"USABLE" CARBON CYCLE SCIENCE: EXPLORING THE NEXUS OF CARBON CYCLE SCIENCE AND CARBON MANAGEMENT AT DIFFERENT SCALES

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ABSTRACT

To date there has been little systematic research on how carbon cycle scientific information will be used to support decisions at various scales. There is therefore a strong need to begin to understand how carbon cycle science is currently being used, who potential users might be, and how to effectively engage stakeholders and scientists on the issue. Many assumptions are being made about the scales and information that will be of most use to decision-makers. Decisions and information flow do not necessarily translate between scales, and thus matching the scales between provision of scientific information and scale of decision-making is critical to effectively making information useful. This paper will examine the ways in which carbon is being or may be managed by users at various scales, characterize decision making processes of those users, and discuss implications for carbon management and science policy.

INTRODUCTION

The past few decades have witnessed a rapid rise in scientific and, more recently, policy interest in carbon cycle science. Much of this interest is motivated by a desire to understand and manage the rising atmospheric concentrations of carbon dioxide (CO_2) and methane (CH_4) and their potential effects on Earth's climate [IPCC, 2001]. Because of these concerns, society is considering options to mitigate or sequester CO_2 emissions. The scope of options now includes examination of options for deliberate management of the land surface, ocean depths, and energy systems in order to mitigate CO_2 and CH_4 emissions and to remove CO_2 from the atmosphere [*Dilling et al.* 2003]. These actions are being considered at all scales of government and private industry—from local city pledges to statewide legislation to credits for agricultural practices to national commitments.

BACKGROUND AND METHODOLOGY

It is the clear intent of the U.S. carbon cycle program to be useful to decision making. For example, Sarmiento and Wofsy (1999) state that the goal of the carbon cycle program is to conduct "coordinated rigorous, interdisciplinary research that is strategically prioritized to address societal needs." This goal is highlighted even more strongly when North American Carbon Plan research was prioritized under the U.S. Climate Change Science Program (CCSP) as one of a few initiatives that will "best support improved public debate and decision making in the near term" [*U.S. Government*, 2002].

However, it is also clear that earth sciences research that is aimed at being useful to society in the near term must be deliberately designed in consultation with the intended user community in order to be successful. Evidence for this can be found from many areas, especially in the experience of the seasonal to interannual climate forecasting community [*Stern and Easterling* 1999]. Research in policy-relevant scientific issues such as acid rain, ozone depletion and water management has revealed that providing policy-relevant scientific information is a complex and delicate process [*Russell* 1992, *Parson* 2003, *Herrick and Jamieson* 1995, *Pulwarty and Redmond* 1997, *Pulwarty and Melis* 2001, *Pielke and Conant* 2003, *Jasanoff* 1990]. If deliberate, ongoing mechanisms are not put in place to connect the scientific priority setting process with societal goals, research will tend to proceed on its own assumptions about what might be useful, perhaps only to find over time that its results are not very useful for decision-makers [*Russell* 1992, *Stokes* 1997].

The method of "reconciling supply and demand" has been proposed as a way to discover opportunities for carbon cycle science to better inform decision making [*D. Sarewitz and R. Pielke Jr.*, manuscript, 2004]. The concept is applied to the use of information in order to identify where there is a good match of information needs and supply, and where there is a "missed opportunity," or a chance to perhaps better connect the supply of scientific information to societal need.

USERS AND SCALE

Current management of carbon in the U.S. (and most places in the world) can be characterized as "inadvertent." This means that actions decision makers take that affect the carbon cycle (such as energy use, land use and land management) are largely unrelated to carbon concerns. We also know that multiple users affect the carbon cycle at scales from the individual to multinational corporations and groups of nations. There are thus many decision makers, at a range of spatial scales, affecting the carbon cycle at multiple time scales. In the U.S., land use decisions are made partially by the private sector, and partially by the public sector. A high percentage of the land area in the western U.S. is publicly owned, and managed by a variety of Federal agencies, operating on policies set at the national level or sometimes the regional level (U.S. Geological Survey). Much of the high value agricultural land is privately owned (U.S. Department of Agriculture). In the south and northeast, much of the forested land is also privately owned (USDA Forest Service). Private sector decisions are dominated by "responses to economic opportunities as mediated by institutional factors" [*Lambin et al*. 2001].

Private sector, public sector, local scale, national scale—the characteristics of the decisions made by a user will determine the types of information he or she needs (Cash and Moser 2001). For example, a city manager seeking to reduce emissions may need to have extensive information on the energy use of individuals and businesses, need to prioritize activities according to effectiveness, and need a way to track progress. Information on global carbon budgets is unlikely to be of use in this situation, but a way of quantifying local carbon budgets might be quite useful.

Part of reconciling supply and demand for carbon cycle information thus includes consideration of scales—of decision making and available information. If there is a need but no corresponding supply, an opportunity exists to create new research to fill that need. Often, boundary organizations may be the appropriate mechanism to connect between scientific results and users needs. Only by developing ongoing mechanisms to connect users and suppliers of carbon science can we discover gaps and improve our ability to help decision makers manage carbon.

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