Net Ecosystem Production and carbon balance of an SRC poplar plantation during its first rotation (POPFULL)*

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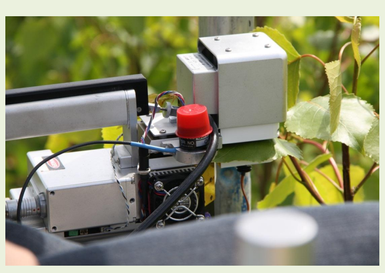
Objectives

- To quantify the components of the carbon (C) balance of a poplar bio-energy plantation
- To quantify NEP and determine the sink-source status
- To compare the estimated NEP with NEE measured through eddy covariance techniques

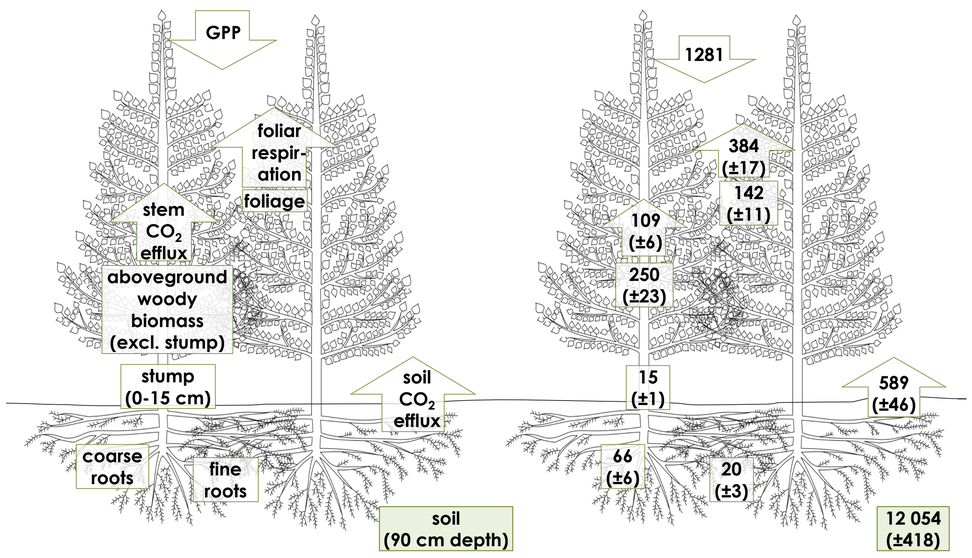
Materials & Methods

- Large scale (18 ha) short rotation coppice plantation in Flanders (Belgium) with 12 poplar genotypes
- C pools and fluxes were quantified on an annual basis during the 2nd growth year of the 2-year establishment rotation
- Determination of biomass **C pools**: combination of sample harvesting, non-destruvive sampling + allometric techniques and upscaling
- Determination of **C fluxes**: chamber measurements using IR-gas analysis techniques + temporal & spatial upscaling and modeling
- **Net C balance** calculation:
  1. Pool-change-based approach: $NEP = NPP - R_{het} = F + (Ste + Br) + Stu + CR + FR - 0.6 \cdot R_S$
  2. Component-flux-based approah: $NEP = GPP - R_{eco} = GPP - (R_S + R_{Ste+Br} + R_F)$
  3. NEE assessment via eddy covariance techniques




Results



Boxes represent annual pool changes, and arrows represent annual integrated C fluxes for the second growing season (values in g C m^{-2} y^{-1}). The green filled box (soil) represents the standing soil C pool before plantation establishment (in g C m^{-2}). Averaged values are given with standard errors; gross photosynthesis was a modeled parameter, not including an error range.

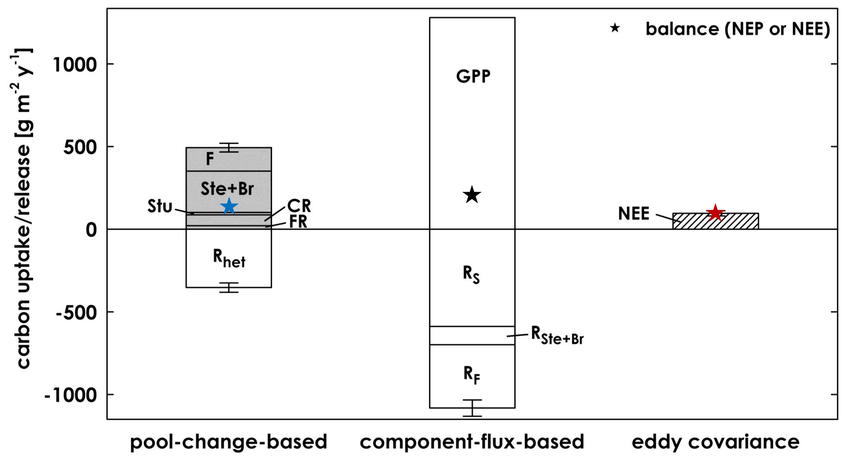
A few minor *missing* C-pools and fluxes include:

- small CH_4 release fluxes (non-CO_2 losses) were observed
- volatile organic compound (VOC) emissions: estimated at 1-2% of GPP, corresponding to 13-25 g C m^{-2} y^{-1}
- dissolved organic compound (DOC) losses to deeper soil layers: estimated at ± 4.7 g C m^{-2} y^{-1}
- foliage C losses due to herbivory: maximum 1%
- understory (weed) vegetation was sparse (not quantified)

NEE	Net Ecosystem Exchange measured through the eddy covariance technique
NEP	Net Ecosystem Production
NPP	Net primary Production
GPP	Gross Primary Production
Ste + Br	aboveground woody biomass pool
Stu	aboveground stump (15 cm stem) pool remaining after coppicing
CR	coarse root (Ø > 2 mm) pool
FR	fine root (Ø < 2 mm) pool
F	foliage pool
S	soil pool till 90 cm depth
R_{eco}	total ecosystem respiration
R_S	total soil CO_2 efflux
R_{het}	heterotrophic soil respiration (60% of R_S)
$R_{S\ aut}$	autotrophic soil (root) respiration (40% of R_S)
R_F	foliar respiration
R_{Ste+Br}	CO_2 efflux from aboveground woody biomass

Relative contribution of carbon pool changes to NPP and GPP and relative contribution of fluxes within R_{eco} and GPP. Values are given in percentage (%) of NPP, R_{eco} and GPP.

	NPP	R_{eco}	GPP
NPP	**100**		**40.4**
F	28.8		11.6
Ste + Br	50.6		20.4
Stu	3.1		1.3
CR	13.3		5.4
FR	4.1		1.7
R_{aut}		**67.4**	**59.6**
R_{Ste+Br}		10.1	9.0
R_F		35.5	31.4
$R_{S\ aut}$		21.8	19.3
R_{het} ≈ $R_{S\ het}$		**32.6**	



Components of C balance, using three different approaches. Uptake and storage displayed positive, release or loss displayed negative. grey bars = pool changes; non-filled bars = integrated fluxes; hatched bar = eddy covariance assessment.

Stars show the C balance **net result** (in g C m^{-2} yr^{-1}) representing the NEP or NEE for the eddy covariance measurements:

- ★ pool-change-based: **140.3**
- ★ component-flux-based: **199.2**
- ★ eddy covariance: **95.7**

Conclusions

- Considering the size of the C balance constituting components and associated uncertanties, the three approaches give comparable results
- The efficient biomass production – with the highest part of the total C uptake allocated to the aboveground wood – led the poplars to counterbalance the high respiratory soil C effluxes

  ⇨ The ecosystem was a **net carbon sink** in the 2nd year of the first 2-year rotation

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