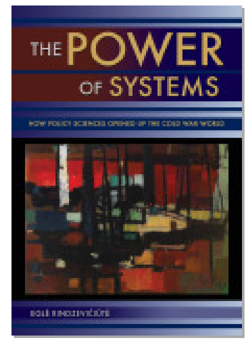
7. Acid Rain: Scientific Expertise and Governance across the Systemic Divide



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ACID RAIN

Scientific Expertise and Governance across the Systemic Divide

In the 1960s Scandinavia and Finland found their fields, forests, and lakes invaded. The invaders were not tanks and soldiers, however, but pollutants. In 1967 Swedish scientist Svante Odén warned the governments of these countries that acid rain was a new problem that could do great damage to the natural environment.[1] Rain infused with sulfur was killing Swedish forests and fish, as pollutants from smokestacks in Poland mixed with pollutants brought by the winds from the Ruhr in Germany and from Britain. The division between the Eastern and Western blocs was literally blown away: a concept of "downwind states," the ones suffering from pollutants that were emitted in other states, began to circulate in scientific and policy circles.

Under pressure from Sweden, the OECD produced its first research report on acid rain in 1968. New terminology was invented to describe this phenomenon, such as "long-range transboundary air pollution." In the 1970s transboundary pollution was traced along the West-West axis; the scope was broadened in the early 1980s to include East-West pollution. Through acid rain the Eastern bloc and the Soviet Union became integrated in the common space of polluted Europe, a space no longer partitioned by national boundaries, but assembled through a grid of a specific number of square miles, from which environmental measurements were taken, consisting of air currents and precipitation. This unprecedented integration of Europe as a complex system in which the environment and industrial outputs interacted without regard for the East-West divide was made possible by a particular technique: computer-based modeling of regional acidification information and simulation, known as RAINS, which was developed at IIASA in 1984.

Why do some models turn out to be influential in policy making when others struggle to establish authority and provide a basis for consensus? Can the answer be found in the results of modeling, or, rather, in the socio-organizational process of modeling? The acid rain case shows that both are equally important. In chapter 5 I showed that the scientific development of global computer models was based to a large extent on lengthy periods of face-to-face communication among the modelers, thus forcing the Soviet government to open up to a sustained, if carefully monitored, cooperation with the West. Then, in chapter 6 I detailed the ways in which global computer modeling was used by different actors to promote disarmament and research into global environmental change, both in their own ways undermining the Cold War divide. In these cases the issues of scientific credibility, public acceptance, policy usefulness, and usability of the computer modeling-based results came to the fore. Scientific hypotheses and evidence were questioned by both peer scientists and the public, and the impact of these studies on the policy process was indirect and therefore difficult to establish. The resolutions, in turn, were not simple fixes, but complex arrangements of interlocking systems of material objects, practices, and institutions, thus inserting global modeling as an important practice in system-cybernetic governmentality. I suggest that the systems approach, instrumentalized by computer modeling, stabilized and facilitated the ongoing sociopolitical change in the organization of both transnational science and politics. This chapter develops this argument further by examining the development of the regional air pollution information and simulation model (RAINS), a project which has been retrospectively described as one of the highest achievements of IIASA, substantiating East-West collaboration beyond scientific diplomacy.

So far the history of RAINS has been explored by historians of environmental science, because this model was fundamental for the implementation of one of the oldest environmental conventions, the United Nations Economic Commission for Europe (UNECE) Geneva Convention on Transboundary Air Pollution. The convention was signed in 1979 and entered into force in Western Europe in 1983, although the Soviet Union had already ratified it back in 1980.

Historians exemplified the development of this convention to advance several different arguments about international cooperation during the Cold War. For instance, Robert Darst argues that the Soviet membership in the Convention on Transboundary Air Pollution revealed the manipulative and hypocritical character of Soviet foreign policy. According to Darst, the Soviets participated in international programs of environmental protection seeking to advance their foreign policy goals, leading to what he describes as a “greening of foreign policy.” Because Soviet intentions were cynical—they did not seriously mean to engage in environmental protection, wrote Darst—their participation in international environmental programs did not result in what he called "transnational learning" and did not have any impact on local environmental policies inside the Soviet Union. In joining the convention, argued Darst, the Soviets merely "projected cooperativeness" and did not actually cooperate.[2]

Although Darst makes an important point that the Soviet interest in international cooperation in environmental sciences was reinforced by foreign policy goals, in my view he unfairly downplays the importance of this international cooperation for the internal development of Soviet environmental and policy sciences. Darst's argument also builds on a particular methodological bias, which focuses on a very particular end product (the convention) and disregards the process of its production. Similarly, few scholars have addressed the backstage side of the convention, in particular the complex work of the development of the RAINS model and gathering the required data. Indeed, Darst disregarded the role of IIASA, the RAINS model, and even more importantly, the role of Soviet actors representing lower levels of politics.

Unlike Darst, Stacy VanDeveer focuses on the modeling efforts themselves and argues that the outcomes of the convention extended beyond pollution control, because this convention established a new, regional notion of Europe.[3] In line with VanDeveer, I argue that the case of acid rain was not a mere card in the game of East-West foreign relations, but a part of the emerging new politics of nature, where the very meaning of what constitutes nature was a matter of political negotiation.[4] I suggest that the preparations for the convention should be examined as a significant case of forging and institutionalizing new networks, which not only provided an infrastructure to circulate soft power across the Iron Curtain, but also mobilized a new framework, which was empowered by the systems approach and which merged nature and political action. I argue, therefore, that Soviet involvement in the convention was not merely an expression of the "greening of foreign policy," but a symptom of internal changes in Soviet governance.

All of this makes for an important rationale to reassess the history of RAINS. In spite of the huge volume of specialized literature dedicated to this model, the production of RAINS in the 1980s remained little known outside STS scholarship and environmental history. Yet historical sociology of modern governance has much to benefit from incorporating cases from environmental governance in its mainstream narratives of governmental change. Indeed, Cold War history still has much to discover about the processes that cut across the political divides and shaped new networks, organizations, and practices, all of which contributed toward a peaceful ending of the Cold War. I suggest that the densifying transnational networks that evolved in multiple governmental niche areas provided a certain safety net for post-Soviet institutions. Thus for some of the transnationalized Soviet governmental and scientific elite the collapse of the Soviet Union did not mean looking into an abysmal future of postcommunism but, in contrast, the continuation of business as usual, in this particular case, fighting to secure viable global and regional futures. In this chapter, therefore, I introduce the case of RAINS as an example of rearranging the Cold War Europe, in which the systems approach equipped with computer modeling played a key role, detailing both the consequences and the limits of this process for the transformation of East and West.

Acid Rain

From the 1960s on, the acidification of rain increasingly became recognized as a problem. Pollutants emitted by factories, but also by cars, into the atmosphere were transported by air currents that did not observe national borders and fell on soil and water in countries from which they did not originate. Accordingly, a country that had few polluting industries could suffer from pollution more than a heavily industrialized country. Tall smokestacks resolved the issue of local pollution by injecting poisonous particles into higher layers of the atmosphere, but then those particles were carried by air currents to fall out elsewhere. Furthermore, certain ecological systems were more sensitive to pollution; for instance, conifers were particularly vulnerable to acid rain. Some countries thus appeared net exporters and others net importers of pollution. Nevertheless, according to Rolf Lidskog and Göran Sundqvist, the phenomenon of transboundary pollution was something that scientists only slowly woke up to. It was first posited as a hypothesis, the proof of which required the launching of large research programs.[5] Pollutants, however, do not carry passports, so that externally imposed pollution poses a difficult conceptual and political dilemma: polluters have to be identified and made to compensate for the damage inflicted on the environment in other countries. The first such disputes arose between Canada and the United States, and were soon followed by disputes in West European countries. Political smear campaigns intertwined with scientific debates.[6] In any case, the struggle over the scientific evidence could not mask the actual ongoing damage, caused by pollution, as roofs of houses were corroding in Dresden, Germany, and fish were dying in Canadian lakes.

The phenomenon of acid rain, in this way, emerged as a political hot potato, an issue that could not be dropped but which appeared impossible to solve. Wherever there was an international controversy emerging around an "objective" matter, there was an opportunity for IIASA. Invoking the ideas of Howard Raiffa, Buzz Holling wrote to the US Environmental Protection Agency saying that "when conflict or controversy loomed between two or more nations, they would turn to

IIASA to host a group who would attempt to clarify the technical and factual issues lying behind or triggering controversy."[7] The subsequent events unfolded with typical Cold War ambivalence: although the Soviets supported the idea that IIASA should get involved in modeling acid rain, particular strategies had to be developed to ensure a meaningful Soviet cooperation. Therefore I suggest that the process of developing the RAINS model was just as important as the end product, the model itself which provided international negotiators with the data on which to base their agreement.

In the beginning an alliance to tackle the problem of acid rain was forged between the Soviet Union and Scandinavia. Norwegian prime minister Gro Harlem Brundtland visited Moscow in early 1978. It was agreed that the Norwegians would convince the other Nordic countries about the need for an international agreement on acid rain, and, in turn, the Soviets would mobilize Eastern European governments around this cause. However, the proposal was attacked by the UK, France, and West Germany at the Economic Council of Europe in Geneva. Not only was the proposed agreement contested, but even the very problem of transboundary pollution was questioned. Nevertheless, the Cooperative Program for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (currently known as EMEP) was launched in 1978. The following year, the results of a preliminary study indicated that pollutants could indeed be transferred over long distances and across national borders.

At this initial stage the argument of intertwining foreign policy and international cooperation in the area of environmental protection can explain Soviet involvement. The environment was an important area in which the Soviet government sought to exert its soft power by positioning itself as a globally progressive regime. In the early 1970s the Soviet Union strategically expanded international cooperation through programs for environmental protection, pursuing this direction especially intensely after the Helsinki agreement in 1975. For instance, in 1976 the Soviet government proposed a series of European meetings within the framework of the United Nations Economic Commission for Europe. But enthusiastic Soviet involvement in programs for international cooperation on environmental issues was often met with skepticism by Western governments, because it was regarded as a mere ideological gesturing.[8] It was thought that the Soviet government was attempting to shift the attention of the Western public away from the issue of Soviet violations of human rights by emphasizing their benevolent efforts in environmental protection.

Yet I suggest that the acid rain case was a hybrid project, able to serve simultaneously different agendas in politics and science; just like in the case of the establishment of the East-West institute, where a group of scientists harnessed a foreign policy initiative to advance their own goals. Indeed, acid rain was a perfect example of a universal problem mixed with a global problem, that is, the problem of acid rain was experienced in different countries, but this problem could not be solved from within national borders. The definition of the very problem of acid rain required a systems approach, showing how industrial pollution, the natural environment, and the economy interacted, which in turn required international cooperation to obtain the necessary data. First, mutual vulnerability had to be demonstrated in order to communicate the extent of damage and urgency of concerted governmental action. In the Soviet Union, following the Scandinavian example, the Institute of Applied Geophysics under the State Committee for Hydrometeorology and Control of Natural Environment (*Upravlenie* from 1974, *Committee* from 1978, henceforth Goskomgidromet) published a study showing that acid rain inflicted USD 150 million worth of damage on the European part of the Soviet Union each year.[9]

Once foreign policy goals and the need to advance environmental science were combined, the problem of acid rain was put on the agenda of the Economic Commission for Europe. The 1979 study, conducted under the auspices of the Cooperative Program for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe, demonstrated the transboundary flow of pollutants in a "blame matrix" that paved the way to a compromise and the convention.[10] The representatives of East and West achieved an important compromise, however, to put the policy agreement into action, concrete implementation protocols on pollution reduction had to be developed: it had to be decided just how much and at what rate the countries involved in pollution flows should modernize their polluting industries. The decision making required "hard facts," showing the actual level of pollution and the economic effect of abatement measures. It was at precisely this moment that IIASA became involved, as a neutral host for loosely coupled networks, knotted at numerous meetings in Laxenburg, dedicated to the mathematical modeling of both decision aid systems and environmental processes.

In this way, the same logic underpinned the projects to study acid rain and nuclear winter, where scientific experts helped to discover and articulate a new, significant problem and pushed for new governmental action at the same time pursuing their own scientific agenda. But the issue of acid rain was subject to no fewer and perhaps even more security constraints than the nuclear winter prognosis. It might strike the reader as something counterintuitive, but the Soviet scientists found cooperation with Western scientists in simulating the environmental effects of a nuclear war easier than working with them on the effects of acid rain in Europe. Acid rain, being a phenomenon of the present, was much more heavily politicized than a simulated nuclear disaster. Furthermore, the different degree of politicization depended on the different types of information used in the models. Whereas the nuclear winter project used internationally open data and drew on hypothetical scenarios of the course of events, the acid rain model could make sense only with actual data of emissions and damage. As it turned out, much of the environmental data in the Soviet Union was strictly classified, not only because the Soviet government wanted to conceal the extent of environmental damage from its own population, but also for military reasons.

To be sure, the atmosphere sciences were heavily militarized on both sides of the Iron Curtain, but especially so in the Soviet Union, where the key center for the data and infrastructure of meteorological forecasts was Goskomgidromet. Thus when in his study of East-West relations in the acid rain project Darst suggests that Goskomgidromet was a “lowly” meteorological bureau, he disregards the central role that this institution played in the Soviet industrial-military complex for atmosphere science.[11] For instance, the highly strategic status of Goskomgidromet is clearly revealed by the background of the chief Soviet representatives in negotiations on acid rain at the Economic Commission for Europe. The head of the Soviet participation was Iurii Izrael’, the chairman of Goskomgidromet, who, just like his deputy Valentin Sokolovskii, was in his mid-fifties at the time of negotiations and claimed solid experience in both military research and high-level administration.[12] Born in Tashkent in 1930, Izrael’ was raised in a highly educated family in Central Asia. His father, of Estonian origin, was a military doctor who moved from the army to academia; his Russian mother also had a doctoral degree in medicine and worked in the same department. Beginning in 1954 Izrael’ worked on the atmospheric impact of nuclear explosions at Evgenii Fedorov’s Institute of Geophysics at the Soviet Academy of Sciences. Retrospectively, Izrael’ wrote with pride that he was the first civilian scientist to fly into a radioactive cloud following a test nuclear explosion in Semipalatinsk. Appointed as the head of Goskomgidromet, Izrael’ was in charge of a gigantic system, consisting of thirty-four control centers, twenty-two research institutes, and thousands of observation stations and satellites, devised to monitor the environment of the Soviet Union. Although Izrael’s expertise was predominantly in radioactivity, he authored a book on acid rain in 1983, thus signaling the importance of this issue and legitimizing research into it.[13] Izrael’ was also in charge of the studies of global environmental change and served from 1975 to 1986 as a vice president of the World Meteorological Organization (WMO).[14]

The chief Soviet negotiator, Valentin Sokolovskii, was also brought up in a military family: his father was a marine artillery officer. Trained in hydroengineering and dispatched to Soviet Latvia in the 1950s and 1960s, Sokolovskii was in charge of the mass hydrological improvement program in the Baltic states, something that coincided with forced collectivization and was negatively received by local populations not only because smallholding farms were eliminated to make way for large-scale agriculture, but also because the measures increased water pollution. Ironically, since 1973 Sokolovskii had been in charge of environmental protection programs as a vice chairman of the GKNT, thus nominally holding the same status as Gvishiani. When Sokolovskii was appointed as a senior consultant on the environmental problems of the Soviet Union at the Economic Commission for Europe in 1977, he already had well-established links within the GKNT and environmental agencies, which overlapped with the research agenda pursued at IIASA. In 1979 Sokolovskii also became vice chairman of Goskomgidromet.[15]

In this way, Soviet participation in the international cooperation around acid rain was anchored in Gosgidromet and tightly linked to the military. The determination to control Soviet data was therefore not surprising, and it was expressed in the institutional setup: when in November 1979 the Convention on Long-Range Transboundary Air Pollution was signed by thirty-three countries in Geneva, it was also agreed to appoint two research centers to produce the required data, in Oslo and in Moscow.[16] Thus the Soviet Union committed to disclose some of the data on transboundary pollution, but also made sure that this would be done through a carefully monitored channel. In chapter 6 I mentioned Izrael's maneuvers between his commitment to state secrecy and public support of nuclear winter studies; this engagement indeed overlapped with the Geneva negotiations on policies to combat acid rain. In what follows, I detail how Soviet scientists were torn between the two imperatives: to disclose as few Soviet data as possible to West, but also to meaningfully contribute to the European convention on transboundary pollution. Here IIASA appeared as an important mediator, which helped to resolve these conflicting rationales through highly networked practices.

The Laboratory of Sensitive Facts

As I mentioned earlier, acid rain was a highly controversial issue: the origins, character, and the extent of the damage caused by acid rain were questioned. As a rule, skepticism was voiced by culprit countries. The question was how an agreement could be reached when the economic stakes were high and denial pervasive. This was a perfect opportunity for IIASA to use its neutral status in the service of international agreement; indeed, from as early as 1973 IIASA, according to Koopmans, positioned itself as "an objective commentator on controversial issues."[17]

Scientific objectivity, however, is not something that can be measured against a certain universal standard, but a particular condition, the character of which varies in relation to a particular problem and context: according to sociologists of science, all facts are artifacts, produced by particular scientific communities. Data, for instance, can be viewed as a hybrid object that can never be entirely detached from the infrastructure which was used to produce it and which might be necessary to verify it. The case of acid rain shows that factual information on a controversial subject tends to garner more influence when it is produced in an international institutional setting. But the international setting itself here should be approached as an infrastructure in its own right, which has been strategically assembled; this is precisely what was done at IIASA in relation to the European acid rain study. First, at IIASA the acid rain project was initially developed on the axis of West-West cooperation: the idea of modeling acid rain in Europe was first formulated in discussions among American and Canadian scientists in 1981, at a time when American and Canadian authorities were searching for independent reviewers of transboundary pollution.[18] However, following the Lidingö conference on acidification of the environment, Sweden, and a joint workshop on air pollution arranged by IIASA and World Meteorological Organization, in 1982 IIASA decided to launch a three-year project to study acidification in Europe.[19] At the initial stage, connections with the Nordic countries were forged, as in June 1983, Sweden, Norway, and Finland proposed a schedule to cut emissions by 30 percent by 1990.[20] Eliodoro Runca, an Italian scientist who came to IIASA from the IBM Scientific Center in Venice in 1980, initiated contact with Swedish scientist Uno Svedin, who made sure that IIASA was granted observer's status at Lidingö.[21] Following this, Runca launched discussions with the Economic Commission for Europe and initiated contacts with regulatory and scientific organizations in East European countries, and with the signatories of the convention,[22] including the Central Electricity Generating Board of the United Kingdom and the National Swedish Environmental Protection Board.[23] The US Environmental Protection Agency reported that the East Europeans committed to supply the necessary data and to participate in the project.[24]

Before we proceed, a few words on the United Nations Economic Commission for Europe (ECE) are necessary. Based in Geneva, the ECE was a prominent platform where a new postwar Europe was being constructed as a specific area, brought into being through econometric statistics. To be sure, this version of an economic Europe was clearly marked by the East-West divide, yet it also transcended this divide, because it defined Europe from a global perspective as one of the world's economic regions. As a key meeting place for Soviet, East European, and West European econometricians and policy makers, the ECE was appointed to deal with the problem of acidification under the 1979 Geneva Convention on Transboundary Pollution. The loop was closed in a way that reflected the link that was first explicated in *The Limits to Growth*, that economic growth caused pollution, the solution of which had a financial cost and economic consequences.

As the issue of acid rain was highly politicized around the question, which countries should brace for additional investment to abate the pollution of other countries and to what extent, a premium was put on informal ways of preparing the basis for the international cooperation. In February 1983, IIASA's director Holling sent a very cautious letter to Gvishiani seeking official approval, writing that Runca had assembled a "very carefully developed network of scientists," in this way "quietly and effectively" opening up the possibility of IIASA becoming "a center of synthesis" of existing research on acid rain.[25] The November 1983 meeting at IIASA gathered representatives from meteorological centers in East Europe as well as Scandinavia; the next year, in 1984, the Polish Institute for Meteorology and Water Management and the East German Institute of Cybernetics and Information joined the acid rain project at IIASA. Furthermore, as at that time IIASA was in a precarious financial situation, first because of the withdrawn US NAS membership and then diminished funding, efforts were taken to secure external funding from additional national sources; thus some money came from the Finnish Ministry of the Environment.[26]

It was also at this early stage that the conceptual architecture of the model was developed. The first proposal for the research program emphasized that the computer-based model of transboundary pollution should account for "institutional differences between East and West," although such differences were not specified in this document.[27] Because it specialized in econometric modeling, the Economic Commission for Europe proposed that IIASA should develop a cost-benefit model of abatement policies.[28] Economic cost-benefit modeling was preferred by the US and UK negotiators, who were also quite negative about the possibility that the modelers themselves might offer different policy strategies.[29] The role of scientists, thus, was envisioned as merely auxiliary, a technical role in calculating cost-benefit; scientists were not expected to actively contribute to the development of solutions. However, the appropriateness of a cost-benefit model was questioned by both East and West scientists. I discuss this in greater detail later; here I would only like to note that the idea of a cost-benefit model encountered obstacles of both an ideological and a pragmatic character. Thus the Soviets were not keen on cost-benefit analyses; furthermore, due to the radically decreased budget (as related in chapter 4, this was the period when the US government withdrew its financial support for IIASA), the IIASA team could not afford an economic research assistant.[30] Only in 1985 was a cost-benefit analysis with RAINS included in IIASA's plan.[31]

RAINS consisted of three blocs: pollution generation, atmospheric processes, and environmental impact, with further submodels to investigate emissions, long-range transport, and acidification.[32] The emissions of sulfur were calculated for twenty-seven European countries on the basis of their individual energy pathways, with a time horizon from 1960 to 2030. The model was interactive: a policy maker could select a particular national pathway of energy use, a strategy of pollution control, and environmental impact indicators. On the basis of this information, the computer model simulated the interaction of these three systems, enabling the user to examine the consequences of different alternatives to control acidification.

While the architecture of the model was a subject of scientific debate, access to the data was a subject of intense political lobbying, entailing the leveraging of not only personal contacts, but also the evolving technical and institutional infrastructure of environmental monitoring. As mentioned earlier, the data on transboundary pollution was gathered and processed by the two meteorological centers, one in Oslo and one in Moscow, and IIASA cautiously emphasized that its goal was not to compete with these centers by gathering alternative data, but rather to use these existing data to conduct a systems analysis of transboundary pollution.[33] The model was presented as an instrument enabling the organization of various kinds of information—on energy use, on the atmospheric transport of pollutants, and on the impact of pollution on terrestrial and aquatic ecosystems. In contrast to the computer simulation of the environmental effects of a nuclear war, the goal of RAINS was not a heuristic one; that is, RAINS did not seek to advance scientific knowledge. Instead, the goal of RAINS was pragmatic, to "reconcile existing results" so that they could cast light on problems residing on the borderlines of established disciplinary fields. Typically of computer models of complex, interacting systems, measures were taken to ensure that the model produced plausible results for the future. The choice of time frame was influenced by several constraints, such as the available data, which allowed simulating conditions thirty years ago, and the life cycle of the energy infrastructure, such as power plants and heating systems, which required projecting fifty years into the future. The scientists also chose to model over the long term, because only in this way could they reveal the cumulative effects of acidification, which were not as evident in the short term. Furthermore, IIASA's scientists intended to focus on assessing the probability of different impacts of both acidification and abatement policies on the environment and economy and, in this way, to critically evaluate the existing data.[34] On the basis of this latter aspect, I argue that the RAINS model was equally important as a process and as a final result.

There were some interesting parallels and differences between the projects on acid rain and on nuclear winter, and not only because the study of nuclear winter also showed that acid rains would shower the Earth, damaging conifer forests, after the nuclear blasts. While Soviet atmosphere scientists were bracing themselves for the study of nuclear winter in Moscow, IIASA formally launched the acid rain project, in March, 1983. In both cases the concern with the environment and the future of the populations of Europe and the world was intertwined with institutional interests. Having lost funding from the US National Science Foundation, IIASA badly needed an injection of both symbolic and financial capital to ensure its survival in the future. For instance, Holling expressed a hope that a model of acid rain would help to "enhance the Institute's credibility and visibility."[35] IIASA's burning concern was to prove its relevance to the governments of its member countries. Whereas nuclear winter scientists focused on generating new, hypothetical data about the postnuclear environment and did not pay much attention to the actual usefulness of their model for assisting concrete policy decisions (beyond the impact on public opinion), the initiators of RAINS intentionally and carefully focused on finding a way to prove their model useful for their clients, the national governments. In short, nuclear winter simulation was problem-generating, while simulations of the transboundary acid rain emissions were solution-generating. These different goals shaped governments' trust in the models. The simulation of nuclear winter threatened the status quo by overthrowing the authority of the nuclear "experts," revealing an extreme, long-term uncertainty and establishing the relevance of environmental sciences to nuclear defense strategy. In contrast, the modelers of RAINS were cautious about framing their expertise as mere technical support. In so doing, they strategically relied on the earlier experience, such as the MIT model of seabed mining and tread carefully in the political milieu by adjusting their terminology and claims. For example, the acid rain model was described as "a useful scientific tool" for policy makers, explicating that the authors of the model refrained from taking over the decision making role by offering recommendations.[36] The scientists also assured that they did not intend to propose any particular measures that could possibly compromise the existing policies of individual nations. This intention was communicated to the heads of partner organizations in Poland, Hungary, the Soviet Union, and the United States.

The computer-based model of acid rain was not just a software program. It was a social network bridging scientific and policy-making environments. Having clearly articulated their political stance and distanced themselves from any pretense to a decision-making role, IIASA's team embarked on forging a support network for the model. Given that by 1983 IIASA already had a decade of experience in policy sciences research from both the quantitative and qualitative perspectives, it is not surprising that the environmental modelers were keenly aware of what it takes to make an influential model. Knowing full well that an influential instrument could not be developed solely in isolation inside a laboratory, the modelers cast their nets wide, seeking to enroll supporters from both scientific and extra-scientific fields. The necessary supporters were identified, including influential and distinguished scientists and governmental authorities, and a network was "painstakingly built" by Runca.[37] IIASA provided institutional support and resources for scientists to spread the word about the model face-to-face.

In the spring of 1983 Runca traveled to Moscow, Helsinki, Stockholm, Oslo, Amsterdam, and Frankfurt to brief his colleagues about the idea of a computer-based model of acid rain to governmental authorities. During this trip it was agreed that the participating countries would officially request the Economic Commission for Europe to collaborate with IIASA.[38] Importantly, the executive secretary of this commission, a Finnish-Swede by the name of Klaus Sahlgren, was personally impressed with the idea of modeling transboundary pollution with a computer. The path was successfully broken through this stage of institutional overtures: at the convention meeting in June 1983 several national representatives placed the planned IIASA study on the agenda for negotiations.[39] In September 1983 the Economic Commission for Europe officially confirmed its support for the development of a model of acid rain at IIASA.[40] When Leen Hordijk, the Dutch scientist with whom the RAINS model would become associated in the future, arrived at IIASA, the main components for the acid rain project were already in place. However, it was thanks to the scientific and organizational skills of this Dutch scientist that IIASA would be propelled into the highest levels of East-West cooperation.

A small country whose infrastructure was designed in response to a constant struggle with the ever-encroaching Atlantic, and which had been boasting a great pedigree of systems thinking, dating back to Spinoza's philosophy in the seventeenth century, in the second half of the twentieth century the Netherlands emerged at the forefront of nationwide computer-assisted planning. Long-range planning grew from the postwar spillover of military to civil research in the United States and, as Jenny Andersson notes, long-range governmental programs were transformed into the long term.[41] The Dutch concern with long-range and long-term planning was best expressed in the work of Jan Tinbergen, but interest in the social and economic consequences of technoscientific innovations was also exemplified by the activities of Gerhart Rathenau, the chair of the first public commission on technology assessment of the effects of computerization, in 1978. The Dutch context was not, to be sure, the sole determinant of the future success of the RAINS model, but it is quite important, because it provided a key resource from which scientific expertise in economic and environmental planning could be drawn, as well as the networking skills necessary to mediate between scientific research and governmental policy. Operating on the principle of a balance among the nations represented through the national member organizations, IIASA's council noted that Dutch scientists were underrepresented as project leaders (the Netherlands joined IIASA in 1977), and the secretary of the Dutch member organization, the Dutch Research Council, Eric Ferguson, disseminated a call for candidacies in planning sciences, which would eventually reach Leen Hordijk.

Initially trained in econometrics, Leen Hordijk went on to study environmental economics, and hence became familiar with chemistry and biology. He did not become a specialist in either of these two fields, but learned enough to be able to understand and communicate with chemists and biologists, something that would prove vital in his later career. Hordijk received his first hands-on experience working at the Economic Bureau in Hague, where he examined the environmental consequences of economic development. It was then that, on behalf of the Dutch secretary for IIASA, Eric Ferguson, the economist Peter Nijkamp approached Hordijk, asking whether he might be interested in the opportunity to direct a project on economic planning at IIASA. Hordijk already knew about the institute, because he had visited IIASA for a conference; thus he visited Laxenburg for the second time in 1983 to discuss possible cooperation. However, this engineered meeting did not work: Hordijk realized that he was not interested in the agenda of the economic program, chaired by a Russian scientist, whose approach he found coming "from a different planet." But as a matter of luck, Hordijk was approached by several young scientists, including Joseph Alcamo, who would later become the chief scientist at the United Nations Environment Program. The young IIASA researchers proposed that Hordijk join them in developing an environmental model of acid rain in Europe. Hordijk immediately saw an opportunity to extend the work he was doing in the Netherlands to a larger scale and, consequently, asked IIASA's director if he could collaborate instead on the acid rain project, in whatever role possible. This proposal was accepted and in summer 1983 Hordijk received an offer to join the IIASA as a research scholar, to arrive in Laxenburg to replace Eliodoro Runca in early 1984.[42]

At IIASA Hordijk found himself the leader of a truly international team, made up of scholars from Finland (Pekka Kauppi and others), the United States (Joseph Alcamo), Austria (Maximilian Posch) and Poland (Jerzy Bartnicki).[43] Before his departure, Hordijk got in touch with the Dutch Ministry of Environment requesting a contact who could help him learn more about the problem of acid rain. Hordijk was given a stack of mathematical papers, mathematics being an interdisciplinary language that he could understand, on air quality concentration. Equipped with these materials, Hordijk moved his family to Austria.[44] The IIASA group already had an operational model of European Air Quality, developed in Oslo, Norway. Hordijk's task was to link the atmosphere bloc with other blocs, such as forest and water. According to the initial plan, Hordijk was expected to stay for two years, but his stay was extended to four years before he returned to the Netherlands to become a professor in systems analysis at Wageningen University. In 2002 Hordijk would return to IIASA, now as the director of the institute.

Activating the Coproducers of Knowledge

At the early stage of negotiations on the convention, it was made clear that the model of acid rain was expected to serve as a "neutral" platform for East-West cooperation.[45] However, in this case the meaning of neutrality had nothing to do with laboratory-like isolation, where presumably neutral experts established reliable data, and everything to do with active management of the participating countries. Neutrality, therefore, emerged as an effect of active intervention. The archival documents show that, although IIASA was regarded as an established and, because of its orientation to quantitative methods, a neutral platform for East-West cooperation, partner organizations did not automatically enroll in the acid rain project. Instead, partners had to be actively co-opted through labor-intensive and sometimes, as Runca confessed, painstaking efforts. Like Runca, Hordijk was acutely aware that in order to make the model trustworthy and usable, vast networks had to be forged, including both scientists and high-level policy makers. Indeed, Hordijk meticulously documented his networking efforts through the reports. For instance, at the Munich multilateral conference on the environment, attended by the representatives of thirty-one countries and eighteen ministers, outside of the main program Hordijk briefed the delegates from ECE, UNEP, the UK, the Soviet Union, Sweden, Portugal, Norway, the Netherlands, West Germany, East Germany, Finland, Denmark, Czechoslovakia, Austria, and Canada about the progress of his project, and in all these cases received agreement to support the acid rain modeling at IIASA.[46] In Paris, Hordijk briefed another twenty-eight policy makers and consultants from the OECD Group of Experts on the Environment.[47] Likewise, Hordijk spread the word at the meeting of the Executive Council Panel of Experts in Environmental Pollution of the World Meteorology Organization in Garmisch-Partenkirchen in 1984.[48] Contacts were also pursued with the Dutch headquarters of Shell in a quest for additional funding, and the representatives of Shell came to IIASA to meet the acid rain group, subsequently contributing a small grant to the project.[49] Links were extended across the Atlantic: James Fay of the MIT Energy Laboratory got in touch about possible cooperation.[50]

The Cold War context imposed certain limitations on the selection of relevant partners. For instance, beginning in 1969 environmental issues were studied at the NATO Committee on the Challenges of Modern Society, an institution which was deemed relevant to the acid rain project, but IIASA could not even consider getting involved with any NATO agency.[51] There was an attempt to involve other American collaborators through the US National Acid Precipitation Program, but it was stressed that the model was a European one and therefore Hordijk's networking efforts targeted European meetings.[52] Then, not only international, but also national organizations had to be convinced to participate: over 1983 and 1984 intense correspondence was conducted with the institutes in Poland, East Germany, and the Technical University in Prague. At the Munich meeting in June 1984 the Soviets officially announced their support for the negotiations, and a year later, in July 1985, a protocol on the reduction of sulfur emissions was signed by nineteen states, including the Soviet Union.[53]

Given the financially precarious position of IIASA in the early 1980s, the acid rain project was an astonishing success: the model was developed rather quickly, it was used by high-level policy makers, and it achieved its purpose in just a couple years. It can be argued that this success was the combined result of evident, ongoing environmental damage and the presence of highly motivated individuals, keen to mediate across the East-West divide. For instance, at the Economic Commission for Europe the acid rain group initiated contact with a Swedish civil servant, Johan von Luttemberg, who was extremely helpful in arranging first the presentation of their work and then their participation in negotiations. But this was also the case of a joint transnational scientific effort. Just like with the nuclear winter project, the RAINS model was a result of bricolage rather than creation *ex nihilo*. IIASA's scientists linked a Norwegian atmosphere model of long-range transboundary pollution (known as EMEP), which was developed by the Norwegian modeler Anton Eliassen, with an environmental damage model, adding to it the calculations of abatement procedures.[54] Polish and Dutch scientists collaborated with Eliassen to develop the atmosphere bloc. The contribution of the Finnish scientists was to model pH levels in soil and surface water.

The acid rain model also assumed a public life. The first presentation of the model to the Executive Body of the Economic Commission for Europe Convention was scheduled for the September meeting in 1984.[55] On behalf of the commission, executive secretary Klaus Sahlgren invited Hordijk to present the acid rain model for thirty minutes outside the formal meeting.[56] The model was presented during a lunch break in the negotiations session at the commission on September 26. About twenty-five policy makers attended, a much smaller number than expected, thought to be a consequence of the overlap with other meetings. Coincidentally, a similar study from the UK was presented and the two groups decided to collaborate in the future.[57] From then on the IIASA group became involved in one sublayer of the negotiations, the task force for economic analysis.

According to Hordijk, an important factor in the development of the model was that the chief Soviet, Canadian, and Dutch negotiators quickly became convinced that the model was the only way to reach any agreement. Several representatives at the commission argued that IIASA's team of scientists should not be involved in the negotiations, because IIASA did not have a formal relationship with the UN. However, due to the effort of Russian negotiators, who were first skeptical and then positive, the modelers got the go-ahead. Given that the Russian negotiators were Valentin Sokolovskii and Izrael's deputy chairman of Gidromet, their support was not surprising at all: Izrael' was directly involved in the promotion of the US-Soviet study of the environmental effects of nuclear war, which I detailed in chapter 6. Hordijk also recalled that Sokolovskii and Izrael' pushed the Canadians, and Hordijk himself was personally acquainted with the chief negotiators on behalf of the Netherlands.[58]

In this way, through intense personal efforts and thanks to lucky coincidences, a window for IIASA's modelers was opened into the heart of the policy making world. Beginning in September 1984 the RAINS team would travel to Geneva regularly for a year and a half. It is important to note that even with this approval granted, the relevance of scientists to these high-level negotiations was not self-evident to many negotiators. During their first visit the scientists were still considered a disturbance and kept at a (physical) distance, in an adjacent lounge, because the Economic Commission for Europe was convinced that members of an organization without affiliation with the UN could not be granted access to the hall where negotiations took place. This guarded behavior continued for several months. IIASA's team reacted to this by resorting to their social and technical skills to make their study visible. For instance, whenever possible, the research done at IIASA was presented via remote computer links, such as Datex-P, to high government officials in Amsterdam in February 1985.[59] In doing this, scientists tapped in the symbolic power of a new technology, such as data links, in order to make their case heard at the high policy level. It appears that the use of new technology adds additional legitimacy to new data, just as in the case of nuclear winter study.

But even more important is the point that those principles of the model of acid rain, which made it successful as a tool for an international policy agreement, strongly contradicted the notion of opaque, technocratic decision making empowered by scientific expertise. Governance by scientific experts has been criticized as a complex and arcane activity, shaped by informal customs known only by few and taking place behind tightly shut doors. Although the RAINS model was produced and circulated among scientific and policy elite groups, there were also important moments that revealed the logic of openness and inclusivity. For instance, the description of the acid rain model stated that it had to be "co-designed by analysts and potential users" and "as simple as possible." Occam's principle was at work: the modelers emphasized that more complexity would be introduced only if "necessary and only in conjunction with potential model users."[60] The model also allowed for flexibility, because it was, in fact, an open system of models that could be expanded by adding additional blocs if needed. Furthermore, the principle of openness to external scrutiny was paramount: the modelers wished that RAINS would break away from the image of electronic oracles.[61] The official description stated that the model was intended to "explicitly reflect uncertainty."[62] It was anticipated that the model would be subject to "very close external scrutiny," and therefore the model's uncertainty was evaluated and communicated to the scientific community: the technical specification of the model was available for free to anyone wishing to inspect it.[63] The group organized workshops in which the model was examined by scientists hailing from different disciplines, such as soil science, meteorology, energy, and ecology, but also policy makers from the Economic Commission for Europe and the United States.[64] Also, the creators of the acid rain model were alert to the risk that the claims of their model could be mistaken for reality and therefore dismissed as such. Preventive measures were taken to counteract such criticism: the acid rain model was therefore described as "a decision support system" and "a model for organizing information."

Scientific credibility was to be reinforced by political credibility. Here the institutional context in which the model was produced was of crucial significance. According to Hordijk, as IIASA enjoyed the special status of being a transnational organization it was relatively immune to knee-jerk accusations of national bias that pervaded the ongoing negotiations around acid rain: Nordic countries identified the UK, the Eastern European bloc, and the Soviet Union as culprit polluters, the sources of acid rain that fell on Scandinavia and Finland. But some British scientists dismissed the data, denying that the damage was caused by acid rain or that the UK had anything to do with it. National studies were accused of being biased, their results questioned. Furthermore, scholars "trembled at the simplifications" that they had to make in order to communicate their results to the media.[65] The biochemical processes of the acidification of forests, soil, and water were complex, varied, and sometimes insufficiently understood.

However, there was an acute feeling that action had to be taken sooner rather than later. This sense of urgency was also shared by national negotiators, who needed some kind of mutually acceptable data set in order to reach an international agreement. The RAINS model responded to this need, first and foremost by providing negotiators with a system that showed, visually, the interrelating causes and effects. The maps and graphs, nicknamed "the Alps of Europe," as they showed the curves peaking and dropping down sharply, illustrated different scenarios of actions from which a policy maker could chose an energy pathway for a country. In response, the model calculated the sulfur emissions and the resulting environmental impact over the whole European area, including the Soviet Union, for a fifty-year horizon.[66] The policy makers, wrote IIASA scientists, could see how a problem "evolves and can be corrected with time."[67] Visualized in, as one scholar put it, "maps over time," the problem was assembled as an amenable process, which required action and intervention.[68]

Nevertheless, it was easier to ensure openness to external scientific scrutiny than to arrange access to the data without which the model made no sense. Here accessing the Soviet data on pollution was a particularly difficult problem, which was further exacerbated by the methodological requirements of the modelers. In order to establish the precise areas of origins and fallout of pollutants, the model required data taken from a grid of many square kilometers, covering all of Western Europe, Eastern Europe, and the European part of the Soviet Union. At that time the data for Europe were aggregated for 150/150-km grid cells (at the moment of writing in 2015 they are 50/50 km in size). This seemingly harmless requirement immediately clashed with Cold War secrecy. According to Sokolovskii, the Soviet government refused to reveal such data of localized pollution, because this could indirectly reveal the location of heavy industry factories, which constituted strategic objects in the case of military conflict. For this reason, only the data on total national emissions were initially submitted to the commission's atmosphere transport model, although it was also agreed that the Soviets would supply some data on the fluxes that crossed the western borders of the Soviet Union.[69] Further data were pooled from the databases of the WMO, the UNEP, and the ECE Collaborative Program on the Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe.[70]

Here I would like to add that, while the environment was deemed to be apolitical and therefore a suitable area for East-West cooperation, some environmental data were subject to tight security. Such was, for instance, the case for tree pulp samples, which were used for dendrochronological studies of climate change. Different chemical processes left marks on a tree's rings and in this way a tree constituted a document, a record of the changes in the immediate environment, be it the fluctuation in CO2 or radioactive emissions. Yet, because such samples were collected from a rather small, four-by-four kilometer grid in the European part of the Soviet Union, an actual sample would enable a dendrochronologist to detect the location of, for example, nuclear missile silos.[71] Nature, in this way, appeared to have a potential to tell stories about military defense systems and industrial accidents, something which was never explicitly acknowledged in the discussions on East-West data sharing, but rather ran in between the lines, being a source of continuous delays and evasive answers.

How did IIASA scientists deal with the Soviets, the "masters of openness without disclosure?"[72] This difficulty was anticipated, and collaboration with East European scientists was not self-evident from the beginning of the acid rain project: the early research plans did not place a strong emphasis on the Eastern European contribution.[73] Originally oriented toward the Canada-US axis, then Europe-Scandinavia, the project came to include the Eastern Bloc only at a later stage. Polish scientists were brought in first, because they cooperated in conducting an uncertainty study of the model. East Germany and Czechoslovakia also cooperated. Part of the Soviet participation in the acid rain project, as in the case of nuclear winter study, was organized within the framework of the UNESCO program on the sustainable development of the biosphere. Although Soviet representatives at the Economic Commission for Europe were instrumental in getting the acid rain model on the agenda, the development of actual contacts with the Soviet institutes was not straightforward.[74] Predictably, VNIISI was listed as a collaborating institute, but it was through Izrael' that IIASA sought official permission to contact Soviet atmosphere scientists. There were hardly any horizontal relations involved at this point. At a meeting in Warsaw, for instance, members of the acid rain project met a scholar from the EMEP Meteorological Synthesizing Center-East of the Institute of Applied Geophysics in Moscow (this Center-East was a counterpart of the Center-West in Oslo). Then the director of IIASA, Thomas Lee, approached Izrael' with a request to cooperate by providing the data produced at the Center-East for further use in the RAINS model.[75] This chain of command is telling: whereas Hordijk always directly corresponded with Western scientists, UNECE, and other international organizations, he needed support from his superiors in order to achieve cooperation with the Soviets.

Furthermore, from the Soviet point of view the project on acid rain was a small piece in a larger puzzle, which probably partially explains the rather lenient and inflexible approach to data supply, as such requests may have fallen through the cracks. Soviet participation in IIASA's acid rain project was pursued within a wider framework of the program on sustainable development of the biosphere, which involved quite a few prominent names. In the mid-1980s there were several high-profile meetings bringing together the world's leading environmental scientists in Soviet Russia. Thus the August 27–31, 1984 meeting brought together Izrael', Viktor Kovda, Anatolii Dorodnitsyn, Georgii Zavarzin, and Dmitrii Zviagintsev, as well as Thomas Schelling, Thomas Malone, oceanologist McElroy, mathematician Jeremy Ravetz, Paul Crutzen, and Harvey Brooks, the chair of the US committee for IIASA.[76] Another meeting in Suzdal, March 11–15, 1985, included Izrael', Thomas Lee, Ted Munn, Hordijk, Buzz Holling, McElroy, and Crutzen; Bert Bolin and Martin Holdgate were also invited. The Soviet side was represented by Izrael' and Gvishiani and other scientists, who included such prominent climatologists as Mikhail Budyko, Iu. Aniukhin, and the microbiologist Zavarzin.[77] Although Nikita Moiseev and Kovda were mentioned in earlier correspondence, they were absent from the final list.[78]

I invoke these meetings as examples of the Soviet will to cooperate, which turned out to be constrained by unknown factors, possibly by faulty administration. According to the archival documents at IIASA, the organization of these meetings resembled a roller coaster. The Soviets, it seemed, were slow with absolutely everything: issuing visas for participants, making their own participant list known, and preparing the final program. Throughout the turbulent period, IIASA's leaders were anxious to avoid any further blots on the reputation of the institute. For instance, William Clark stated this in a confidential letter to Kaftanov, saying that there was a risk that the Soviet Union would fail to ensure the participation of senior scientists and hence even further compromise IIASA's reputation. He also firmly insisted that Soviet scientists supply their papers beforehand, even if they were only available in Russian, making it clear that the stage of science diplomacy was over, and that the substance of East-West cooperation must prevail over the form.[79]

Here, as in any cases where official organizing ran into difficulties, informal routes were taken to compensate for the slow and unpredictable machinery of Soviet bureaucracy. Indeed, informality played an important role throughout the entire process of creating and inserting RAINS into the policy process. For instance, that the RAINS model was first demonstrated outside formal sessions was an asset and not an obstacle, because contrasting and critical views were almost never exchanged in the formal sessions. But there was also a straightforward, centuries-old function of informality as an ice-breaker. The Soviet negotiators were cautious about providing data, but lavished vodka and caviar on the Westerners. Such was the case, for instance, at the Munich meeting in 1986, where after a four-and-a half-hour dinner, Izrael' invited then-EPA administrator William Ruckelshaus, together with two aides, to his suite at the Four Seasons Hotel to discuss bilateral programs. The party included Izrael' himself, Sokolovskii, and I. Kazakov. Reportedly, it was during this long and well-lubricated-with-vodka meeting that Ruckelshaus and Izrael' agreed to personally manage the planned agreement.[80]

Informal ways were also used to get the internal mechanism of the model, not only the external social and institutional machine, running. The acid rain project constructed its own database, which brought together previously scattered data, and that in turn posed the question of whether the data could be trusted. The data pertained to both energy structures in the countries involved and emissions of pollutants, as well as the costs of reducing the emissions. The data sets did not always correspond: for instance, the size of the industry and the supplied data on pollution might not appear to match. To deal with such cases, the following practice was adopted: once the modelers suspected that the data had been tweaked, they made hypothetical calculations of what more probable data could be. Then they confronted the national officials with their alternative data. This was the case of Poland, for example, but also Italy and Romania. While this method of data correction was obviously a sensitive issue, and probably a time-consuming one, scholars benefited enormously from being based at IIASA, because they did not have to travel far to get to Warsaw from Vienna; it was also easier to locate the right contacts through IIASA's networks. I was told that these investigations usually revealed not so much falsification as methodological flaws, although my interlocutor told me that in some cases the modelers felt that it was a question of good manners not to dig too deeply if the methods had been tweaked to obtain smaller emission numbers.[81]

Another difficult issue that emerged concerned the question of whether RAINS was to be primarily a geophysical or an economic model. Hordijk personally was extremely cautious about the use of cost-benefit analysis in policy making, and, indeed, he removed this cost-benefit bloc at a later stage, because he saw that policy makers had a propensity to extract a single number from a range of uncertainty. In Hordijk's view, this habit of using discrete numbers rather than ranges threatened to undermine the scientific credibility of the model. For different reasons, the Soviets were also against cost-benefit analysis, because, as Atsushi Ishii noted, the cost-benefit analysis was based on market economy principles, thus disagreeing with the fundamental ideological principles of Soviet political economy.[82] Also, as explicated by Anthony Patt, cost-benefit analysis presupposed aggregated preferences of a given population despite the values differences across the political spectrum. Different national cultures, for instance, may place a different value on nature, or inhabitants of one remote region might not agree to pay for cleaning lakes in another remote region. In all, it was thought that this kind of analysis could not enable international comparisons of utility between capitalist and communist regimes.

Later in the 1980s a new concept of "critical loads" was forged by Swedish scientists. Applied only to geophysical systems, "critical loads" constructed nations as nonpolitical geophysical systems. The limits of changing these systems were determined by natural scientists, and the measures taken to limit the impact of industries on them could be agreed upon by policy makers, thus effectively eliminating the problem of public choice. As a result, RAINS allowed the costs associated with abatement policies to be identified, but this was not a full-fledged cost-benefit analysis.[83]

The case of the acid rain model supports the argument made by Marie-Laure Djelic that in order to succeed transnationally, experts need to be well anchored in and reinforced by their national organizations.[84] The nuclear winter scientists largely disregarded the importance of the embedding their project in their respective national bureaucracies, engaging instead in a horizontal, transnational cooperation. This was both an asset and an obstacle: in consequence, although the nuclear winter study produced spectacular results, it had limited direct usability in policy making. In comparison to Lynn Eden's study of the organization of the US research into postnuclear fire damage, the nuclear winter scientists had much more room for experimentation, because, unlike fire research scientists, they were not entrenched in a well-institutionalized organization, such as the US Department of Defense.[85] But the nuclear winter scientists faced a different problem: being organized in horizontal networks of research teams, they had but limited possibility to translate their expertise into organizational routines. Here the position of acid rain modelers was somewhere in between: they were organized in a network, but they were also hosted by a well-established organization, IIASA. Furthermore, the acid rain model was carefully grafted onto the agenda of top national authorities in charge of international negotiations. Positioned as a neutral tool rather than a set of results and recommendations, the acid rain model could perform and be used in actual decision making. In 1985 in Helsinki, sixteen countries signed a protocol to reduce SO2 emissions, which was followed with the 1988 Sofia protocol on nitrogen emissions.

The acid rain modeling exercise also had a conserving effect that reaffirmed the existing power structure: attached to the top decision makers, the modelers did not engage with the civil society activists altogether. Scientific authority and credibility was at stake. Who produced the model mattered as much as the modeling results and, as the nuclear winter study revealed, scientists preferred to carefully manage the involvement of activists, because activists tended to prefer more radical versions of forecasts. And yet the RAINS model was also subversive because, strictly speaking, it was not merely a tool in the hands of policy makers. The modeling effort was a performative process in that it facilitated the establishment of new East-West networks and helped move the data across borders. Some efforts spilled over from the acid rain model to further East-West collaborations; such was the case of Jerzy Bartnicki of the Institute for Meteorology and Water Management in Poland and Joop den Tonkelaar of the Royal Netherlands Meteorological Institute.[86] As in the case of the nuclear winter project, cooperation around the issue of acid rain added to the change in Soviet thinking: that environmental security entered the ranks of highly prioritized issues, being listed alongside national defense in the Soviet was a result not only of a series of environmental disasters, but also an outcome of transnational East-West cooperation.[87] The case of acid rain thus becoming another component in the system-cybernetic governmentality, which, through a series of studies, posited that the biosphere set limits to the Soviet government.