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Carbon and Greenhouse Gas Budgets for Wisconsin Forests and Forest Product Chains

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The economy of Wisconsin is closely tied to the forest industry. The forest industry in turn is very dependent upon the energy sector for its power needs. These two industries also share involvement in issues surrounding the rising concentration of greenhouse gases in the atmosphere, primarily CO_2 (carbon dioxide), and their effects on the biosphere.

Most electric power in Wisconsin is generated by coal, a fossil fuel that contributes substantial carbon dioxide to the atmosphere when it is burned. CO_2 is absorbed and stored by trees and plants as part of their photosynthetic process, making Wisconsin's vast forest resource a key component in a strategy for partially offsetting the rate of global warming through storing, or sequestering excess carbon dioxide.

The primary objects of this study are (1) use life cycle analysis to quantify potential opportunities to reduce greenhouse gas emissions associated with the production of wood and paper products, and (2) estimate carbon sequestration capabilities of Wisconsin forests using cutting-edge remote sensing and modeling tools. The results will help identify and increase biological carbon sequestration for present-day and future environmental conditions and forest management options.

Traditionally, forest carbon budgets have focused only on the biological cycle up to the point that harvested wood leaves the forest. This study recognizes the importance of following through the entire life cycle of forest products by analyzing the harvest, the primary and secondary milling, the product use and the final disposal processes of the industrial forest carbon cycle. It is essential that life cycle inventories of wood and paper products use a common comparable methodology so that results are transparent to policy makers and future researchers. The industrial forest carbon cycle should not be overlooked in a U.S. forest carbon management plan.

Specific components of the study include:

(1) Quantifying the carbon content in forest vegetation, detritus, and mineral soil for forests in Wisconsin.

(2) Initially modeling and evaluating the carbon budgets for three model forests, and then expanding analyses to include all forests in Wisconsin. The Chequamegon-Nicolet National Forest, the Northern Highland American Legion (NHAL) State Forest, and private forests in Northern Wisconsin represent the major source of timber for Wisconsin and include a broad range of forest ownership.

(3) Conducting life cycle analyses of forest product chains to identify management and industrial processes that can be modified to mitigate greenhouse gas (GHG) emissions and/or increase carbon sequestration.

(4) Incorporating CO_2 elevation projections and warming mechanisms into an ecosystem process model to simulate forest carbon budgets and forest product chains for the future.

Components three and four were undertaken to identify opportunities in forest and forest product chains where greenhouse gas emissions can be mitigated, carbon sequestration can be increased, and waste disposal practices of end products can be modified. This study was designed to provide results greatly needed by policy makers, supervisors of national, state and county forests, CEO's of forest product and energy/utility companies, transportation and waste sectors, and environmental organizations to develop sustainable forest management practices and to reduce net greenhouse gas emissions.

Methodology and Results

The Wisconsin forest landscape consists of a diverse mix of tree species and forest stands whose growth is influenced strongly by climate and land use history. The overall objective was to estimate the carbon sequestration potential of Wisconsin's forests, and determine how forest management and product decisions affect the net biological and industrial carbon emissions.

This research used a combination of remote sensing tools and GIS analysis (satellite-based Geographic Information Systems) to develop spatial maps of key forest ecosystem variables. These maps were then used to build an ecosystem model that simulates the ongoing biological carbon cycle. Forest carbon sequestration was simulated for both present day and anticipated climate change scenarios up to100 years.

Life cycle analysis revealed dimensional lumber, and oriented strand board (OSB) products were net sources of CO_2 emissions, and previous study showed that magazines are a net source of CO_2. Simulation results suggest that forest management activities could be adjusted to maximize long term forest carbon sequestration and minimize emissions from industrial processes. Climate change increased net primary production of the forest in the Chequemegon-Nicolet National Forest by approximately 50% for a normal (business as usual) harvest regime, and when the CO_2 emissions from wood and paper products were accounted for, the Chequemegon-Nicolet National Forest was still a net carbon sink. These data imply that the forest can supply humans with needed wood and paper products and still store carbon. More work is needed to expand the LCA analysis boundaries and improve biological simulation specifics for Wisconsin forests.