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

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Objective
• To quantify the components of the carbon (C) balance of a poplar bio-energy plantation
• To quantify NPP and determine the sink-source status
• To compare the estimated NEE 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-destructive sampling + allometric techniques and upsampling
• Determination of C fluxes: chamber measurements using IR-gas analysis techniques + temporal & spatial upsampling and modeling
• Net C balance calculation:
  1. Pool-change-based approach: NPP = NPP - Rnet = F + (Ste + Br) + Su + CR + FR – 0.6 · Rs
  2. Component-flux-based approach: NEE = GPP - Rmet = GPP – (Rs + RH + Rs)
  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 CH₄ release fluxes (non-CO₂ 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]

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 y⁻¹) representing the NEE 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 uncertainties, 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 close the carbon balance as the high respiratory soil C fluxes
  The ecosystem was a net carbon sink in the 2nd year of the first 2-year rotation

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