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Carbon sequestration Vs. other forest ecosystem services: are they in conflict?

Gloria Rodríguez-Loinaz , Miren Onaindia & Ibone Amezaga
Department of Plant Biology and Ecology, Faculty of Science and Technology, University of the Basque Country (UPV/EHU), P.O. Box 644, 48080 Bilbao. Spain

1. INTRODUCTION

In recent decades, global climate change has focused attention on the carbon sequestration service of forestlands, leading to an increasing worldwide interest in managing forests for carbon sequestration (Woodbury et al., 2007). Several studies have found that growing trees to sequester carbon could provide relatively low-cost net emission reductions for a number of countries (Keleş and Başkent, 2007). However, many of these studies have largely neglected ecological limitations, trade-offs with other forest products and services or restrictions to implementation (Seidl et al., 2007). For example, conflicts between Natura 2000 and renewable energy projects are inevitable (Jackson, 2011). Today, there is an increasing international recognition that carbon projects should not compromise other services, such as biodiversity protection (Canadell and Raupach, 2008; Diaz et al., 2009).

The aim of this study is to answer the following question: Is there a real conflict between C sequestration and the provision of other services in timberlands?

2. METHODS

Study area: Biscay Province (area 2213 km^2). 47% of the area is covered by timberland (Fig. 1).

Methods: We created three alternative future scenarios:

a) **Services scenario:** new land-use policies will limit the expansion of pine and eucalyptus plantations in areas with high slopes (>30%) or with erosion risk. In these areas, when the existing pine and eucalyptus plantations reach the end of their turn, the native species *Q. robur* and *F. sylvatica* are planted. The existing pine and eucalyptus plantations persist in areas of low slope and without erosion risk.

b) **Biomass scenario:** eucalyptus plantations will be established in all the timberland suitable for that species when the existing pine plantations reach the end of their turn.

c) **Business as usual scenario.**

In the three scenarios, we assumed that: i) the area covered by timberland does not change within the studied period, and ii) when a plantation is clear-cut, the area is replanted within a year. We ran all the scenarios over 150 year simulation period.

The changes in the C stock in living biomass of timberland in these scenarios have been simulated by a hybrid approach using forest inventory data supplemented with data from intensive research sites and the CO2FIX V 3.1 model (Masera et al., 2003). In this work, a constant climate and no natural disturbances were assumed.

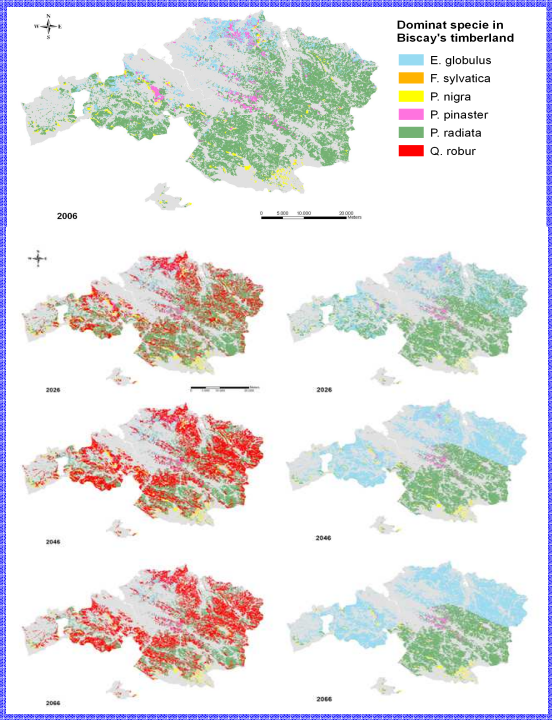

Figure 1: Timberland distribution in the reference year (2006) (a) and its changes along the study period for the Services scenario (b) and the Biomass scenario (c).

3. RESULTS

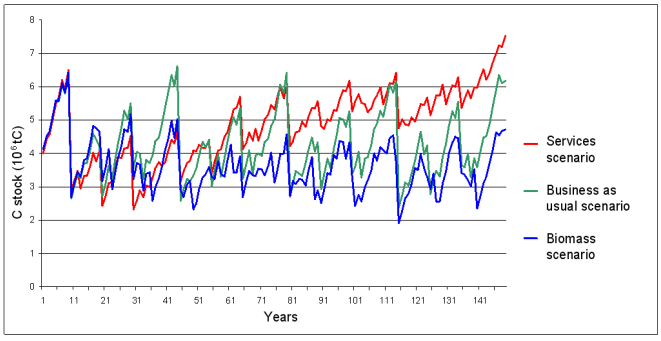

Figure 2: Evolution of the C stock in living biomass in the three studied scenarios

1. In the short (0-25 years) and mid-term (25-50 years), the total amount of C stocked in the living biomass of timberland was lower in the **Services scenario** than in the other two scenarios (Fig. 2), being 4% and 7% smaller in the short-term and 21% and 7% in the mid-term than in the **Business as usual** and **Biomass scenario**, respectively.

2. In the long-term (more than 50 years), in the **Services scenario**, the C stock in the living biomass of timberland is greater than in the other two studied scenarios, with the former accumulating 38% than the **Business as usual** and 70% more C than the **Biomass scenario** at the end of the study period (110-150 years).

3. When the **Business as usual** and **Biomass scenario** were compared (Fig. 2), the C stock in the short-term was 3% greater in the latter, and in the mid- and long-term, it was 18% greater in the former.

4. CONCLUSIONS

1. The C sequestration service depends on how fast carbon is captured and transformed into biomass by plants, how fast it is lost from the system, how large the stock is when at near equilibrium and for how long the C is captured. The trade-offs between C sequestration service and the provision of other ecosystem services appear when the emphasis is mostly on the first of these four points.

2. Shift towards faster-growing species, such as *E. globulus*, not only does not increase C sequestration, but also that the amount of C sequestered is reduced after 45 years.

3. Climate change mitigation depends much more strongly on the amount and permanence of carbon in the biosphere than on the velocity of its capture. Our data indicate that changing pine and eucalyptus plantations to native species plantations sequesters more C in the living biomass in the long-term while improving ecosystem services such as biodiversity conservation, flood control and soil protection.

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