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Short communication

Optimal harvest age considering multiple carbon pools – A comment☆

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ABSTRACT

In two recent papers, Asante and Armstrong (2012) and Asante et al. (2011) considered the question of optimal harvest ages. They found that the larger are the initial pools of dead organic matter (DOM) and wood products, the shorter is the optimal rotation period. In this note, it is found that this conclusion follows from the fact that the authors ignored all release of carbon from decomposition of DOM and wood products after the time of the first harvest. When this is corrected for, the sizes of the initial stocks of DOM and wood products do not influence the optimal rotation period. Moreover, in contrast to the conclusions in the two mentioned papers, our numerical analysis indicates that inclusion of DOM in the model leads to longer, not shorter, rotation periods.

Introduction

Concerns related to the accumulation of CO_2 in the atmosphere have given rise to studies on how the carbon pools of forests should influence forest management; see, for example, Haberl et al. (2012),

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Haberl et al. (in press), Hoel et al. (2012), Holtsmark (2012), Holtsmark (in press), McKechnie et al. (2011), Price and Willis (2011), Schulze et al. (2012), Searchinger et al. (2009), Tahvonen (1995), and van Kooten et al. (1995).

In two recent contributions to this research field, Asante et al. (2011) and Asante and Armstrong (2012) studied the question of optimal rotation age when carbon pools such as dead organic matter (DOM) and wood products were included in their model. They reached the conclusion that the larger is the initial size of these carbon pools, the shorter is the optimal rotation period. More generally, they found that if DOM as a carbon stock was included in their analysis, there was a tendency towards a shorter rotation age.

Their first mentioned finding with regard to the initial size of the carbon pools of DOM and wood products is surprising. The time profile of the release of CO_2 emissions from these pools is determined by these pools' initial sizes and their speeds of decomposition, but is not influenced by the harvest age. It is therefore difficult to understand these results. However, for the purpose of mathematical simplicity, they considered a single rotation period only. Moreover, with a time perspective strictly limited to the first rotation cycle, they did not take into account the release of CO_2 from the initial pools of either wood products or DOM *after* the time of the first harvest. Consequently, the shorter is the rotation cycle, the smaller are the accounted emissions from these pools, with their method. In this paper, we will show that, when we account for the release of carbon from the initial pools of DOM and wood products during and after the time of the first harvest, the initial sizes of these carbon pools do not matter with regard to optimal harvest age. Moreover, for similar reasons, their conclusions with regard to the effect of including DOM and wood product pools in general in the model are not confirmed. Our numerical analysis indicates that inclusion of DOM in the model leads to *longer*, not shorter, rotation periods.

Theoretical framework and result

The model

To make our analysis comparable, we adopt the theoretical approach of Asante and Armstrong (2012), considering a single rotation period only. However, as we nevertheless will take into consideration decomposition of DOM and wood products after the time of the first harvest, some adjustments of their model are required. We will return to this issue later in our paper.

Let W_V be the net present value of the net income from harvest from the considered forest stand. Following Asante and Armstrong (2012), we have:

$$W_V(T, p) = (pV(T) - C^a)e^{-\rho T}, \tag{1}$$

where p is the net price of timber (gross price of timber minus harvest costs per unit volume) measured in monetary units per tC, $V(T)$ is the timber volume at the time of harvest T, measured in tonnes of carbon per ha (tC/ha), C^a is a fixed harvest cost, and ρ is the discount rate. We assume that $V'(t) > 0$ and that $V(0) = 0$. To simplify our notation, we measure all variables with regard to their carbon content.

Next, assume that there is a social cost related to carbon emissions, p_C (measured in monetary units per tC). Let $B(t)$ be the stock of living biomass on the stand, assuming that $B(t) > V(t)$, $B'(t) > 0$ and that $B(0) = 0$. The net present value of carbon sequestration in living biomass over the considered rotation period is then:

$$W_B(T, p_C) = p_C \int_0^T e^{-\rho t} B'(t) dt - p_C\, e^{-\rho T} B(T). \tag{2}$$

The first term on the right-hand side represents the value of carbon sequestration in the forest over the first rotation cycle, whereas the second term represents the costs of the removal of the pool of living biomass at the time of harvest. Note, however, that a share of the living biomass, $B(T) - V(T)$, at time T, is transferred to the pool of residues. This is taken care of by the first term in Eq. (5), as explained below.