HOW CAN IMPACTS MODELS, INFORMATION ABOUT THEM, AND THEIR USE BE IMPROVED?

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Climate change impacts have been analyzed in many developed and some developing countries for years now. Typically, such assessments have combined scenarios of climate change with impacts methods.\(^1\) The development, selection, application, and evaluation of impacts methods has been conducted in somewhat of an *ad hoc* fashion. This is not necessarily bad because an unstructured environment can allow for innovation and experimentation.

There are a number of concerns that arise with this project:

\(\)   Do users and even developers fully understand the strengths and weaknesses of the various methods that are used to examine similar matters, e.g., estimation of impacts of climate change on agriculture? How can the methods be improved to address weaknesses?

\(\)   Is information on the strengths and weaknesses of various methods as well as appropriateness of applications available in a useful format to users?

This paper briefly addresses both matters. The paper is a discussion piece and is meant to stimulate discussion at the combined United Nations Development Programme and United Nations Framework Convention on Climate Change Secretariat in Montreal, June 11 – 14, 2001.

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\(^1\) The term “impacts methods” includes not only quantitative models, which are often used, but also other quantitative and nonquantitative methods.
Improving Comparisons of Methods

While there has been a lot of focus on shortcomings of GCMs and how they can be improved, what has generated much less attention is the quality of impacts methods. Many impacts assessments use quantitative models, and a reasonable question is how accurate those models are in projecting the behavior of natural or societal systems under a changed climate. Such uncertainty about impacts could be greater than uncertainty about climate change. This raises two questions:

\{ Are the methods accurately estimating current or historic conditions? \}
\{ How well do the methods estimate changed conditions? \}

The first can be verified quite readily. The second cannot be verified, but can be evaluated.

There are also other issues regarding the quality of the methods. One is whether the methods are ignoring important variables or factors. Evaluating vulnerability is a very complex exercise, which should account not just for biophysical impacts of climate change, but also socioeconomic changes that may happen anyway (and which will affect vulnerability), cross-sector impacts, and adaptation. Ignoring these factors can yield biased or inaccurate results. For example, underestimating the potential for adaptation can make vulnerability appear to be greater than it actually is by underestimating gains and overestimating losses. On the other hand, overestimating the potential for adaptation to ameliorate harmful effects of climate change can result in an underestimate of vulnerability by overestimating gains and underestimating losses.

This suggests that an evaluation be done pointing out the limitations of existing (or widely used) methods. This should not be a “model trashing” exercise. Rather it should seek to educate users on both what insights different methods can provide and their limitations. This has been successful with GCMs. Many users have become more sophisticated in recognizing the limits of GCMs and yet also seeing their usefulness as, for example, inputs to creation of regional climate change scenarios.

A second and related issue is to understand whether impacts methods that estimate approximately the same variables, e.g., crop yields, runoff, differ in their results and why. As a first order, differences across methods can be an indication of uncertainty. Certainly, differences in estimates of regional climate change by GCMs is an indication of uncertainty about regional climate change.

One exercise may be to run the models with common data sets. This can be done by first using a common observed climate or other data with all of the models. That will show model differences in
estimating observed conditions. An advantage of estimating observed conditions is that accuracy of models can be assessed. The models can than be run with common climate change data sets (i.e., scenarios). One should be careful not to assume that models that best simulate current conditions will best simulate future conditions. Both exercises demonstrate uncertainty about impacts due at least to model specification. Note that this exercise is exactly what the “VEMAP” group did to compare and improve models of terrestrial ecosystems (VEMAP, 1995).²

A second and more sophisticated and challenging exercise involves method diagnostics. This would involve method builders and users evaluating why the methods yield differences. The differences might be explained by inconsistent parameterizations or assumptions. For example, Titus et al. (1991) estimated much higher costs for protecting U.S. coasts from sea level rise than did Yohe et al. (1996). Both used the same data set on property values. The major difference in models was assumptions about adaptation to sea level rise. Titus et al. (1991) assumed that all areas with more than 10 inhabitants/km² would be protected. Yohe et al. (1996) assumed that property would implicitly or explicitly conduct a benefit-cost analysis of the cost of protection versus the value of protected property.

This kind of analysis can be very useful to users. Oftentimes, it is hard to say that one method is “better” or “more accurate” than another. Understanding why the methods differ, what one method may capture that another does not, can help users better understand how they should be applied and, most important, how their results should be interpreted.

Beyond this is the question of whether the methods are addressing the right questions and perhaps leaving out some important variables. For example, changes in socioeconomic conditions can have a tremendous effect on vulnerability. They can change exposure, sensitivity, and, perhaps most important, adaptive capacity (Smit and Pilifosova, in press). Many climate impact methods do not consider adequately or at all such changes. It is important that an evaluation examine whether all important variables are considered.³

How can this notion of model comparison and evaluation be put into practice? It may make sense to replicate the VEMAP approach for other types of models. Crop production and water resources are good candidates. Both involve many models, which should be compared with common observed and

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² Such evaluations using common assumptions such as observed data may be quite difficult, if not impossible, to do with methods that do not involve quantitative models.

³ To be sure, this in many cases is the function of the analyst not considering socioeconomic changes. The methods may well be able to accommodate such considerations if the analyst wishes to include them.
perturbed data sets. Since we are addressing this in the context of climate change impact studies, such comparisons should be done in selected developing countries with the collaboration of developing country scientists. This could be done in a few selected countries to compare results. In addition, there are also a number of methods for assessing coastal and health impacts. These could also benefit from such a comparison.

Beyond running the models, a team of model developers and experts on the models and their applications should evaluate the models. They should look at the following questions, which are specific for agriculture but can easily be modified for other topics:

- How well do the models simulate current crop yields?
- How well do the models simulate future crop yields?
- How good are the models for estimating production (noting that production considers farm level management decisions)?
- Why do the models yield different results (if they do)? What assumptions or parameters differ and how important are those differences in causing different results?
- Are the models ignoring important factors or variables?
- Are the models reliable for different climates and other agricultural conditions such as level of development and socio-economic conditions? (Some models may be better at simulating conditions outside of where they were produced than others.)
  - How difficult is it to modify the models for different conditions?
- Do the models require a lot of data? Are the data readily available in developing countries?
- Are the models available for use in developing countries? Are the models affordable? Are their technological requirements insurmountable for developing countries?

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4 Wolf et al. (1996) and Semenov et al. (1996) compared wheat models in two sites in western Europe. They examined estimation of current crop, but mainly focused on comparing the models’ estimates of changes in wheat yields under climate change scenarios. It may be desirable to replicate such comparisons in other countries, particularly developing low-latitude countries so the setting is quite different from western Europe.
Different teams need to be created for evaluating different types of models. Agronomists and agriculture specialists are needed to evaluate agriculture models. Hydrologists and civil engineers are needed for water models. It is important that the teams include model developers and users from developed and developing countries. The developers will understand the particulars of the various methods, while the users will understand how the methods have been applied and interpreted.

An important element in such evaluation is ensuring that appropriate methods exist for different situations. User needs vary widely. In some countries, there are long detailed data records, and technical staff are well trained in the use of impacts methods, sometimes even building them themselves. In other countries, data quality may be quite limited or poor and technical staff may be more challenged in training and even in equipment. It may be appropriate to have a suite of methods for application in such different situations. Some countries may be able to apply models that require a lot data and more challenging analytic techniques. Other countries may need more simple techniques that do not require as much data or may be easier to apply. Indeed, nonquantitative methods such as expert judgment may be most appropriate for some situations.

It is conceivable that such an evaluation will favor or push more and more sophisticated models. The participants should be sensitive to the need for simple models to compliment the more sophisticated ones. The team can help users by clearly identifying how much accuracy is gained by more sophisticated techniques and how much more data, computing power, or training may be needed with the more sophisticated techniques. With such information, users can make an informed decision about selection of analytic technique.

**Making Information on Methods Useful to Users**

The second issue related to improving the methods and making sure that they meet the needs of users is making information readily available on them. There have been a number of attempts to identify the various analytic techniques available for impacts assessment. For example, Feenstra et al. (1998) review and analyze various models and other techniques for assessing climate change impacts. In 1999, the UN Framework Convention Secretariat unveiled its compendium of climate change impacts and adaptation methods (Stratus Consulting, 1999).

These are useful tools for users to find out about what methods are available and to get information on what methods are most appropriate for various data and user requirements. The reports were developed using the expert judgment of the authors regarding what assessment methods readers should be aware and, more important, what types of information about those methods would be most useful to
users. To be sure, both publications were reviewed by many researchers in developed and developing countries. However, they were not based on a request from users on what information they would like.

So, one way to improve on these efforts is to reach out to the user community in a more systematic effort to ascertain the wishes and needs of the user community to inform how to organize the information. One approach would be to bring users together in a workshop. The back-to-back UNFCCC and UNDP workshops in Montreal, June 11-14, 2001 present an opportunity to discuss the issue with the user community. Beyond this, focus groups of users could be created to test various approaches for disseminating information, including what information should be made available and how it could be made available, e.g., web sites, clearinghouses.

**Conclusion**

This paper offers some preliminary ideas on ways to improve comparison and development of methods as well as dissemination of information about such methods. An organized effort to conduct such comparisons and make the information available to those assessing vulnerability to climate change could result in improved methods and more appropriate application of them.

**REFERENCES**


