Carbon balance of an old unmanaged deciduous forest

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Introduction

Unmanaged forests at a late developmental stage are considered to be insignificant as carbon sinks, since in theory, assimilation is thought to be balanced by respiration. However, little experimental evidence for this hypothesis exists so far at the ecosystem level. Therefore, we studied the carbon balance of an unmanaged beech forest in the Hainich National Park in Central Germany as part of the EC-project *Carboeurope*. This forest shows typical characteristics of a late developmental stage forest with large dead wood pools, a diverse stand structure and a wide tree age class distribution, up to 250 years.

Discussion

This forest was a large carbon sink of about 4.9 t C ha^{-1} y^{-1} independently estimated from continuous eddy covariance measurements and ground-based inventory measurements (table B). This was similar to the carbon uptake of a highly productive managed beech forest, located nearby. Our data clearly indicate that unmanaged forests at a late developmental stage can act as significant carbon sinks, which has implications for the negotiations about biological sinks within the Kyoto protocol.

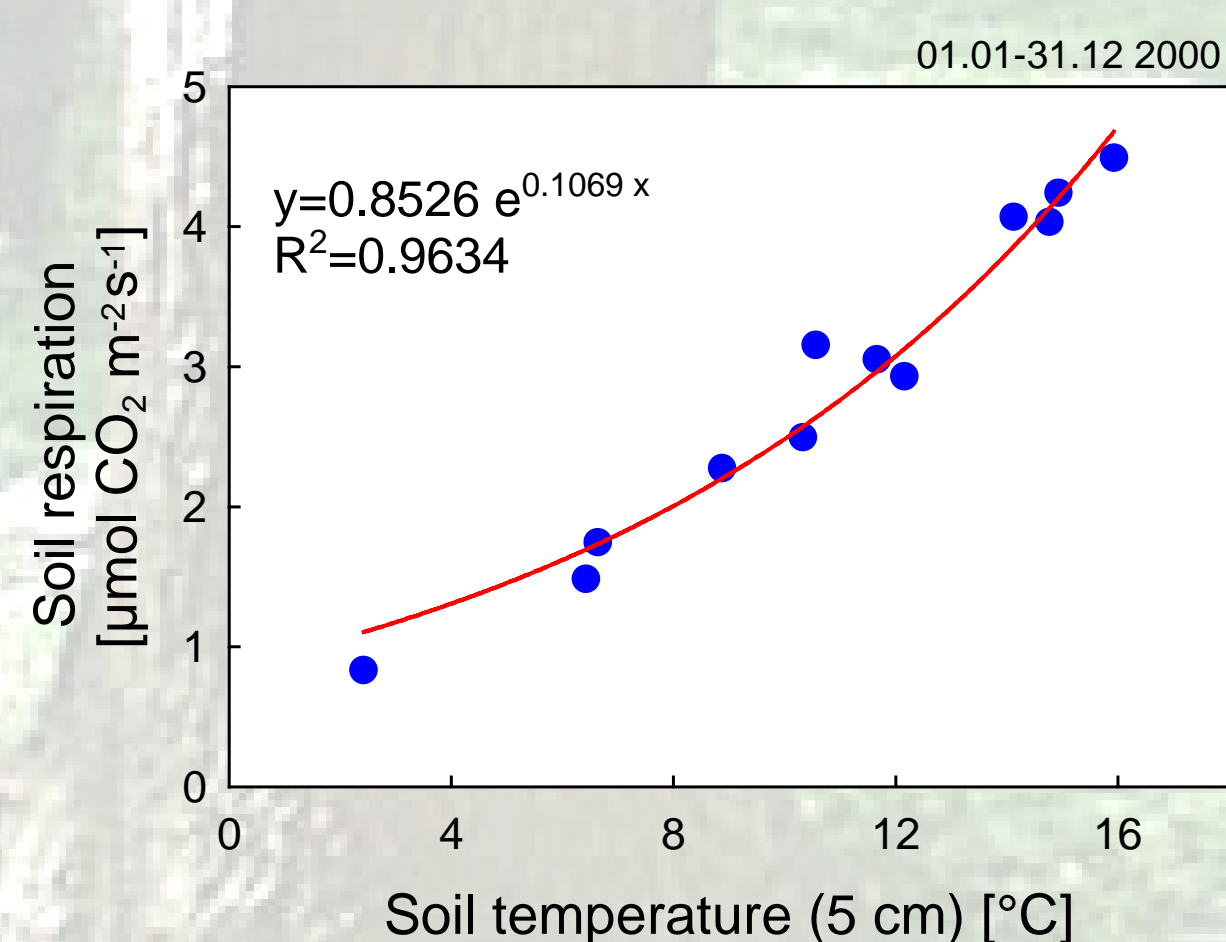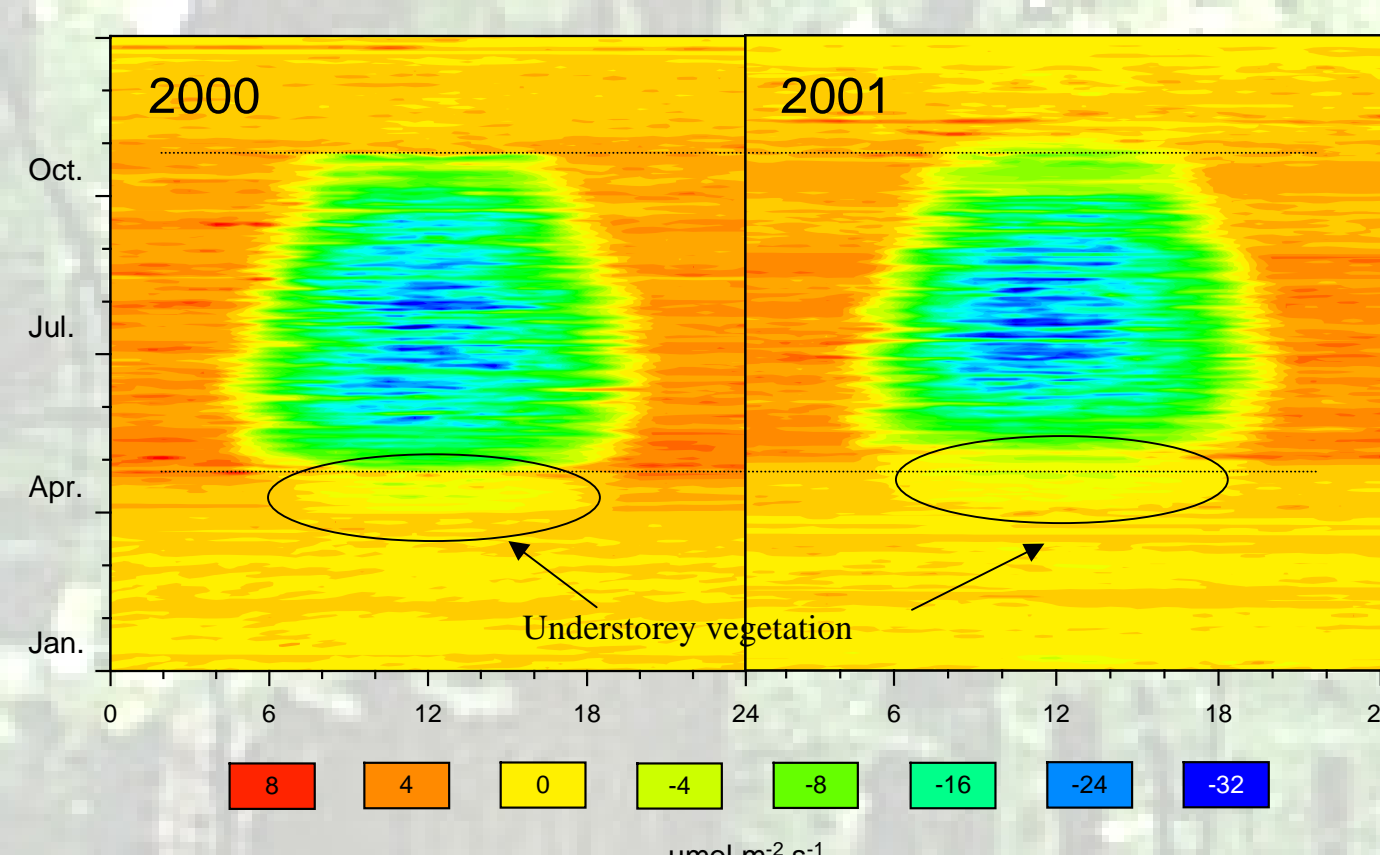## Carbon pools and fluxes

A) Total carbon pools (t C ha^{-1})

Aboveground tree biomass	178
Stem, branches & twigs	*176.3*
Leaves	*1.7*
Belowground tree biomass	34.3
Dead wood	13.5
Soil organic layer	1.2
Mineral soil	110
Total	**337**

B) Carbon fluxes (t C ha^{-1} year^{-1})

Total net primary productivity (NPP)	- 9.3
Stem, branches & twigs	*-5.0*
Leaves	*-1.7*
Fine roots	*-1.7*
Coarse roots	*-0.9*
Accumulation of C in soil	- 0.05
DOC output	- 0.05
Dead wood accumulation	- 0.09
Microbial respiration (~50 % of total soil respiration)	+ 4.6
NEP (based on ground measurements)	**- 4.8**
NEP (Eddy-Covariance technique)	**- 5.0**

NEP (2000/2001)   -5.0/-4.9 t C ha^{-1} yr^{-1}
Respiration   10.8/10.5 t C ha^{-1} yr^{-1}
Assimilaton   -15.8/-15.4 t C ha^{-1} yr^{-1}

data: A. Knohl

2000 2001
Oct. / Jul. / Apr. / Jan.
Understorey vegetation
0 6 12 18 24   0 6 12 18 24
8 4 0 -4 -8 -16 -24 -32
µmol m^{-2} s^{-1}

$y=0.8526\,e^{0.1069\,x}$
$R^2 = 0.9634$

01.01-31.12 2000

Soil respiration [µmol CO$_2$ m^{-2}s^{-1}]
Soil temperature (5 cm) [°C]
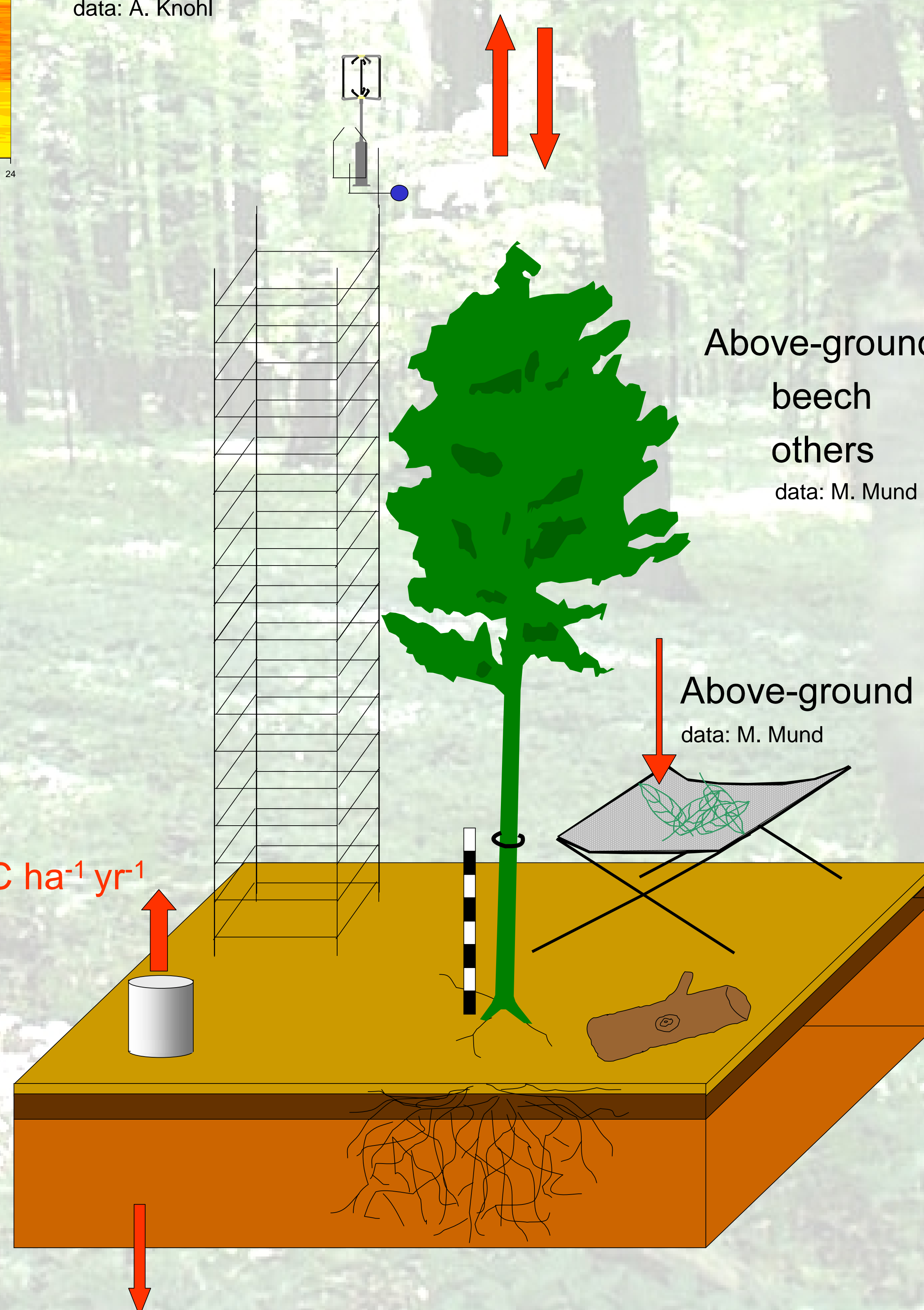
Soil respiration (2000/2001) +9.1/+9.2 t C ha^{-1} yr^{-1}
data: A. Søe

Soil organic pools

organic horizon (LFH)   1.2 t C ha^{-1}
mineral soil   110 t C ha^{-1}
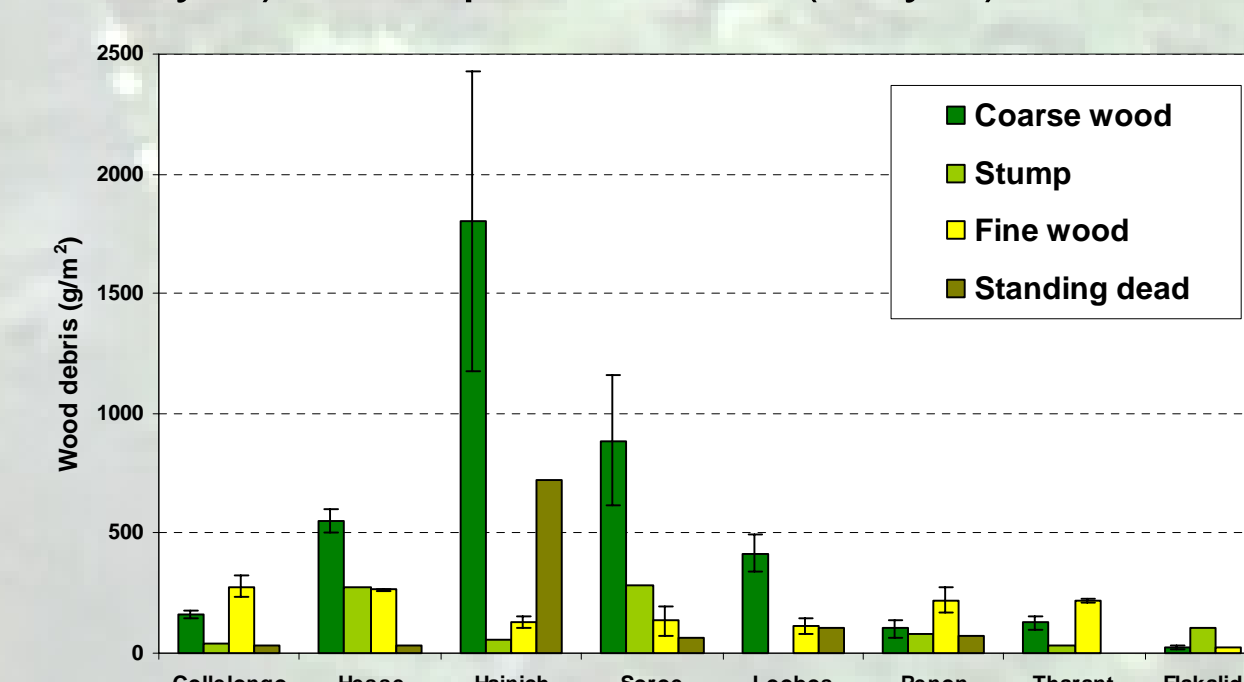
data: M. Mund

Above-ground biomass   178 t C ha^{-1}
beech   114 t C ha^{-1}
others   64 t C ha^{-1}

data: M. Mund

Above-ground litter input (average)   2.5 t C ha^{-1} yr^{-1}
data: M. Mund

Dead wood pool   13.5 t C ha^{-1}
data: F. Cotrufo

Dead wood input   -0.9 t C ha^{-1} yr^{-1}
estimated from pool, exp. decay
(k=0.07 yr^{-1}) and input duration (60 yrs)

Wood debris (g/m^2)
Coarse wood / Stump / Fine wood / Standing dead
Collelongo Hesse Hainich Soroe Loobos Renon Tharant Flakaliden

DOC output   -0.05 t C ha^{-1} yr^{-1}
data: G. Gleixner, M. Fink

Below-ground biomass   34 t C ha^{-1}
beech   22 t C ha^{-1}
others   12 t C ha^{-1}

data: M. Mund

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