Uncertainty in emissions estimates in the spotlight

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National or other emissions inventories of greenhouse gases that are used to develop strategies and track progress in terms of emissions reductions for climate mitigation contain a certain amount of uncertainty, which inevitably has an impact on the decisions they inform. IIASA researchers contributed to several studies in a recently published volume that aims to enhance understanding of uncertainty in emissions inventories.

Estimates of greenhouse gas (GHG) emissions are important for many reasons, but it is crucial to acknowledge that these values have a certain level of uncertainty that has to be taken into account. If, for example, two estimates of emissions from a country are different, it does not necessarily imply that one or both are wrong—it simply means that there is an uncertainty that needs to be recognized and dealt with. A special issue of the Springer journal *Mitigation and Adaptation Strategies for Global Change*, aims to enhance understanding of uncertainty in estimating GHG emissions and to provide guidance on dealing with the resulting challenges. IIASA researchers and colleagues from other international institutions including the Lviv Polytechnic National University in Ukraine, the Systems Research Institute at the Polish Academy of Sciences, and Appalachian State University in the US, contributed to the 13 papers featured in the publication, addressing questions such as the size of the uncertainty dealt with, how to deal with this, and how uncertainty might be decreased.

According to the researchers, there are ways to decrease uncertainty but these are often difficult and ultimately expensive. In their respective papers, they point out that there are seven important issues that currently dominate our understanding of uncertainty. These include 1) verification; 2) avoidance of systemic surprises; 3) uncertainty informing policy; 4) minimizing the impact of uncertainty; 5) full GHG accounting; 6) compliance versus reporting; and 7) changes in emissions versus changes in the atmosphere.

In terms of how uncertainty in observations and modeling results can influence policy decisions on climate change mitigation, some of the papers also looked at how decision-making procedures can be improved to produce more fair rules for checking compliance and how information around emission inventories can be communicated to make it more transparent and easier to understand. The authors explain that understanding the uncertainties is very important both for those who do

the calculations or modeling and for the consumers of this information, like policymakers or consultants, as it provides an indication of how much they can rely on the data, in other words, how "strong" the conclusions are and how sure the decisions derived from the data can be.

"Uncertainty is higher for some GHGs and some sectors of an inventory than for others. This raises the option that, when future policy agreements are being designed, some components of a GHG inventory could be treated differently from others. The approach of treating subsystems individually and differently would allow emissions and uncertainty to be looked at simultaneously and would thus allow for differentiated emission reduction policies," explains Matthias Jonas, an IIASA researcher in the Advanced Systems Analysis Program and one of the editors of the special issue. "The current policy approach of ignoring inventory uncertainty altogether (inventory uncertainty was monitored, but not regulated, under the Kyoto Protocol) is problematic. Being aware of the uncertainties involved, including those resulting from our systems views, will help to strengthen future political decision making."

The authors all agree that dealing with uncertainty is often not a quick exercise but rather involves a commitment that is painstaking and long-term. Proper treatment of uncertainty can be costly in terms of both time and effort because it necessitates taking the step from "simple" to "complex" in order to grasp a wider and more holistic systems view. Only after that step has been taken, is it possible to consider simplifications that may be warranted.

"Decision makers want certainty, the public wants certainty, but certainty is not achievable. We can work with the best information available and we have to keep moving forward and learning. I think that we need to convince data users such as policymakers or the public that uncertainty in these kinds of numbers is normal and expected and does not mean that the numbers are not useful," says study author Gregg

Marland from Appalachian State University in the US.

Special edition co-editor Rostyslav Bun from Lviv Polytechnic National University in Ukraine confirms this sentiment and in conclusion adds: "The presence of uncertainties in estimates of GHG emissions may suggest that we have to devote more energy to decreasing uncertainties or it may simply mean that we need to be prepared to deal with a future that includes a certain measure of uncertainty."

More information: Matthias Jonas et al. Quantifying greenhouse gas emissions, *Mitigation and Adaptation Strategies for Global Change* (2019). DOI: 10.1007/s11027-019-09867-4

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