FOREST CARBON SEQUESTRATION IN ATLANTIC, MEDITERRANEAN, MOUNTAIN AND SUBTROPICAL AREAS IN SPAIN

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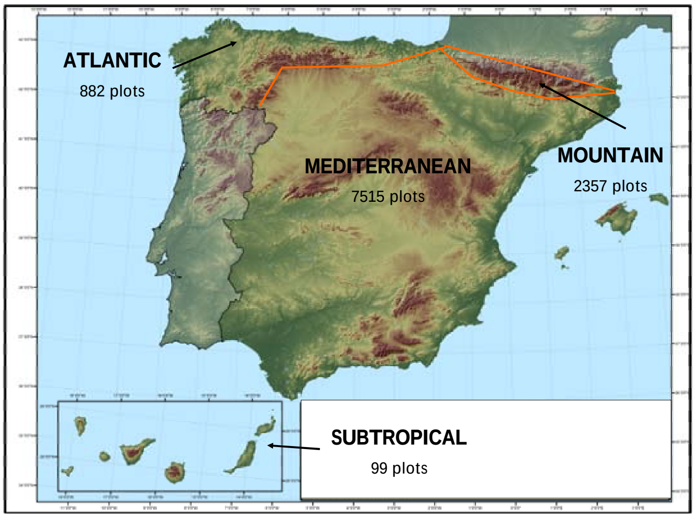
(photo by A. de Lucas)

INTRODUCTION: Increases in accumulation of atmospheric gases due mainly to human activities are the primary cause of global warming (IPCC, 2007a, Raupach et al., 2007). Forests around the world play an important role in CO2 fixation. For this reason, forest management is a key factor in mitigating the effects of climate change (Bravo et al, 2008b). Carbon stored in terrestrial ecosystems is distributed among three compartments: biomass of living plants, plant detritus and soil. Carbon content in living biomass can be assessed through species specific equations or conversion factors to estimate carbon from oven dried weight of biomass. Human activities have historically affected, positive or negatively, forest carbon content (Bravo et al, 2008b), So it is not strange that the Intergovernmental Panel on Climate Change (IPCC, 2001 and 2007a) warned of the temporality of carbon deposits in forests and of the possibility of great emissions from large-scale forest fires if not controlled. Forests can contribute to carbon sink if living biomass increment exceeds carbon loss due to dying biomass, forest fires and harvest. But some forest ecosystems are considered to be vulnerable to loss of biodiversity and carbon sequestration services under intense global change process (IPCC, 2007b)



AREA	NFI2 (Mg/ha)	NFI3 (Mg/ha)	Yearly rate (%)
TOTAL	105.667 (109.649)	135.758 (125.157)	3.466 (6.151)
ECOREGION			
Subtropical	228.462 (197.090)	267.555 (199.726)	2.878 (5.235)
Mountain	142.639 (126.511)	190.219 (148.738)	3.493 (6.556)
Atlantic	135.532 (167.841)	157.414 (184.592)	2.776 (8.860)
Mediterranean	88.948 (86.742)	114.398 (97.469)	3.546 (5.616)

CO_2 content (Mg/ha) and yearly rate (%) by ecoregion. Mean and standard deviation (kn brackets) Figures with different colors means that Tukey-Kramer test indicate significant differences

Fig. 1: Climate change can have an strong impact on Mediterranean forests. In this picture *Pinus pinaster* forest in Eastern Spain (photo by F. Bravo)

OBJECTIVE: The main objective of this contribution is to determine the impact on carbon sequestration of forests from different ecoregions and with different species composition

MATERIAL AND METHODS: Fifteen different forest areas in four ecoregions (Mediterranean, Atlantic, Mountain and Subtropical) have been analyzed in Spain. In each forest area the CO_2 accumulated (in Mg ha-1) in different forest types (pines and broadleaves) calculated by using the biomass estimation functions developed by Montero et al. (2005). The percentage of carbon in each fraction and in the whole tree is calculated by multiplying each value by 0.5 according to Kollmann (1959) and IPCC recommendations (IPCC, 2007a). We have followed IPCC Guidelines (2007a) in order to estimate carbon stock changes and removals associated with changes in biomass in these forests. They are included in the land-use category "forest land remaining forest land", and we have computed estimation of changes in carbon stock from two of the five carbon pools usually considered (aboveground biomass and belowground biomass). We have no reliable data from changes in carbon stocks associated to dead wood, litter, and soil organic matter. A mean basic density of 0.50 Mg m-3 was assumed in all species. Finally, in this contribution a scenario including carbon storage in harvested wood products has not been included, following IPCC Guidelines (IPCC, 2007a). 10 853 plots from the Spanish National Forest Inventory (Second and Third) have been used. Data were extracted by using BASIFOR 2.0 (Bravo et al. 2005) software. For each combination of ecoregions and forest type the annual CO_2 accumulation rate (in percentage) and the total CO_2 (at NFI2 and NFI3) were calculated. An ANOVA analysis was conducted in order to determine the significant effects and its possible interactions on this variable.

Source	NFI2 (Mg/ha)	NFI3 (Mg/ha)	Rate (%)
Ecoregion	p<0.0001	p<0.0001	p=0.5834
Variable	p<0.0001	p<0.0001	p=0.2864
Ecoregion*Variable	p<0.0001	p<0.0001	p=0.0027

Analysis of Variance. Type III SS. P-values. Variable means CO_2 content at NFI2 or NFI3 or yearly rate

RESULTS: Growth and upgrowth have a different impact on carbon sequestration in the different studied forests. Differences between forest types were found. Also significant differences between species were found in CO_2 content (always pine forest stock more carbon that broadleaves forest) but not in yearly rate. Differential results can orient forest policy to more adequate ecoregions or species and to modulate operational forestry from no manage to intensive manage. At landscape scale simple indicators as harvest ratio are needed to assess the impact of management intensity on carbon sequestration.

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