FOREST RESERVE AS A MODEL AREA FOR FUTURE CLIMATE FOREST RESTORATION – A CASE STUDY

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Abstract: We adapted and parameterised the CO2FIX carbon sequestration model for near-natural, uneven-aged, mixed forests. For this adaptation we made the retrospective case study of the Várhegy Forest Reserve (Bükk mts, North Hungary), which is dominated by Pannonian oak woods (91G0, 91H0, 91M0). Through forest inventory data (from 1880 to 2006) and a detailed survey in 2005, we followed the history and the carbon sequestration of the Várhegy forest with the CO2FIX model. We ran four scenarios to show the significance of unexpected events in creating near-natural (climate) forests and estimating their carbon sequestration.

Keywords: 91M0 Pannonian-Balkanic Turkey oak –sessile oak forests, 91G0 Pannonic woods with *Quercus petraea* and *Carpinus betulus*, 91H0 Pannonian woods with *Quercus pubescens*, modelling climate change, land use change, reafforestation, reclamation of former agricultural land, creating new landscapes, environmental policy, climate forests, carbon sequestration, modelling

Introduction

Reafforestation of abandoned fields or degraded grasslands is planned to be a general way to reduce carbon in the atmosphere (see Kyoto Protocol, Article 3.3.) These “climate forests” are expected to be capable of self-regulation and adaptation to climate change. A near-natural, uneven-aged, mixed forest with native species that fit the landscape can meet these criteria.

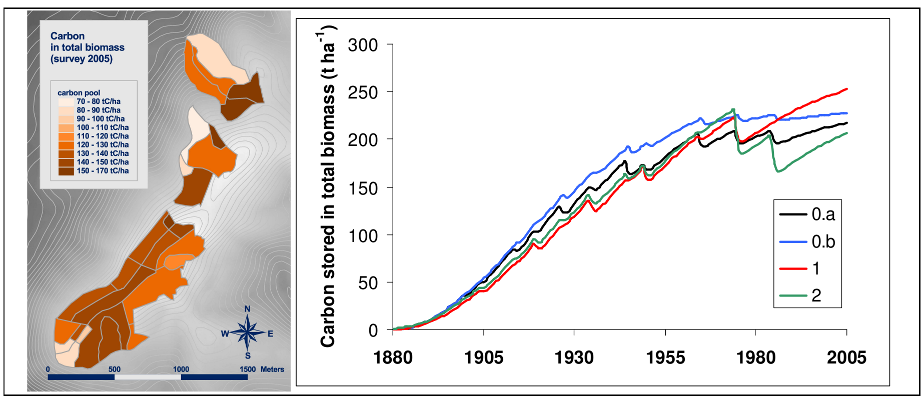


Figure 1.a. (left) Carbon stored in living and dead biomass (t ha^{-1}) for the 28 patches.
Figure 1.b.(right) Example of the CO2FIX simulation for one of the patches. Numbers indicate the four different scenarios.

The carbon sequestration of climate forests needs to be modelled, but the results of conventional harvest-focused forestry research don’t provide sufficient information about natural or near-natural forests. Therefore, we chose Várhegy Forest Reserve (Bükk mts, North Hungary), a 120-130-year-old, Turkey oak-sessile oak dominated forest as a model area. In 2005, a detailed stand (living and deadwood) and soil survey was carried out here (see Mázsa et al 2008, in this conference abstract). We use these data to calibrate our model, CO2FIX 3.1 (Schelhaas et al, 2004). Further, this model will be useful for calculating the carbon sequestration of a climate forest.

Materials and methods

We subdivided the 94-hectare core area of Várhegy Forest Reserve into 28 patches that represent different forest stand types. For each patch we determined the amount of carbon stored in living biomass and deadwood. Aboveground woody biomass calculations were based on our stand survey. Since other biomass components weren't measured in our survey they were calculated according to the recommendations of the IPCC 2006 report.

We simulated the carbon sequestration of the patches in the past 125 years from the beginning of traditional clearcutting forest management system with CO2FIX. We ran 4 scenarios for each patch: „PLANNED" scenarios simulate a standard Hungarian afforestation project. In the parameterisation of „REALISED" scenarios we considered the unexpected events that took place in Várhegy Forest Reserve (extraordinary fellings, oak disease, designation as forest reserve) in the past 125 years. "REALISED" scenarios simulate the feedback of a monitoring. For sources of the main parameter values see Table 1.

Table 1. Sources of main parameter values.

Groups of main parameters	„PLANNED-0.a/0.b"	„REALISED-1"	„REALISED-2"
1. Current annual increment	yield tables with mixture ratios estimated from the 2005 survey	yield tables with mixture ratios estimated from the 2005 survey	yield tables with mixture ratios estimated from the 2005 survey
2. Allocation rates	CO2FIX estimated	CO2FIX estimated	CO2FIX estimated
3. Turnover rates	CO2FIX estimated	CO2FIX estimated	CO2FIX estimated
4. Mortality rates	none	none	none
5. Management	conventional Hungarian silvicultural treatment model	silvicultural treatment model to the 95th year, no management after	silvicultural treatment model to the 95th year, two times thinning after (estimated from local management plans)
6. Decomposition rates	standard	standard	standard
7. Wood products	a) standard: high proc. & rec. eff. b) none	standard: high processing & recycling efficiency	standard: high processing & recycling efficiency
8. Firewood	a) standard b) none	standard	standard

Results and discussion

For each patch we compared CO2FIX output data with our survey data for two variables: merchantable timber volume and the amount of carbon stored in total (living and dead) biomass (see Tables 2.a and 2.b.). Timber volume is an important parameter: it contains the least uncertainty (IPCC 2006) among the parameters based on the field survey.

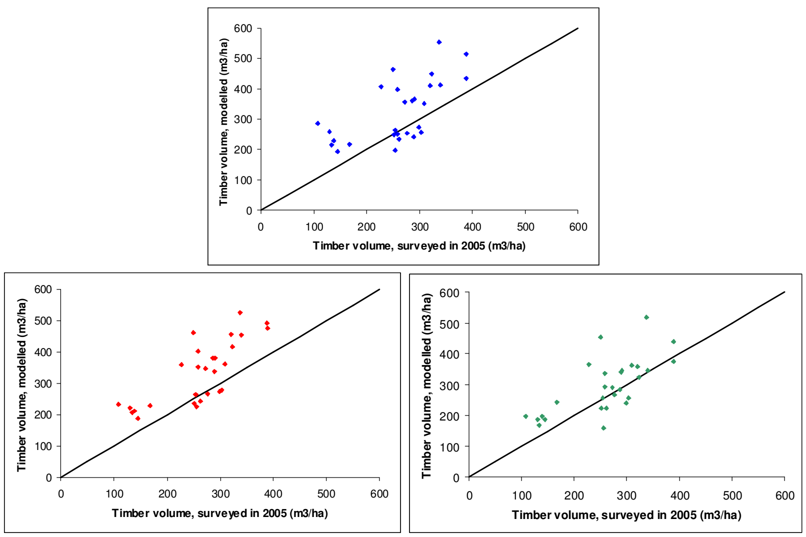
We found large variations among the patches (Fig. 1.a.). Timber volume was around 300 m^3 ha^{-1} in both the surveyed and the modelled cases, carbon in total (living and dead) biomass was 160-170 t ha^{-1}, which indicates an average-low production forest in

Hungary. On average, timber volume was significantly higher in the model simulations than in our field survey (Table 2.a.), while difference in total biomass was not so pronounced (Table 2.b.).

Tables 2.a-b. Comparison of surveyed and modelled values.
2.a. Merchantable timber volume (m^3 ha^{-1}), *2.b.* Carbon in total (living and dead) biomass (t ha^{-1})

2.a	Surveyed (2005)	Modelled (CO2FIX)		
		Scen 0.a-b	Scen 1	Scen 2
Mean	260	325	332	294
SD	76	102	102	91
Min	108	192	188	159
Max	389	553	526	517

2.b	Surveyed (2005)	Modelled (CO2FIX)			
		Scen 0.a	Scen 0.b	Scen 1	Scen 2
Mean	178	165	174	179	163
SD	58	58	58	56	51
Min	83	94	107	112	90
Max	352	300	307	294	292



Figures 2.a-c. Comparison of surveyed and modelled data of merchantable timber volume for the 28 patches. (The black line is the y=x line.) *2.a.* Scenarios 0.a-b (above), *2.b.* Scenario 1 (left), *2.c.* Scenario 2 (right).

Table 3. Mean square deviations (MSD) of the differences between the measured and the modelled values.

	Timber volume		Biomass carbon	
Scenarios	MSD	MSD %	MSD	MSD %
0.a	10250	100	6852	100
0.b	10250	100	6565	96
1	9159	89	6540	95
2	5439	53	6069	89

If we consider all patches one by one, we can relate the surveyed and the modelled values to the line y=x (see Figs 2.a-c.). We also calculated the mean square deviations (MSD) of the differences between the measured and the modelled values. They decreased in both cases (timber volume and biomass carbon) across the scenarios but were only significant for timber volume (Table 3.).

Conclusions

Each consecutively refined model simulation approaches the measured values better. The estimated error of this method is between 10 and 20 % due to lack of data in some local forest management plans. Country level data are satisfactory but not in all cases. The model is being refined continuously so these errors may decrease.

This study shows that unexpected events pay a significant role in the history of a forest. Therefore, the continuous monitoring of a new climate forest is indispensable for the accurate estimation of carbon stocks.

Acknowledgements

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