The Economics of Climate Change

The estimation of the potential economic costs of climate change involves a range of natural and social systems and entails projecting their future states in the near, medium and long term, under a variety of possible scenarios. As such, this task is characterized not only by uncertainty from a wide range of sources and types, but also by ignorance due to the current lack of knowledge and to the limits of what can be known.

Integrated Assessment Models (IAM) are one of the tools widely used for studying the economics of climate change (impacts, mitigation and adaptation). IAM provide a very simplified mathematical representation of some of the relevant natural and human systems, their processes and interactions. These models provide a feasible and flexible manner to explore the consequences of different scenarios and policy measures. Nevertheless, most of IAM fail to reflect the inherent uncertainty of the problem they address and that is produced by the oversimplifications they are based on. To date, the most widely used IAM completely ignore uncertainty, being the PAGE2002 and PAGE2009 model an exception due to the probabilistic representation of its parameters, although it assumes deterministic inputs for which their uncertainty is not accounted. As part of my PhD project a new stochastic IAM is being developed that takes into account both the aleatory and epistemic uncertainty in its climate and impact modules.

Probabilistic climate scenarios

A large part of the available probabilistic climate change scenarios as well as some of the risk measures that are derived from them are based on a frequentist approach (see, for example the IPCC AR4). This approach can be seen as an extension of the framework developed for producing weather and climate forecasts, completely ignoring the conditions for interpreting frequencies as probabilities and the dominance of epistemic uncertainty (see, for example, Gay and Estrada, 2010; and Estrada et al., 2012a).

The climate module in the IAM that is being developed offers the possibility of generating probabilistic climate change scenarios that integrate the range of possible changes in global temperatures with expert opinion for producing tailored probabilistic scenarios. From this global temperature scenarios, regional projections of temperature and precipitation with a spatial resolution of 2.5ºx2.5º are generated, emulating 20 of the IPCC’s AR4 general circulation models. The regional scenarios are weighted by different probability distributions reflecting, for example, model performance (Fig. 1).

Probabilistic damage functions

The basic structure and parameterization of the damage functions in the new IAM is taken from the PAGE2002 (Hope, 2006), although significant modifications are being introduced to improve, for example, the temporal and spatial dynamics of impacts. The impact functions explicitly address the existence of epistemic uncertainty in their parameters and are fully stochastic. Uncertainty in this case is represented by triangular distributions parameterized to reflect the state of knowledge of the potential impacts of climate change in both the market and non-market sectors. Fig 2 shows the mean economic impact as percent of regional GDP lost in year 2100 under the A2 emissions scenario.

Economic growth, vulnerability, resilience, adaptation, poverty traps and large scale discontinuities

Several relevant processes and their uncertainties are represented very poorly or are completely missing in current IAM. Vulnerability, expressed in the parameterizations of the damage functions, is seldom considered uncertain and is conceived as invariant in time. Adaptation is now included in some IAM but in a very limited manner and its effects are treated as deterministic. Economic growth, technology and development in most cases are exogenous and no uncertainty is considered, despite these are variables on which the results of the evaluation of climate change impacts heavily relies on. The existence of poverty traps and other nonlinear responses to shocks are, until now, not considered.

Some other processes are implicitly included but in an unintended manner, and in some cases misrepresenting important characteristics of the systems under analysis. This is the case of the resilience of natural and human systems to shocks, where most of the current IAM assume that the effects of impacts dissipate from one period to the next (Estrada et al., 2012b).

Current IAM in most cases are limited to simulating global temperature changes, ignoring other variables such as precipitation and regional changes in climate. Extreme events and the occurrence of large scale discontinuities are also poorly represented.

References

- Estrada F (2011) PhD research project. IVM-VU.