

INFORMATION NEEDS FOR ADAPTIVE MANAGEMENT OF THE CARBON CYCLE: FROM REGIONAL CARBON BUDGETS TO A HOLISTIC DECISION-SUPPORT FRAMEWORK

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ABSTRACT

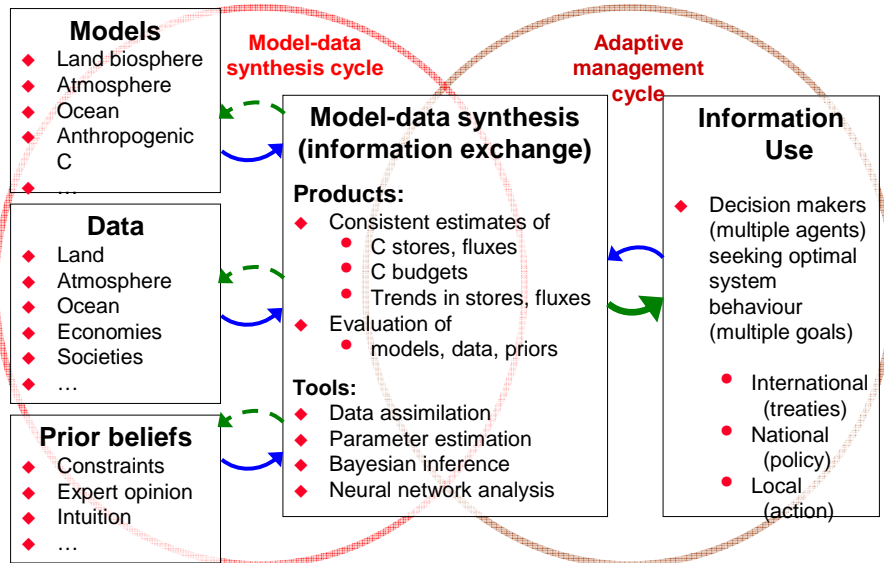
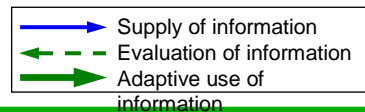
During the past two centuries, human activities have undertaken a vast earth system modification of the carbon (C) cycle. Early during this period, humans have converted native vegetation to croplands. Such land use changes have mobilized massive amounts of C. During the past century, increased use of fossil energy sources, primarily coal and oil, have resulted in the rapid expansion of industry and technology throughout the world. The resulting impact has been to greatly increase the atmospheric concentration of C dioxide (CO₂) to where in 2004 it is estimated to 375ppm, nearly 100 pm greater than the pre-industrial levels. Fossil fuel emissions and land use change have moved the global C cycle out of balance.

Recent concerns of the impact of these increases and efforts to further understand the regional C sources and sinks around the world have triggered a greater focus on accounting, at regional scales, of the changes in C management and patterns of C exchange. With increasing human population growth, technology development, regional and international trade markets, and other economic and sociopolitical forces evolve a new suite of drivers that build up inter-regional C flows and thereby alter local/regional C stocks. Hence, inter-regional C exchange adds a new as of yet completely unaccounted for dimension to the C cycle, namely that of cross-scale regional interactions of C stocks. So far, efforts to develop regional budgets have focused on estimates for fossil fuel emissions, ecosystem sources and sinks, and ocean uptake, although mostly separately. However, few studies have incorporated the role of C management activities on regional differences in C sources and sinks and cross-scale regional interactions.

The importance of C management activities is becoming increasingly apparent as greater effort is placed on development of mitigation strategies to reduce future C emissions and to enhance the potential C sequestration through technological efforts or through ecosystem sequestration. The development of these strategies has made it apparent that a more detailed understanding of C management-related decision-making is needed to evaluate the various activities are undertaken to use or to store C within a particular setting or region. Social and environmental factors affecting regional capacity to manage C are complex; they include aspects of energy use, modes of transportation, industry, agricultural activities, and natural resource use. Analyses of these complexities that determine and link decision-making and C management within a regional context are crucial to both evaluate current and predict future regional C budgets.

The development of a decision-support framework for regional carbon budgets can contribute to the goal of more integrated, adaptive management and analysis of the carbon cycle which addresses multiple criteria related to energy needs, GHG reductions, food production, resource management, and specific information needs of C managers. Our aim is to sharpen the utility of regional biophysical and socioeconomic carbon budget information as a contributor to holistic decision-making.

Model-data synthesis for carbon management



Such a decision-support framework needs to include short-term, mid-term and long-term goals as well as (adaptive) policies. The following are key criteria that need to be addressed in a highly satisfactory manner in any C management protocol:

- An integrative management plan should not only emphasis particularly land management options but treat the system as a coupled socio-ecological entity;
- Full risk/uncertainty assessments are obligatory;
- C-sequestration projects need to be designed such that the desired additional C gain can clearly be demonstrated in the short, mid and long-term;
- C-sequestration projects have to be tailored for specific socio-ecological systems aiming for the establishment of a sustainable system with a long life-expectancy;
- Successful C management programs need to be linked to capacity building, technology transfer, and consensus among multiple decision-makers.