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Accounting for Climate Change: Introduction

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Abstract The assessment of greenhouse gases (GHGs) emitted to and removed from the atmosphere is high on both political and scientific agendas internationally. As increasing international concern and cooperation aim at policy-oriented solutions to the climate change problem, several issues have begun to arise regarding verification and compliance under both proposed and legislated schemes meant to reduce the human-induced global climate impact. The approaches to addressing uncertainty introduced in this article attempt to improve national inventories or to provide a basis for the standardization of inventory estimates to enable comparison of emissions and emission changes across countries. Authors of the accompanying articles use detailed uncertainty analyses to enforce the current structure of the emission trading system and attempt to internalize high levels of uncertainty by tailoring the emissions trading market rules. Assessment of uncertainty can help improve inventories and manage risk. Through recognizing the importance of, identifying and quantifying uncertainties, great strides can be made in the process of Accounting for Climate Change.

Keywords Uncertainty analysis · Greenhouse gas inventories · Kyoto protocol · Emissions trading · Verification and compliance

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The assessment of greenhouse gases (GHGs) emitted to and removed from the atmosphere is high on both political and scientific agendas internationally. Under the United Nations Framework Convention on Climate Change (UNFCCC), parties to the Convention have published national GHG inventories, or national communications to the UNFCCC, since the early 1990s. Methods for the proper accounting of human-induced GHG sources and sinks at national scales have been stipulated by institutions such as the Intergovernmental Panel on Climate Change (IPCC) and many countries have been producing national assessments for well over a decade. As increasing international concern and cooperation aim at policy-oriented solutions to the climate change problem, however, several issues have begun to arise regarding verification and compliance under both proposed and legislated schemes intended to reduce the human-induced global climate impact.

Pilot and voluntary GHG emissions trading schemes exist in the United States, United Kingdom, Australia and Europe, and—since January 2005—the European Union has become the world's largest legislated GHG emissions trading market. Common to burgeoning market-oriented GHG reduction schemes both worldwide and global, as well as to national GHG inventory analyses, is the concept of single-point estimates of emissions and emission changes. This accounting method raises a host of crucial questions either directly or indirectly linked to the issue of uncertainty, especially in the context of accounting for emission changes, the central focus of the Kyoto Protocol to the UNFCCC.

The issues of concern at the *International Workshop on Uncertainty in Greenhouse Gas Inventories*, held 24–25 September 2004, in Warsaw, Poland, are rooted in the level of confidence with which national emission assessments can be performed, as well as the management of uncertainty and its role in developing informed policy. Jointly organized by the Systems Research Institute of the Polish Academy of Sciences (http://www.ibspan.waw.pl/) and the Austrian-based International Institute for Applied Systems Analysis (http://www.iiasa.ac.at/), the Workshop covered state-of-the-art research and developments in accounting, verifying, and trading of GHG emissions and provided a multidisciplinary forum for international experts to address the methodological uncertainties underlying these activities. The topics of interest covered national GHG emission inventories, bottom-up versus top-down emission analyses, signal processing and detection, verification and compliance, and emission trading schemes.

Central to current international policy concerns and the present discussion alike is the need for a well-defined role—if, in fact, any role is to be played—of uncertainty analyses in national GHG inventories at the country level, as well as in those falling under the purview of international regulatory schemes. International schemes such as EU emissions trading or that set forth by the Kyoto Protocol—if they are to function as binding agreements—must be able to demonstrate that estimates regarding emission changes are not only measurable but also that they comply with an objective and standard measure that ensures consistent treatment of the uncertainty with which they are associated. It is thus of primary importance to evaluate of the multiple methods through which uncertainty analyses are incorporated into national GHG inventories and the reasons for using them.

While uncertainty estimates are not intended to dispute the validity of national GHG inventory figures, the variability that they communicate underscores the lack of accuracy characterizing many source and sink categories' methodologies and thus makes for a difficult foundation on which to base policy. This does not, however, imply that environmental agencies, corporate environmental departments, and other stakeholders should simply do without uncertainty estimates; on the contrary, a number of arguments illustrate the importance of these analyses.

According to the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, uncertainty analysis is intended to help "improve the accuracy of inventories in the future and guide decisions on methodological choice."[1] Uncertainty analyses function as excellent indicators of opportunities for improvement in data measurement, data collection, and calculation methodology; only by identifying elements of high uncertainty can methodological changes be introduced to address them. Currently, most countries that perform uncertainty analyses do so for the express purpose of improving their future estimates; this rationale is generally the same at the corporate level. In either case, estimating uncertainty helps prioritize resources and take precautions against undesirable consequences. Depending upon the intended purpose of an inventory, however, this may or may not be the extent of the utility of uncertainty analysis. Another rationale for performing uncertainty analysis is as a policy tool, a means to adjust inventories and compare emission changes in order to determine compliance. While some authors find the quality of quantitative uncertainty data associated with national inventories insufficient to use for these purposes, a number of studies offer justification for conducting uncertainty analyses to inform and enforce policy

[1] J. Penman, D. Kruger, I. Galbally, T. Hiraishi, B. Nyenzi, S. Emmanuel, L. Buendia, R. Hoppaus, T. Martinsen, J. Meijer, K. Miwa and K. Tanabe (eds.) (2000). *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.* Institute for Global Environmental Strategies, Hayama, Kanagawa, Japan, p. 6.5. Available at: http://www.ipcc-nggip.iges.or.jp/public/gp/english/.