Policy Forum 97-10: Baseline Assessment of Acid Rain in Northeast Asia

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The ESENA Policy Forum Online is intended to provide expert analysis of contemporary energy, security and environmental issues in Northeast Asia, and an opportunity to participate in discussion of the analysis. A set of questions based on the following work is appended below. The Nautilus Institute invites your responses, based either on these questions or on any other thoughts you have after reading the work. We will post selected responses on our Web site.

Baseline Assessment of Acid Deposition in Northeast Asia

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Global & Regional Environmental Research, a large multidisciplinary research center focused on environmental science and policy. His research interests are focused on the impact of human activities on the atmospheric environment on urban, regional and global scales. He has published extensively on issues related to long range transport of pollutants and acid deposition. He has been performing research in Northeast Asia for the past decade. Richard Arndt is presently finishing his Ph.D. thesis on acid deposition in Asia.

Summary

Within the next two to three decades, as the regional sulfur dioxide emissions increase (by as much as a factor of three), sulfur deposition levels are anticipated to reach levels which are higher than those observed in Europe and North America during the 1970s and 1980s, and in some cases will most probably exceed those observed previously in the most polluted areas in central and eastern Europe. This increase in sulfur emissions will severely threaten the sustainable basis of many natural and agricultural ecosystems in the region. Taking the critical loads as an indicator for sustainable levels of acid deposition, future sulfur deposition will exceed critical loads (in some places by more than a factor of ten) throughout Northeast Asia. These levels of sulfur deposition would cause significant changes in the soil chemistry over wide areas in Asia, affecting growing conditions for many natural ecosystems and agricultural crops. Furthermore, ambient levels of sulfur dioxide would exceed WHO health guidelines not only in cities, but also in many rural regions. If no countermeasures are taken, a degradation of the environmental quality to unprecedented levels could result. To avoid such a grave situation energy will have to be used more efficiently and more cleanly.

What differences can sulfur emission controls and energy efficiency make?

There are a variety of measures that could be taken to reduce sulfur emissions and thereby reduce/avoid widespread excess deposition in the region. These include changes in fuel use, energy efficiency measures, and the use of simple to advanced control technologies. Advanced emission control technologies could reduce emissions below current levels even in a high growth energy scenario, albeit at extremely high costs. In the year 2020 full application of advanced emission control technologies would require US$35 billion per year (1990 dollars), which is about 0.6 percent of the regional GDP assumed for the underlying energy scenario. For comparison, the relative costs for the latest agreement on reducing sulfur emissions in Europe (the Oslo protocol) were only about one third of this level (0.2 percent of the GDP). Obviously the costs associated with such a strategy would put significant burdens on many developing economies in the region.

Illustrative scenarios demonstrate the potential for an increase in the cost-effectiveness of strategies if measures are focused on specific fuels, technologies, economic sectors, emission sources or ecologically sensitive regions. All of these activities make a difference. However the analysis leads to the conclusion that in the long run a strategy relying solely on control technologies with modest removal efficiencies will not be able to preserve important agricultural areas from serious excess deposition. Energy planning is also an important factor for controlling adverse environmental effects, in

particular acidification. The development of carefully designed energy systems is of particular importance for controlling emissions in those countries considering an expansion or replacement of the present energy infrastructure.

Compounding the problem of acid deposition is the fact that deposition is not just due to pollutants emitted locally. Substantial portions of emissions are transported by winds hundreds of kilometers from their source, making acid deposition in Northeast Asia a transboundary pollution issue, which will require regional cooperation to manage. To help quantify and anticipate environmental impacts associated with the growing emissions it is imperative that a greater understanding of the mechanisms of long range transport of pollutants in Northeast Asia be established. Increased monitoring and modeling activities are needed, which could be conducted as regional and/or bi-lateral initiatives. These activities are necessary because there is considerable uncertainty associated with modeling acid deposition in a region as large as Northeast Asia. The lack of a comprehensive observation network prevents a rigorous evaluation of model performance. Furthermore, the present modeling efforts make use of parameterizations which have been derived based on modeling studies at the mid-latitudes in North America and Europe. Although extensive experience can be drawn from Europe and North America, the Northeast Asian situation is sufficiently different in terms of mixes of pollutants, meteorology, etc., that Asian-specific information on the mechanisms of acid deposition and long range transport is required. There is a clear need to conduct more model comparisons and fundamental studies to better determine the most suitable parameters for use in modeling studies in Northeast Asia. Until such studies are done all source-receptor relationships must be treated with extreme caution. Moreover, the present estimates are not yet sufficiently robust to serve as the foundation for policy analysis related to allocation of responsibility and liability for transboundary air pollution in the Northeast Asian region. Conversely, the models already demonstrate clearly the need to address the issue of acid deposition at the source - whatever the ultimate transboundary distribution of the acid rain precursors.

Unfortunately, the situation in Northeast Asia may be even more bleak. At present sulfur is the main component of acid deposition in Northeast Asia (especially in China). While this is generally true in this region, the contribution of nitric acid is rising along with the increase in NOx emissions. The attendant increase in NOx emissions will not only lead to an increase in acid deposition, but will also pose additional environmental concerns through increases in ambient ozone levels. Increasing levels of ozone have significant environmental impacts, including human health and reduction in crop yields. Initial studies have suggested that the increase in NOx emissions and fertilizer use in Northeast Asia, may lead to ozone levels sufficiently high to threaten rice, wheat and corn production. Ozone, like acid deposition, is a regional problem, which will require regional cooperation and emission reduction policies to control.

Ammonia presents still another concern. Because of the predominately rural and agricultural nature of large portions of Northeast Asia, emissions of ammonia, associated with livestock and the intensive use of fertilizers to meet the growing demand for food, are increasing even more rapidly than emissions of sulfur and nitrogen oxides. While ammonia in rainwater acts as a base, neutralizing the strong acids, and elevating the pH of precipitation, after it is deposited biochemical processes cause ammonia to act as a strong acidifying agent. Thus, ammonia may be masking the extent of the problem of acid deposition in Asia as measured by pH alone, and may actually be contributing significantly to ecosystem damage (as is the case in the Netherlands). The role of

ammonia in this regard is not yet well characterized in Northeast Asia, but its study should be given high priority. The inclusion of ammonia into the acid deposition arena complicates the analysis and requires the simultaneous consideration of energy and food security policies.

Finally, the regional aspect of acid deposition pose a significant challenge to the region. The Asian situation is much different than that in Europe and USA when they encountered acid deposition as a significant problem. In Europe, the UN Economic Commission for Europe (UNECE) provided a forum for countries to discuss the problem and develop policies aimed at reducing sulfur and nitrogen emissions. Under the auspices of UNECE the Convention on Long Range Transport of Air Pollutants (LRTAP) was first signed in 1979. In addition, there were active collaborations and joint research activities among the countries looking at various aspects of the problem providing scientific input into the deliberations. Both research and policy fora will need to be further developed in Asia to address the challenges presented by these regional environmental problems.

Read the full version of "Baseline Assessment of Acid Deposition in Northeast Asia"

The Nautilus Institute Invites Your ResponsesYour are invited to participate in this "Online Policy Forum" by considering the questions below, or collecting any other thoughts you have after reading the paper, and then emailing your comments to: esena@nautilus.org . Responses will be considered for redistribution to the network only if they include the author's name, affiliation, and explicit consent.

1. This paper suggests that no appropriate forums to coordinate efforts to reduce acid rain exist in Northeast Asia. What might be an appropriate mechanism for such a dialogue? What barriers exist to creating such a forum?

2. Carmichael and Arndt state that a strategy relying solely on control technologies with modest pollutant removal efficiencies will not be able to preserve important agricultural areas from serious damage. Do you agree and if so what measures should be considered to prevent the predicted damage?

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