The contribution of chestnut coppice forests in providing ecosystem services for carbon storage and climate change mitigation: A case study

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Introduction

The concept of ecosystem services over the recent past decades has contributed to increased public awareness about the importance of natural capital and its sustainability for human well-being (Daily 1997, MA 2005). Ecosystems such as coppice forests provide a wide variety of environmental goods and services, which create value for humans. Coppice forests are particularly species-rich habitats and make a contribution to the preservation of cultural and historical diversity. Regulation services are the most important ecosystem services provided by forests (e.g. local climate regulation, water cycle and CO_2 sequestration, mitigation of natural hazards etc.). Biodiversity supporting services, provisioning, improvement of landscape and the quality of life they provide give additional important opportunities for physical outdoor activities and recreation and have positive effect on human well-being. **The aim** of this work is to analyse carbon storage of various ecosystem compartments (above-ground biomass, forest floor and soil) of selected coppice forest stands of European chestnut (*Castanea sativa* Mill.) in Belasitsa Mountain, SW Bulgaria, as well as to identify the ecosystem services, provided by these forests.

Provisioning services:
- Food
- Fresh water
- Wood and fiber
- Fuel

Cultural services:
- Aestetic
- Spiritual
- Educational
- Recreational

Regulating services:
- Climate regulation
- Flood regulation
- Disease regulation

Supporting services:
- Nutrient cycling
- Soil formation
- Primary production

Provisioning services:

High quality timber

Furniture from solid wood

Food

Fresh water

Fuel

Materials and methods

The experimental work was carried out in selected chestnut coppice forests on northern slopes of Belasitsa Mountain, SW Bulgaria from 450 to 750 m a.s.l. The chestnut forests in this region are defined as rare habitats with conservation priority under the Habitats Directive of the EU (92/43/ EEC). We investigate two mixed and one pure chestnut stands.The woody biomass was calculated per hectare and then the values, obtained were converted to carbon stock.

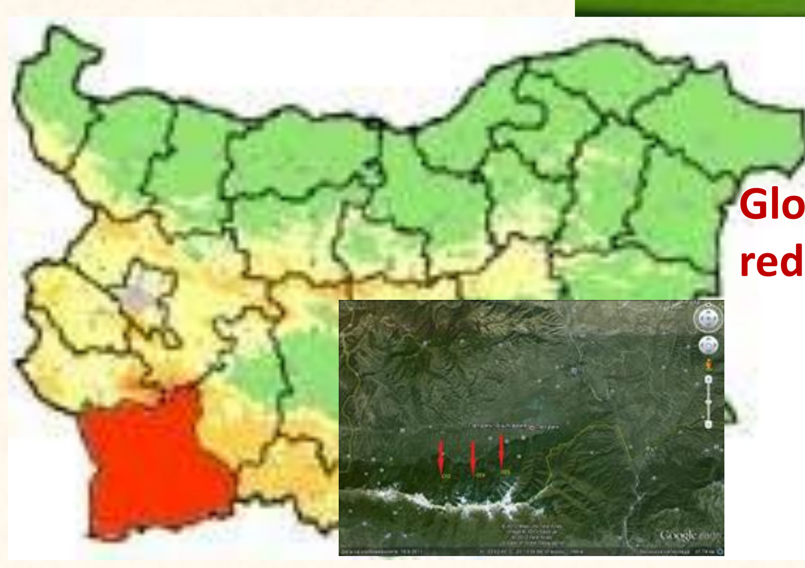


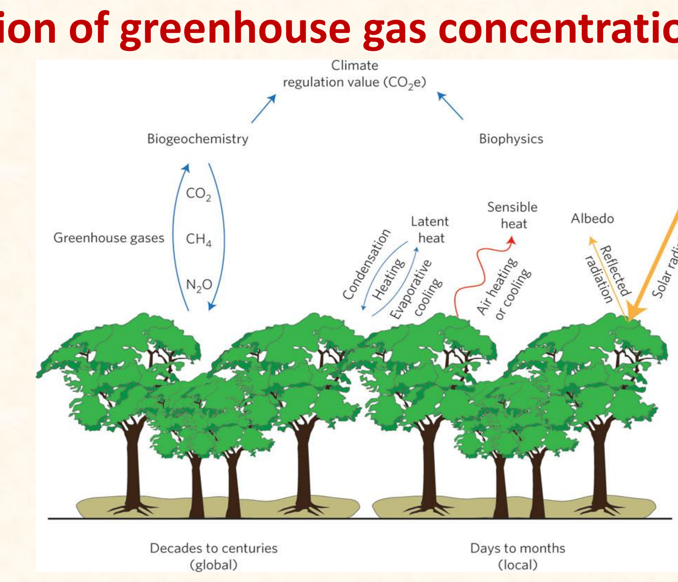
Table 1. Main characteristics of sample plots

Sample plot	Tree composition, %	Altitude m a.s.l.	Age years	No of trees	Height **m**	Diameter **$d_{1.3}$ cm**	Area **ha**
CF 1	Beech 70 Chestnut 30	700	>120	65	17	47.8	24.3
CF 2	Chestnut 70 Beech 30	450	>80	87	15	23.8	13.2
CF 3	Chestnut 100	550	>80	72	16	28.5	14.0

Table 2. Stock of tree biomass

Sample plots	Stock of tree biomass	Stock of chestnut biomass
CF 1	4820 m^3 (169 m^3 ha^{-1})	3900 m^3 (138 m^3 ha^{-1})
CF 2	1710 m^3 (103 m^3 ha^{-1})	1100 m^3 (64 m^3 ha^{-1})
CF 3	1500 m^3 (87 m^3 ha^{-1})	1500 m^3 (87 m^3 ha^{-1})

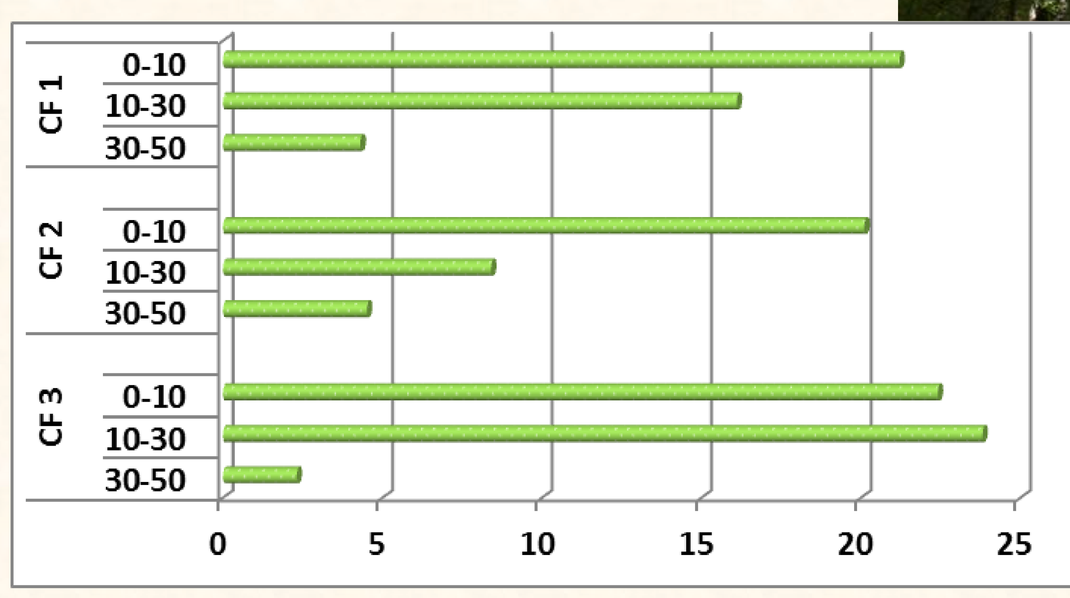
Global climate regulation by reduction of greenhouse gas concentrations



SOCff (t C ha-1) = C x w
SOCplot (t C ha-1) = SOC (g C 100 g-1) × corrected BD (g cm-3) × depth of soil layer (m) × 100
tSOCplot (t C ha-1) = Cff + Cs,

tSOCsite (tC) = tSOCplot (t C ha-1) x area of sample plot (ha)
Ecosystem (t C ha-1) = Carbon stock of AB chestnut per hectare + tSOCplot

C stock, t/ha



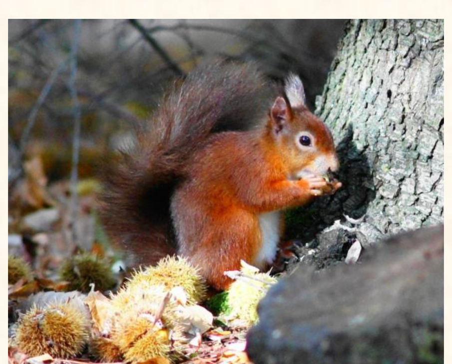
C stock in aboveground biomass

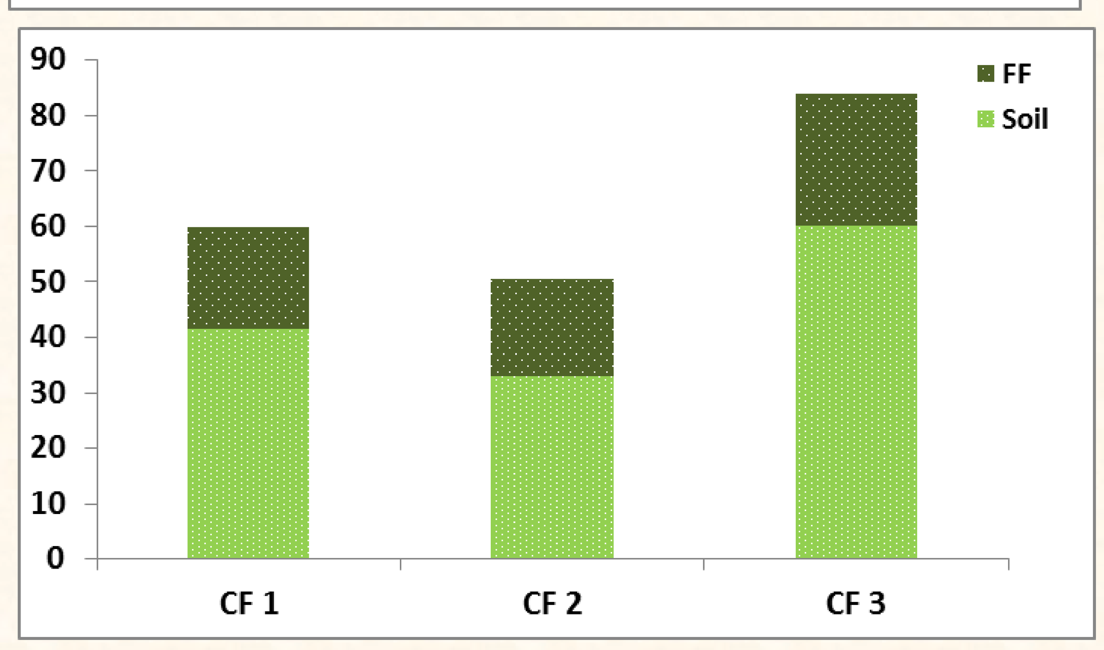
Sample plot	C stock in tree biomass	C stock in chestnut biomass
CF 1	1084.5 t C (38.03 t C ha-1)	337.5 t C (19.6 t C ha-1)
CF 2	384.8 t C (23.2 t C ha-1)	337.5 t C (19.6 t C ha-1)
CF 3	337.5 t C (19.6 t C ha-1)	337.5 t C (19.6 t C ha-1)

Results

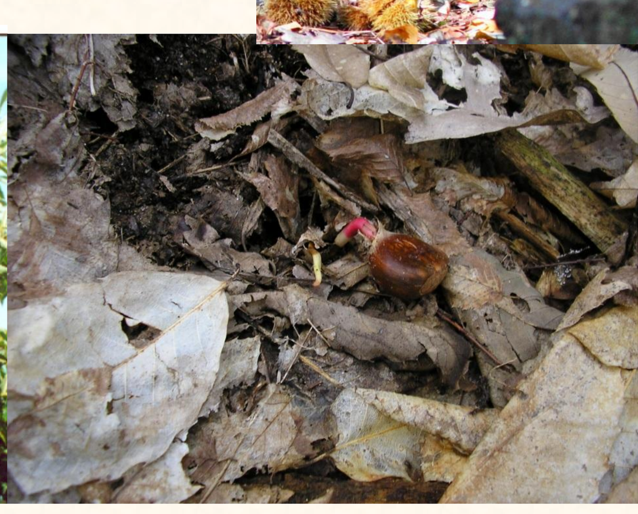
It was observed a trend of increasing C in pure chestnut stand (CF3), where we found the highest C stock in comparison with other sample plots. The highest carbon stock in soil was established for the topsoil (0-10 cm) in all studied plots.
It was observed a tendency of decreasing C stock with increasing the soil depth. The highest stock was established for pure chestnut stand (CF3) 60.2 t C ha-1. The highest total stock of carbon, both in forest litter and soil, was found again in pure chestnut stand CF3 (84.04 t C ha-1), followed by CF1 (59.77 t C ha-1) and CF2 (50.5 t C ha -1).
According to the calculations of C stock in above-ground biomass the examined experimental plots follow the order: **CF3 (105.8 t C ha-1)> CF1 (102.1 t C ha-1)> CF2 (76.3 t C ha-1).**
The pure chestnut stand is characterized with highest C stock per hectare, with only 20.6%, accumulated in above-ground biomass. This confirms the high potential of soil system for carbon accumulation.

Decomposition and fixing processes



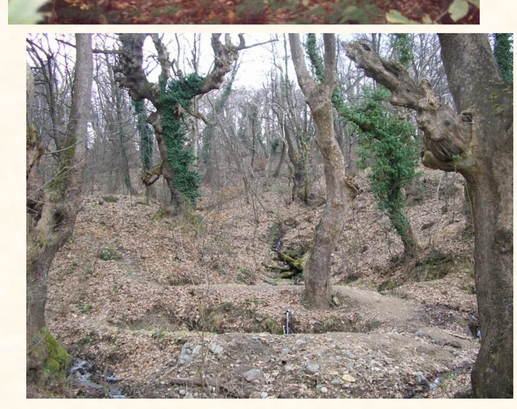


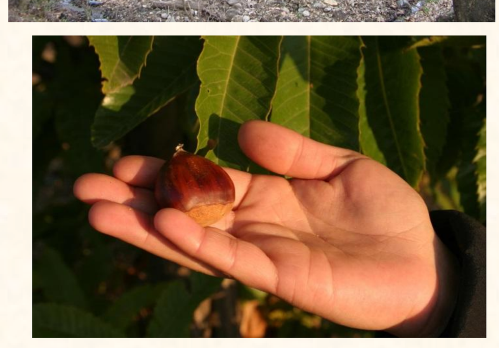
Pollination and seed dispersal



Main findings

Mature, mixed, coppice chestnut stands are characterized with relatively high carbon stock, large part of which was accumulated in the above-ground biomass. At the same time it was established that the pure chestnut stands have the highest potential for carbon storage, mostly in the forest floor and mineral soil (topsoil), indicating the existence of favorable conditions for the inclusion of organic substances in the soil system.
An analysis of the results showed that coppice chestnut forests in Belasitsa Mountain have a high potential for carbon capture and sequestration and they are of essential importance in maintaining and enhancing ecosystem services in the region, in climate change mitigation and for long-term planning and increasing the sustainability and efficiency of coppice forests. A wide range of ecosystem services that this multipurpose species provide make chestnut forests especially valuable. Understanding management practices and processes is fundamental to appreciating the challenges and opportunities for biodiversity conservation in forest landscapes.





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