American Academy of Arts and Sciences. In neither body did his views prevail. Nonetheless, his concerns remain timely. They will remain so until the day when we can all agree that international economics, political maneuverings, the earth's infinite ecology, and all of human behavior have been precisely captured in one unambiguous, verified set of models, mathematical or otherwise.

In the meantime, Mac Lane seems to suggest that we should close our doors, that it is a waste of money to apply research results (on atmospheric chemistry and fossil fuel use, for example) to issues on the public agenda (such as global warming). Such efforts necessarily require combining models, empirical data, and mechanistic theories in an analysis that, no matter how verifiable its component parts, is itself ultimately unverifiable in the aggregate. Unplanned "experiments" on the earth's atmosphere we can only run once.

To discover constructive analysis along the fuzzy boundary between science and policy is a touchy business where there are temptations to lurch to one side or the other. If we stray too far from the scientific touchstones of objectivity and reproducibility, we will be guilty of "grandiloquence," to use Mac Lane's term, and serve neither policy-makers nor the scientific community well. To build an ivory tower, however, declining to apply research to current policy issues until unrealistic (and perhaps unrealizable) standards of scientific rigor are met, would be an equal abnegation of responsibility.

As IIASA's director, council, and the U.S. Committee for IIASA work to balance the Institute's program between these competing seductions, it is valuable to have critics such as Mac Lane challenging us to be ever vigilant against the first temptation and not stray too far from the standards of science. Yet there are equally vociferous critics on the other side—challenging us not to be too cautious in drawing timely relevant policy conclusions from limited scientific knowledge.

Finally, Mac Lane suggests that IIASA's 15-year history is an elaboration of the system dynamics of Forrester and Meadows. Nothing could be further from the truth. IIASA was indeed founded in 1972, the year *Limits to Growth* (*1*) was published; and IIASA did host, during its first decade, a series of seven "Global Modeling Conferences." These meetings were designed to document and review global models in detail by critics and proponents alike, precisely the sort of peer review effort that Mac Lane advocates. The conference played a big part in causing the original proponents of global modeling to retreat from their initial enthusiasm and gave everyone concerned a better understanding of what models could and could not do.

The Institute's own research program has always been kept purposely diverse. Earlier IIASA global studies of food and energy that Mac Lane cites share some common features with some of the better known global models of the 1970s, including those conducted by our own National Academy of Sciences. Perhaps for that reason, of the Institute's products these have remained the most controversial, both within IIASA and elsewhere. But important work on environmental issues, on demographic concerns, and on mathematical programming have, in fact, been the mainstay of the Institute's agenda; and much of this research is not based on global modeling of any sort.

The fundamental question facing our society is whether we can bring the best scientific minds to bear on urgent problems confronting us. IIASA has been an important institution trying to address these problems, and provide some, albeit imperfect, insight. We strongly believe that the continued support of the Institute is warranted.

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REFERENCE

1. D. L. Meadows *et al.*, *The Limits to Growth* (Universe, New York, 1987).

The News & Comment article by David Dickson about IIASA (15 July, p. 285) is an accurate reflection of the current position and development of the Institute. Established in 1972, IIASA has a unique track record in applying systems analysis to the study of large-scale issues such as sustainable development, or population growth. It is surprising that the article should have provoked the letter from Mac Lane, but the multidisciplinary approach to examining policy issues is often unsatisfying for scientific specialists.

Mac Lane is a great algebraist and one of America's most distinguished mathematicians. However, his comments about the absence of science in IIASA's work ignore the fact that many of the most difficult problems we have to face cannot even be precisely formulated in the present state of knowledge, let alone solved by existing techniques of science.

The variables determining world energy or food supplies, to which he refers, are so numerous, and interconnected in so many hidden ways, that the best we can do is exactly what he describes—make models that in the first instance are not verifiable, but that can be amended and adjusted in the hope that they will come to provide an understandable view of the phenomenon. Verification must inevitably be piecemeal and partial. Such models, although unsatisfying to many scientists, are still the best guide to policy that we have.

If a mathematician does not see them as providing crisp solutions, it is perhaps because the problems in question are not mathematical. They lie at the interface between nature and man. It would be simpler to forget about them and concentrate on pure science alone, but that is a luxury not permitted to the late 20th century. Problems of energy, food, the environment, population, and the impact of technology are intrusive: they will not leave us alone. IIASA was established in the belief that science can contribute to the development of tools to examine and hopefully deal with these societal problems.

The researchers at IIASA are among the first to agree that the methods currently used to tackle these problems need to be improved. That is why their work is largely focused on developing better methods to replace them. Anyone concerned with increasing the chances of our collective survival must wish them luck, while offering the support they require to succeed.

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Biodiversity Bill

I could not agree more with the biologists calling for an international species survey ("Hard choices ahead on biodiversity," Research News, 23 Sept., p. 1604). If we are serious about protecting biological diversity, we have to know what's out there, and in what quantity.

That is why I will be introducing a bill in the U.S. Senate to provide a framework for assessing and managing the diversity of global species. Once we adopt this measure, we'll be well on our way to bringing biodiversity to the top of the environmental agenda—where it belongs.

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