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# *Interactive comment on* "The carbon budget of terrestrial ecosystems at country-scale – a European case study" *by* I. A. Janssens et al.

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The carbon budget of European terrestrial ecosystems is the focus of intensive research (e.g. Janssens et al. 2003) and continues to hold unresolved scientific questions regarding the role of different ecosystem types and land management on the carbon sinks and sources. The recent manuscript of Janssens et al. (Janssens et al. 2004) attempts to look at the carbon budget at the country scale in Europe, which is challenging, because there are no direct measurements of all ecosystems available. Thus indirect evidence needs to be employed and many assumptions add a lot of uncertainty into the analysis. Some of the assumptions of the authors in this paper appear to be questionable, because there is conflicting evidence available, which is not appropriately addressed in the analysis.

One issue is the estimation of peatland fluxes, which is entirely based on the assumption of older studies that the drainage of peatlands leads to a net loss of carbon from the ecosystems. It is out of question that drainage increases aeration and thus stimu-

lates decomposition of soil carbon in peatlands. However, following drainage, the net primary production increases and the overall balance of the drained peatland ecosystem may be positive and has been found to be a net carbon sink in several studies (Hargreaves et al. 2003, Laiho et al. 2003, Minkkinen et al. 2002, Minkkinen and Laine 1998). Recent data from the CarboAge chronosequence on afforestated peaty soils in Scotland support this view (Zerva and Menccucini unpublished).

In the discussion section 3.6.1 Janssens et al. claim that the current sink behavior of European forests stems primarily from the uneven age structure, whereas in the introduction they did acknowledge the more important influence of the harvest ratio (UN-ECE/ FAO 2000). It is important to realize that forest management is a key for understanding the carbon balance of the forest sector. Essentially, under-utilized forest resources lead to the ageing of the forest ecosystems in Europe, which enhances the sinks, but also increases the risks of disturbances, which could quickly release carbon back to the atmosphere (Körner 2003). The discussion section 3.6.1 is not consistent in the interpretation of the full sectorial carbon balance. Janssens et al. refer to carbon storage in wood products and substitution effects, but fail to acknowledge these important aspects when it comes to the design of C-oriented forest management practices. The contribution of selective cutting and continuous-cover forestry to increase the net carbon balance of forests is speculative because experimental evidence is lacking. Setting aside productive forests would clearly be counter-productive as the sink in the forest saturates quickly and old forests sequester less carbon than productive forests.

The argument in section 3.7.1 for enhanced protection of existing carbon sinks is not convincing under European circumstances, because the disturbance regime and the limited life-span of European tree species prevents the accumulation of very large carbon reservoirs. On the other hand, when a sustainably managed forest is harvested, it is quickly regenerating back into an active carbon sink and the carbon storage in wood products and a possible energy substitution at the end of life need to be considered in the carbon balance as well. Findings from other forest regions, for example from



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cutting old-growths in the rainforests of North-Western America (Harmon et al. 1990) do not fully apply here, because it takes less time to refill the carbon sink (maximum carbon density is much lower in European forests), and the maximum age of the forest types is much lower, too. Chances are high, that despite of small net gains of carbon in undisturbed old forests (Knohl et al. 2003), the carbon sink will not be sustainable, because few European forest systems can naturally become much older than 300 years. (BTW, what is the evidence for non-climatic benefits of increasing soil C?)

Similare point: The last sentence of the abstract asks for special protection of large reservoirs. How is it possible to protect the large reservoirs from natural disturbances? Examples of large carbon reservoirs in European forests include e.g. mature beech stands and dense and tall spruce plantations. Both systems are particularly prone to wind disturbance (which may become more frequent under a changing climate).

There clearly is a need for conscious carbon management in European ecosystems. However, the conclusions of the authors how improved carbon management should look like do not sound well substantiated, at least not for the forest sector.

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