The potential of central hardwood forests to sequester carbon

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ABSTRACT

Rising levels of carbon dioxide in the atmosphere have caused a concurrent rise in temperature by acceleration of the greenhouse effect. Among the options suggested to mitigate this rise is the use of forest management to sequester and store large amounts of carbon in trees and forest products. The central hardwoods region of the United States holds tremendous potential in sequestering carbon through hardwood afforestation and management. This poster presents a review of some of the studies that have been done in this area.

INTRODUCTION

Carbon (C) is released into the atmosphere from both natural and anthropogenic sources. It is the emissions from anthropogenic sources that contribute to the accelerated greenhouse effect (GHE) popularly called "global warming". Global temperatures have increased (Figure 1). Forests convert the CO_2 in the atmosphere into organic carbon (C), preventing it from contributing to the GHE. This C is stored for a long time in soils and forest products.

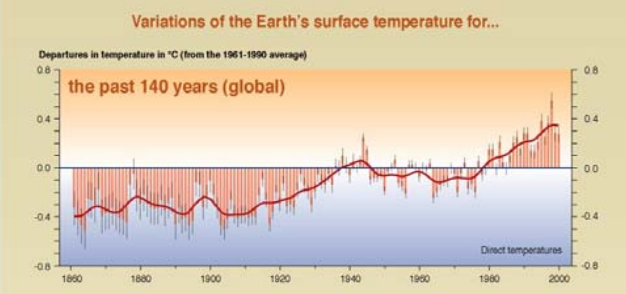

Figure 1: Graph of the global temperature changes over the past 120 years. From: <http://www.ipcc.ch/present/graphics/2001syr/large/05.16.jpg>

THE CENTRAL HARDWOOD FOREST REGION

The Central Hardwood Forest Region (CHFR) of the United States covers most of the Mid-West and stretches from eastern Kansas to Massachusetts and from Minnesota to Tennessee (Figure 2). Common trees in this region are oaks (*Quercus* spp.), maples (*Acer* spp.), black walnut (*Juglans nigra*), hickories (*Carya* spp.), and related temperate deciduous species. There have been studies to suggest that the temperate zone of North America, of which the CHFC is a large part, has been a large proportion of the world C sink in recent times (Armentano and Ralston 1980, Fan et al. 1998) suggested to be as much as half of the C released by fossil fuel burning (Ciais et al. 1995). This implies that this region should be studied in detail when considering afforestation options to help offset the accelerated GHE caused by increased emissions.

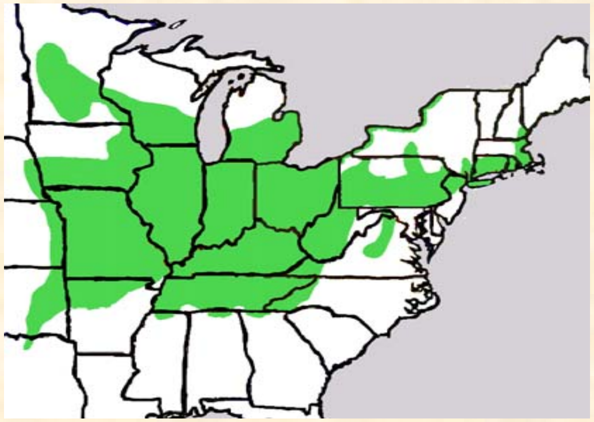

Figure 2: Map of the Central Hardwood Forest Region of the United States. (Adapted from Pijut 2003)

METHODS USED TO STUDY CARBON SEQUESTRATION IN THE CENTRAL HARDWOODS FOREST REGION

There are several methods that have been used in this region to study C sequestration (the capture and long term storage of C) in forest ecosystems. Here are some brief descriptions of the methods used:

• Computer Modeling: Environmental measurements are plugged into a spreadsheet to determine the C sequestered over time.

• Eddy Covariance: Measurements of CO_2 efflux are taken from towers over forest stands to determine the net C input to the stand.

• Allometric Analysis: Measurements are taken on attributes of trees at the site and these are applied to equations from the literature to determine C stored.

Figure 3: Forested landscape in the CHFR.

CHFR C SEQUESTRATION STUDIES

Data from C sequestration studies in the CHFR are shown in Table 1. The predicted C sequestered on these sites ranged from 1.6 to 5.8 Mt C ha^{-1} yr^{-1}. The variation in range is due in some cases to stand age and in some cases to error inherent in the method used. The studies shown here were conducted at the Harvard Experimental Forest in Massachusetts, Morgan-Monroe State Forest in Indiana, and the Walker Branch forest in Tennessee.

Table 1: Rates of net carbon gain per year for sites in the central hardwoods forest region at Morgan-Monroe State Forest (MMSF) in Indiana, Harvard Forest (HF) in Massachusetts, Walker Branch Forest (WB) in Tennessee, and various sites in the lake states (LS). The uptake shown in the table is the mean uptake for the years of each study.

Location	Species[1]	Age	Method[2]	C uptake[3]	Reference
MMSF	ACSA LITU	60-80	EC	2.4	Schmid et al. 2000
			ALLO	3.5	Curtis et al. 2002
			EC	2.4	
			ALLO	2.6	Ehman et al. 2002
			EC	3.4	
HF	QURU ACRU	50-70	EC	3.7	Wofsy et al. 1993
			EC	2.1	Goulden et al. 1996a
			EC	2.1	Goulden et al. 1996b
		60-80	ALLO	1.6	Barford et al. 2001
			EC	2.0	
			ALLO	1.7	Curtis et al. 2002
			EC	2.0	
WB	*Quercus* *Acer* LITU	60-120	EC	5.3	Greco and Baldocchi 1996
			MODEL	5.7	Wilson and Baldocchi 2001
			ALLO	2.5	Curtis et al. 2002
			EC	5.8	
LS	POTR	40	ALLO	2.9	Alban and Perala 1992

[1]Dominant species: ACSA=*Acer saccharum*, LITU=*Liriodendron tulipifera*, QURU=*Quercus rubra*, ACRU=*Acer rubrum*, POTR=*Populus tremuloides*. [2]EC=eddy covariance, ALLO=allometric, MODEL=computer modeling [3]In Mg ha^{-1} yr^{-1}

DISCUSSION

The data summarized in Table 1 suggest that we can expect sequestration rates around 3-4 Mg ha^{-1} yr^{-1} for unmanaged forests in the CHFC. This rate may be increased under more intensive systems. The studies that have been done in this region have been conducted on only a few sites. Future studies should be conducted that represent the range of species and sites in this region. Formulae should be developed specific to tree species that may be used to quickly determine the C for trees based on a few parameters. Considering the importance of this region for maintaining a global C balance, it is important that we have a better understanding the capacity of these lands to store C and the practices that may help us to increase this capacity.

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