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Will either cap and trade or a carbon emissions tax be effective in monetizing carbon as an ecosystem service

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ABSTRACT

Economists argue that if the cost of carbon emissions was bid into markets, consumers would effectively make purchases that would reduce emissions. Life-cycle inventory and assessment studies have identified how to make many environmental improvements such as reducing carbon emissions at every stage of processing. Most importantly, almost every change in building design, product selection alternative or forest management alternative results in changed levels of carbon emissions across many different stages of processing. These studies raise questions about the effectiveness of carbon registries, cap and trade systems or taxes to effectively monetize the reduction of carbon emissions. A three-tier credit system that accounts for carbon sequestration and storage in the forest sector including users of forest products can mimic many of the expected effects of an economy-wide carbon tax. Insight is provided on policies that are more likely to reflect the value of carbon emissions in purchasing and production systems and to avoid counterproductive results. The relationship between carbon emissions and other forest ecosystem services such as habitat is also examined.

1. Introduction

There is much ongoing activity to create tradable carbon credits using a market system (Sampson and Grover, 2005; The Conference Board, 2006; Ruddell et al., 2007; Parry and Pizer, 2007). If these activities produce a successful carbon credit market system they may also point the direction for how many other non-marketable benefits provided by forests may become valued in the market. Understanding the strengths and weaknesses of proposed approaches may be instrumental in determining the degree to which carbon markets may be successful as well as to show whether the methods are applicable to other ecosystem service markets.

Carbon accounting is a complex activity particularly for the forest sector. This is generally recognized at various levels including ongoing international discussions regarding the Kyoto Protocol, attempts to establish state and regional carbon registries and forestland owners deciding whether they can effectively participate in these schemes (DOE, 2007; CCAR, 2005; Prisley and Mortimer, 2004; CCX, 2007). Due to this complexity, the task of creating an effective trading scheme that includes the forest sector is a difficult one. In this paper we outline reasons why an effective market mechanism that reduces the amount of carbon dioxide in the atmosphere is difficult to institutionalize and produce recommendations that may help move the tradable carbon credit debate towards an effective outcome.

We first review the dynamics of forest-related carbon pools from regenerating forests to the uses of wood as a biofuel and/or construction products. We then suggest how using the information from life-cycle assessments of carbon in the forest sector can improve the effectiveness of a carbon accounting scheme using forests and their products as a source of tradable carbon credits. This total systems approach provides a useful framework to analyze in more detail how carbon credits can work under accounting approaches, and how some other important forest ecosystem services might be affected. We include a discussion on cap and trade mechanisms and a carbon tax to indicate the similarities and differences expected under each approach. We conclude with a presentation of complementing or competing ecosystem services.

2. Cradle to grave carbon pools

Life-cycle inventories for all of the inputs and outputs for every stage of processing from forest regeneration (cradle), product processing, building construction, use and final disposal (grave)

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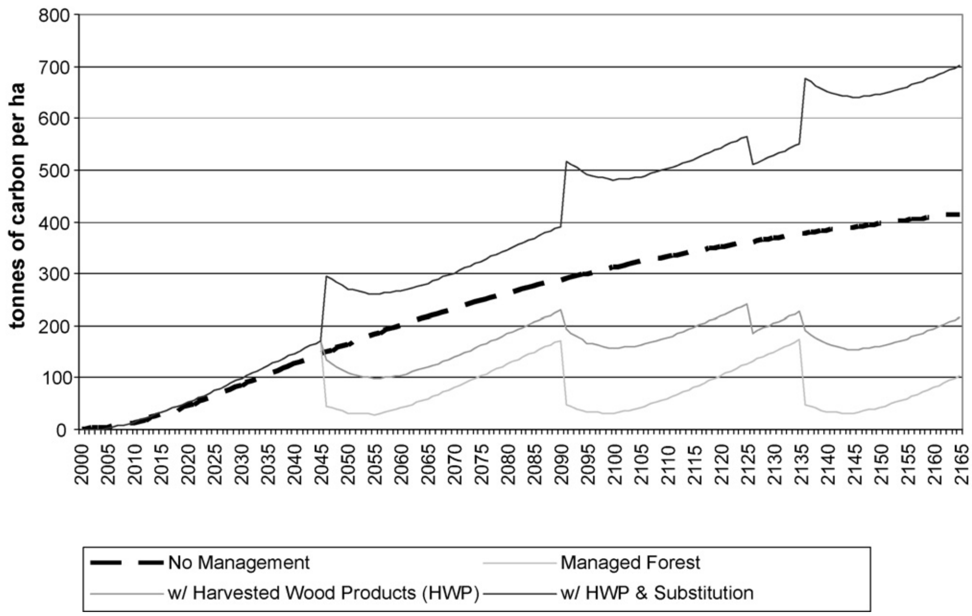

Fig. 1. Forest sector-related carbon over time includes the no-management stand (dash line), the managed forest (lower line as seen from right axis), the managed forest with harvested wood products (second line from bottom), and the managed forest, harvested wood products and substitution carbon (highest line).

have been developed (Lippke et al., 2004). Many carbon pools are altered by decisions affecting the management, design, product choice or processing method when analyzed from cradle to grave (Perez-Garcia et al., 2005). Research on the forest pool (stem, roots, crown litter, dead, soil) has shown that it grows rapidly for a few decades after regeneration but ultimately slows down as stand mortality increases or natural disturbances determine the carrying capacity limit (data from Perez-Garcia et al. (2005)) (Fig. 1, broken line).

Under management, the forest carbon pool cycles around a long-term average restoring the carbon transferred to harvested wood products by new growth in the subsequent rotation (Fig. 1, bottom line: United States (US) Pacific Northwest supply region example). With a harvest and the current commercial economic rotation of about 45 years for this example, roughly half of the volume is processed into long-lived construction products. The remaining volume is processed for chip or other residual based markets that are generally of shorter life decomposing over a few decades or left as litter, also with a shorter life. A fairly small amount of the biomass removals is used as biofuel, currently displacing much but not all of the energy required for product processing as netted out from the carbon stored in products (Fig. 1, line w/HWP i.e. Harvested Wood Products). The carbon stored in products is approximately equal to the carbon stored in the forest after the second harvest but declines with the end of the useful life of the first house (shown at age 2125 for tutorial identification) before increasing again with a third harvest. While forest carbon falls below natural growth for several decades after harvest, over each rotation the combined carbon in the forest and harvested wood products continues to increase (Fig. 1, 2nd from bottom line). Eventually the harvested wood product pools would overtake the carbon stored in an unmanaged forest, although beyond the period shown in Fig. 1.

The uppermost line in Fig. 1 illustrates the carbon associated with the use of wood products as a substitute for other materials. The carbon associated with HWP includes both the carbon stored in wood products and the substitution for the fossil fuel used to produce non-renewable, non-wood products. Substitution is viewed as permanent since each harvest is a separate event that displaces a new set of fossil fuel intensive, non-renewable non-wood products. The use of wood products substantially increases the capacity of forests to sequester carbon as the storage of wood products and substitution for non-wood products grows over time.

Two considerations for an effective tradable credit scheme are important from the studies on the forest carbon life-cycle. First forests produce carbon (C) from carbon dioxide (CO_2). Second, wood processors maintain a portion of this C as C rather than creating CO_2. When foresters discuss climate change they think in terms of C since forests are associated with the absorption phase of the carbon cycle. When consumers discuss climate change, they think in terms of CO_2 since they are associated with the emissions phase. In a process sense, forests use CO_2 to produce C, some of which is maintained as C when wood processors produce lumber, which eventually returns to the atmosphere as CO_2 after a period of time in service and landfill decomposition after all recycling. The question arises as to whether a credit system can be designed that incorporates these aspects into an accounting scheme and achieves lower CO_2 in the atmosphere. Below we suggest viewing this cyclical information as a production process giving credit when production or storage of C occurs.

3. Carbon accounting that credits forest growth and harvested wood products

Consider forest landowners who are interested in participating in a carbon market. How might the credit system be devised so as to achieve lower CO_2 emissions with their participation?

Existing accounting methods allow carbon credits associated with forests to be determined by calculating the carbon under some baseline condition and comparing it to the estimated carbon under an alternative management plan (DOE, 2007; CCAR, 2005). For example, a forest land owner who currently manages his land and produces some level of harvested wood products may choose to enter into a contract that changes his management plan to one that reduces or eliminates harvest activity, say a conservation easement or no-harvest alternative that increases the forest carbon inventory. Using Fig. 1 to illustrate this method, the carbon credits would equal the difference in the carbon sequestered under the