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Biotechnol. Agron. Soc. Environ. 2000 **4** (4), –

Possibilities for carbon sequestration by the forestry sector in Hungary

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In Hungary, gross emissions of carbon amount to some 17.6 Mt C yr^{-1}. Forestry, the only sector which can offset emissions, seems to be a net sink of 1.6 Mt C yr^{-1}. Afforesting large areas could substantially increase the carbon fixing capacity of the Hungarian forests. To assess the possibilities of sequestering carbon by afforestation, the CASFOR model, an adaptation of the COMAP model, was developed for Hungarian conditions. The technical potential scenario showed that, by afforesting 773,000 ha of former agricultural land by 2050, some 46 Mt C could be sequestered. The specific costs of sequestering carbon by afforestation are pretty low.

Keywords. Hungary, carbon mitigation, carbon sequestration, modelling, afforestation, Kyoto Protocol.

1. INTRODUCTION

In Hungary, two National Communications (NC) have been prepared by the Hungarian Committee of Sustainable Development (HCSD, 1994, 1998) and submitted to the United Nations Framework on Climate Change (NC1 in 1994 and NC2 1998). These inventories covered all major sources and sinks of the most important greenhouse gases. In addition to these official submissions, frequent inventories on sources and sinks of greenhouse gases have been compiled since 1985.

According to NC1 and NC2, as well as other recent estimates (Ministry of Environment, 1999), some 60 Mt CO_2 (approximately 6 t CO_2 $capita^{-1}$), and altogether 75 Mt CO_2-equivalent greenhouse gas have been emitted in Hungary annually (**Table 1**). The emission has been declining since the middle of the 1980's, parallel to the declining output of the overall economy of the country, but is predicted to increase again along with the recent recovery of the economy. This emission is quite high compared to GDPper capita (i.e., two to three times as much as in other countries of similar GDP per capita).

Among the overall data for the country, data for pools, emissions and sinks in forestry are also available. The current (1998) pool in aboveground forest biomass amounts to 92.2 Mt C, and is increasing by 1.62 Mt C·yr^{-1} (**Table 1**). This change is equal to 1.76% of current pools, or 9.2% of current emissions. According to the estimates, forestry is the only sector that can be regarded as a sink. Forests in Hungary are a net sink because the annual cut is less than the annual increment, and because afforestation is ongoing.

2. WORKING GROUP 1 RELATED ACTIVITIES (Inventory of C sinks and sources)

The national inventories mostly used the methods and guidelines developed by IPCC (IPCC, 1995). The data for the forestry sector were also estimated by the IPCC methodology (IPCC, 1992, 1994, 1996). As for constants, both national and general data were used. For example, national data were used for the specific weights of tree species, whereas average values of IPCC were used to estimate carbon content of dry

Table 1. CO_2-emissions and sinks and, emissions of greenhouse gases in CO_2-equivalent, in Hungary in the recent past and future forestcasts (HCSD, 1997, 1998; Ministry of Environment, 1999).

	1985–1987	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1998**	**2000**	**2008–2012**
Total CO_2 net emissions			64,2	56,7	56,1	54,4	55,0			
Total CO_2 sink (forestry)			-3,2	-3,8	-4,7	-4,8	-4,8			
Total CO_2 gross emission			67,4	60,6	60,8	59,2	59,8			
Total CO_2 -Equ. gross emission	*99,8*	*82,1*					*73,9*	*73,1*	*74,2–75,9*	*80,6–91,4*

woody biomass. The input data for applying the methods are mostly taken from the National Forest Inventory (NFI).

Unlike in many countries, the Hungarian NFI is a continuous survey of forest resources coupled with the planning of forest management activities at the compartment level (the average size of the compartments is about 5.5 ha). About one tenth of all forests in the country are surveyed each year. For surveying and planning, entire forest blocks are selected depending on the time that has elapsed since the last survey, as well as the need for preparing new management plans. Based on the field measurements and observations of the surveys, the National Forest Database is compiled, and updated annually. The data between two consecutive surveys is updated by using species-specific yield tables; measured or anticipated changes in species composition for compartments where regeneration takes place and other traditional updating methods.

2. WORKING GROUP 2 RELATED ACTIVITIES (Analysis of forest management practices)

The Hungarian Government recently approved its Strategy on Climate Mitigation (SCM, 2000). This states that the current afforestation program of the Government is justified from a climate mitigation viewpoint. The Strategy also states that further afforestation should be promoted on more than 700,000 ha of croplands that will be taken out of agricultural production after the country has joined the European Union. The use of wood as renewable material and the efficient and environmental-friendly use of fuelwood are also promoted by the Strategy.

Of the several carbon mitigation options in forestry (that include, in addition to the above mentioned ones, preserving carbon in trees and soil, increasing of carbon density of stands), it is only afforestation projects that have large potential. They are also relatively cheap (~8.5 EURO/tC) compared to several other carbon mitigation options. To assess these potentials for decision makers, the CASMOR model (Somogyi, 1997) was developed from COMAP (1995). An important characteristics of this model is that, unlike COMAP or other models used by IPCC), sequestration is related to tree age.

To run the model, three basic afforestation scenarios of constant afforestation rates were developed. The technical potential scenario (I) involves afforesting 773,000 ha of former agricultural land in 50 years (ÁESZ, 1999). In the second scenario (II), it is assumed that current afforestation rates (~8,000 ha·yr^{-1}) are maintained until 2050. The third scenario assumes that the afforestation rate is equal to the lowest one in the past few decades (~4,000 ha·yr^{-1}). In each scenario, it was assumed that afforestation is done either with predominantly fast growing, short rotation, species such as black locust (*Robinia pseudoacacia*), poplars (*Populus cultivars*), and pine (*Pinus sylverstris* and *Pinus nigra*), or that at least half of it is done with indigenous, slower growing, long rotation species such as Pedunculate oak (*Quercus robur*). It was also investigated how the choice of baseline scenario affects sequestration estimates. The choices are that the area still to be afforested remains cropland until afforestation, or that it is abandoned at the beginning of the afforestation program, and spontaneous forestation takes place. Estimates were calculated for the total length of the suggested 50 year afforestation project, as well as for the period 2008–2012 (i.e., the first commitment period of the Kyoto protocol).

The results of model runs (**Table 2**) show that the technical potential of sequestering carbon in Hungary amounts to some 46 Mt C in 50 years. This compares well to the estimates of Szendrodi *et al.* (1999a,b). This amount is about the same as the total emissions of three years. Amounts that could be sequestered during the first commitment period (2008–2012) are also substantial, at the order of magnitude of the commitment of Hungary (6%, or 1.63 Mt CO_2-equivalent). However, considerable differences exist between various afforestations scenarios, as well as between various assumptions as to the baseline, or species applied.

The cumulative rate of carbon fixation over time (**Figure 1**) is worth attention. Because of the difficulties to quickly afforest large areas (i.e., only in a few years), and because of the characteristic carbon fixation rate of trees over age, a considerable time elapses after the initiation of the afforestation until large amounts of carbon are fixed. This may bring about adverse reactions of investors; however, the rate of carbon could be accelerated by proper project preparation.

Figure 1 also shows that, even if afforestation stops in 2050, the accumulation of carbon continues

Table 2. Estimated amounts of carbon fixed in various scenarios and under various assumptions. "/2050" means that the project lasts from 2001 to 2050, whereas "/Kyoto" denotes estimates for the same projects for the commitment period 2008–2012.

Scenario	Species Fast-growing	Indigenous
I/2050	**42,6**	32,0
II/2050	22,0	16,5
III/2050	11,0	8,3
I/Kyoto	**2,3**	1,7
II/Kyoto	1,2	0,9
III/Kyoto	0,6	0,4

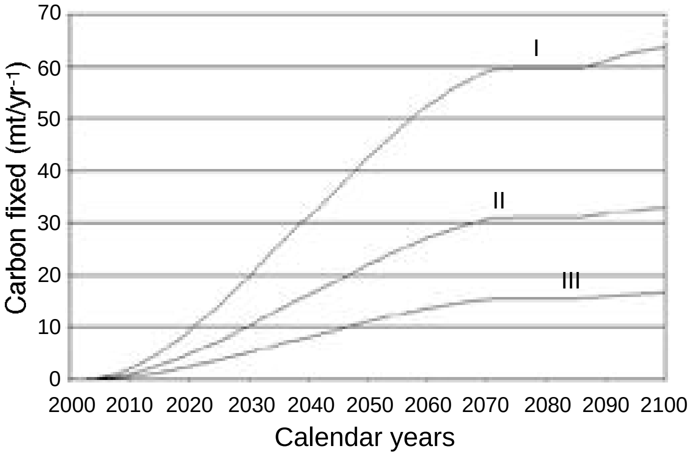

Figure 1. Total amount of carbon fixed in the various afforestation scenarios (with fast growing species, and with the assumption that lands remain croplands until they are afforested).

into the relatively far future (at least 70 years ahead). Although the carbon sequestration does not reach a saturation level until 2100, the increase of the total carbon fixed in the system is low after *ca.* 2070 and is expected to level off soon after 2100. The levelling off occurs after the end of the afforestation programme, because carbon continues to accumulate in the above and below ground biomass, dead wood and wood products after establishing a forest, and because much carbon is still fixed in dead wood and wood products after the first rotation period.

The precondition for preserving all the estimated amount is, of course, that all newly established stands are protected from land-use change. It is, of course, difficult to predict future land use practices, however, there is a good chance in Hungary for these stands to remain well managed forests in the long term.

4. CONCLUSIONS

As to the activity of COST E21, more detailed analysis would be required to assess the strengths and weaknesses of the models that are used for the assessment of various carbon mitigation strategies. Issues such as the carbon content of the wood of various tree species, the variation of the carbon content of the below ground biomass and soil, as well as the reliability of estimates should be in the focus of Working Group I. The methodology to assess carbon pools and rates of changes should be one that can be used in decision-making. To use methods for research purposes is different from coming up with a method that could be used in taking decisions on applying forestry measures (e.g. afforestation) to mitigate greenhouse effects. In order to make informed decisions, the uncertainty of the results produced by the various methods must be assessed, and methods for this must be developed. Similarly, if the method of the carbon inventory will be changed, the policy makers must know what bearing this change in itself has on the results of the inventory.

As to Working Group II, issues of emission trading (prices, permanency, accounting), the impacts of afforestation, and persuading environmentalists to accept afforestation as viable options should be developed. It is clear that carbon mitigation by forestry means must be further elaborated on a professional basis, however, more public relations activities are needed to exploit all possibilities in the forestry sector to mitigate carbon emissions.

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