settings. He discerns three factors characterizing the design of the interplay—interaction, participation, and reflexive mechanisms—and questions addressing how, who, and what in science–policy interactions. The last factor—reflexive mechanisms—is more concerned with quality in that it enables reflection on current and past experience and how to feed them into policy processes. What Siebenhüner finds in his analysis is that the many workshops organized by CLRTAP, which are an essential feature of the convention's work, have strongly promoted close collaboration between scientists and policymakers and made reflection possible. This collaboration has also led to a science-driven policy process. In comparison, the EU's CAFE program is characterized as a policy-driven process in which external reviews are commonly used reflexive mechanisms. Siebenhüner concludes by arguing that the EU uses scientific expertise from outside in the form of reviews, whereas CLRTAP's work, done through workshops, leads to direct and ongoing contacts with scientific experts. He does not play the processes off against each other but considers both of them successful ways to organize science–policy interaction.

In part II, "Expertise and Learning," attention is turned to the roles of science, expertise, and learning. This part starts by giving a broad overview of international environmental regimes and how they have designed scientific bodies to influence policy and then presents more detailed case studies of expert strategies and learning processes in the area of European air pollution policy.

In chapter 5, "Organized Science, Usable Knowledge, and Multilateral Environmental Governance," Peter M. Haas and Casey Stevens provide an overview of how and when usable knowledge—that is, knowledge with both a substantive core and a mechanism for being transferred from the world of science to the world of policy—has contributed to effective multilateral environmental regimes. The authors assess more than 30 existing regimes that have involved scientific bodies to evaluate "when knowledge speaks to power" and to identify the conditions under which epistemic communities can be established. More specifically, they argue that science and policy must be kept apart: expertise and knowledge claims should be developed independently of the policy process, and only after consensus has been reached should scientific experts interact more closely with policymaking. In such cases, they argue, epistemic communities may serve to link knowledge and decision making. The two basic

failures that often occur, according to Haas and Stevens, are that scientific bodies are not insulated from political control and that science tries to influence policy before consensus has been reached. When issues are highly politicized and involve high stakes—such as in the case of climate change—it is difficult for science to inform policy. The CLRTAP case has been more successful in this respect, and other regimes have something to learn from its accomplishments; it has enabled the creation of autonomous scientific bodies that are given the opportunity to develop consensual knowledge that helps foster consensus in the policy field. The authors conclude that knowledge speaks to power only under certain conditions and that social scientists have a mission to investigate these conditions in greater depth.

In chapter 6, "Scientists Learn Not Only Science but Also Diplomacy: Learning Processes in the European Transboundary Air Pollution Regime," Atsushi Ishii addresses the question of whether learning has had beneficial effects on the CLRTAP regime. By critically discussing ideas from the institutional, epistemic-community, and STS approaches, Ishii develops a theoretical framework that includes three learning modes in relation to policy change: one adaptive (change of policy tools), one reformative (change of policy tools and policy goals), and one paradigmatic (a fundamental change in the understanding of policy tools and goals). He then applies this framework in a detailed case study of the process that led to CLRTAP's Second Sulfur Protocol, signed in Oslo in 1994, which is based on the critical-load concept and the RAINS model. He concludes that paradigmatic learning took place when the critical-load concept was applied in the preparation of this protocol. Applying the critical-load approach entailed the creation of "diplomatory science," a new kind of science developed and used in diplomatic settings. This chapter is also a good example of cross-fertilization between theoretical approaches.

In chapter 7, "Fewer Boundaries and Less Certainty: The Role of Experts in European Air Policy," Göran Sundqvist starts from some key STS findings suggesting that science is Janus faced. According to this view, science is on one side uncertain, which is well known to scientists, but on the other a source of certainty for the public because uncertainties are concealed in public presentations of scientific results. This duality leads to separation between groups and false expectations of what science can provide to policy. When these expectations are not met, public trust in science disappears, and a rift emerges between science and society. Sundqvist tests these STS findings according to a historical analysis of

four formative phases in the development of the CLRTAP. He confronts the IR focus on the separation between science, policy, and the public with the STS aim of blurring the boundaries between these three domains. He finds that CLRTAP activities have usually not been characterized by strong divides between these domains and their understandings. Thus, STS seems to oversell its findings regarding how scientific experts present their results to policymakers and the public. In addition, he considers IR wrong to argue that separation between experts and policymakers is necessary for success. Nevertheless, his conclusion should not detract from the fact that STS provides useful tools for studying how scientists present their findings in public and how communication among scientists, policymakers, and the public can be improved. In doing so, STS challenges both IR and current trends within CLRTAP that support stronger boundaries between scientists and policymakers regarding health issues.

In chapter 8, "Co-producing Policy-Relevant Science and Science-Based Policy: The Case of Regulating Ground-Level Ozone," Rolf Lidskog and Håkan Pleijel present a study of a topic rarely considered by STS and IR: the establishment and development of ground-level ozone regulation. By investigating this new object of policy and regulation, the chapter sheds light on how science-based policy and policy-relevant science are co-produced. By discussing various phases in the problem-formulation trajectory for ground-level ozone, the authors demonstrate the importance both of science in environmental regulation and of political considerations in the expert community. Political actors designed a setting for science–policy interaction in which science is both politically and publicly trusted. Scientific activities were formally separated from political negotiations, but behind this separation lay a close interaction and integration of science and policy. Measurement is developed in a social context in which scientists make political calculations regarding how to design policy-relevant knowledge and in which powers other than scientific ones also influence how environmental problems are represented. In this sense, CLRTAP can be seen as a learning environment in which expertise and stakeholders interact, resulting in the co-production of policy-relevant science and science-based policy. Lidskog and Pleijel demonstrate that instruments such as monitoring technologies and mapping activities not only present environment problems, but also play an important role in shaping an understanding of these problems. Scientific measures and political considerations co-produce a dynamic and changing governable space.

Part III, "Citizens and Involvement," focuses on "the missing link" in air pollution policies: the lack of public involvement. Whereas in the 1980s the acidification issue was strongly debated by nongovernmental organizations, the media, and citizens, today's concerns are more scientifically oriented and directed largely toward global warming. The three chapters in this section start from the perspective of public involvement and put forward practical examples and theoretical considerations of citizen engagement in air pollution policymaking. They also address critical issues, not least the decisive question of why it is important for decision makers to involve citizens. The chapters make new contributions to the social scientific study of air policy issues, long characterized by a focus on international institutions and the interplay between science and policy, leaving citizens aside.

In chapter 9, "Citizen Engagement with the Politics of Air Quality: Lessons for Social Theory, Science Studies, and Environmental Sociology," Steven Yearley presents air pollution as an exemplar of environmental problems. Air pollution is an externality; it is complex and variable (with several problems being given a single name); it is international; and its effects are difficult to measure. In addition, air pollution's social dimensions are obvious with regard to the uneven distribution of environmental ills. Yearley's primary concern is to investigate and reflect on what social theory can contribute to the understanding of air pollution and CLRTAP's achievements. In particular, he investigates three important approaches currently being discussed in social theory dealing with environmental problems: STS, ecological modernization, and Beck's theory of the risk society. The STS approach provides tools for studying the politics of public engagement but has little to say about CLRTAP: the convention seems to have been designed to make it difficult for citizens to exert influence. The theory of ecological modernization is based on the assumption that conflicts between economic growth and environmental improvement have been transcended, resulting in a convergent path for all to follow. Yearley finds that the development of CLRTAP is hard to interpret from the ecological modernization perspective, however, because it seems to be a policy-driven process. Last, the air pollution problem, compared with other environmental problems, has been poorly understood and little discussed as a risk issue. Thus, none of the dominant approaches widely employed in understanding other environmental issues has been used in analyzing CLRTAP. Yearley's answer to this gap can be interpreted as a challenge to social scientists. New ground can be broken to the

benefit of both air pollution work and social theory—for example, when trying to develop a new rationale and novel methods for involving citizens in issues that are not on a local scale.

In chapter 10, "Framing Air Pollution and Health Problems: How to Include Stakeholder Perspectives," Arthur Petersen, Leendert van Bree, and Willemijn Tuinstra analyze the European AIRNET Thematic Network. This multistakeholder project's aim was to interpret the results of research supported by EU Framework Programs in the field of air pollution and public health and to make policy recommendations. The author analyze AIRNET from a science–policy–society interface view that aims to support the democratization of expertise and to suggest guidelines for dealing with framing and uncertainties. They argue that the concept of framing is extremely important but is largely overlooked in discussions of and strategies for stakeholder communication. Framing processes determine the scope of a problem and the knowledge and actions that are considered relevant. They also determine what is at stake and who is to be involved. All multistakeholder projects entail tension between the various frames that should be made explicit and discussed if communication is to be strengthened. The authors' analysis of the AIRNET project concludes that framing issues were not initially discussed; the project was established in line with a technocratic perspective in which boundaries between stakeholders as well as the why and how of stakeholder participation were not considered changeable—which they must be for improvement to occur. These topics were raised only toward the end of the project. The chapter's major conclusion is that to get a better start in multistakeholder projects, framing issues should be consciously reflected on and widely discussed from the outset.

In chapter 11, "Governance of Air Quality and Stakeholder Engagement: Lessons and Experience from International Cases," John Forrester and his colleagues present an international outlook on public participation in air policy work. The chapter provides insight into how the Eurocentric CLRTAP experience has spread to other parts of the world, not least South Asia and southern Africa. It examines stakeholder involvement in four cases: CLRTAP, the Malé Declaration (South Asia), the Air Pollution Information Network for Africa, and the United Kingdom's urban Air Quality Management Areas. The authors handle these very different cases by performing a two-step analysis, focusing first on the science–policy interface and then on how citizen engagement is taking

place. They start with the assumptions that all parties have the right to be seen as stakeholders and that all stakeholders should be engaged early on and take part at all levels and stages of the process. These assumptions are based on the ideal of democratic rights and on research results suggesting that robust social knowledge is decisive in linking science and policy ("speaking truth to power"), which can be realized only through multistakeholder engagement. A prerequisite is that citizens should be brought into the process at an early stage and not—as mostly happens—late in the implementation stage. The authors conclude from the four cases that it is more difficult for citizens to engage with regional problems than with more local problems. However, for citizens to engage with local problems, such as urban air quality, it is crucial to understand how the problem became localized—that is, to investigate its regional connections.

The book ends with the chapter "Science–Policy–Citizen Dynamics in International Environmental Governance," in which Rolf Lidskog and Göran Sundqvist refer to general questions on the future of international air pollution work and how to study science–policy–citizen interactions in this field and more generally. Their discussion is based on the insights gained from the book's individual chapters and provides an overview of the conditions and possibilities for the future regulation of transboundary environmental issues. It is important to apply the lessons from CLRTAP when pondering future abatement strategies in this field and when approaching other environmental problems such as climate change. Furthermore, there is a need for ongoing theoretical development concerning the analysis of science–policy–citizen dynamics. Lidskog and Sundqvist argue that STS insights can nurture and improve the understanding of the roles of science and citizens in international regimes; at the same time, STS needs to make better use of findings from the institutional and epistemic-community approaches regarding science–policy–citizen dynamics in international environmental regimes.

European air pollution policy is in transition. Changing scientific understandings, growing political complexity, new political handling demands, and a need for citizen engagement together pose a great challenge to air pollution policies. We need to understand what is happening and to take the current situation into account when developing new strategies for abating transboundary air pollution and other transboundary environmental problems. In this demanding work, improved analyses from social scientists will make important contributions.

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