Federal Ministry of Education and Research

ICOS

TERENO TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

UNIVERSITÄT TRIER

RWTH AACHEN UNIVERSITY

JÜLICH Forschungszentrum

From Monoculture to Diversity:

Spontaneous tree growth and carbon dynamics after Coniferous removal at a humid temperate forest site

Marius Schmidt[1], Alexander Graf[1], Anna Hofer[2], Laura Müller[3], Michael Leuchner[3], Gunnar Ketzler[3], Patrizia Ney[4], Clemens Drüe[5], Thomas Pütz[1], Harry Vereecken[1]

[1]Institute of Bio- and Geosciences: Agrosphere (IBG-3), Research Centre Jülich, Jülich, Germany, [2]Water and Emvironmental Engineering, Faculty of Civil Engineering, RWTH Aachen University, Aachen, Germany, [3]Physical Geography and Climatology, Institute of Geography, RWTH Aachen University, Aachen, Germany, [4]Department of Safety and Radiation Protection, Environmental monitoring: Meteorology (S-UM), Research Centre Jülich, Jülich, Germany, [5]Department of Environmental Meteorology, University of Trier, Trier, Germany

Site – Methods – Aim

In September 2013, 8.6 hectares of Norway spruce (*Picea abies* L.) monoculture were cleared in the Eifel National Park, Germany, and left to spontaneous regrowth of the expected deciduous forest matching the site's climate and soil conditions. The area is located within the 38.5 hectare experimental catchment "Wüstebach" (50° 30'N, 6° 19'E, 595 to 630 m a.s.l.), one of the core investigation sites of TERENO (TERrestrial ENvironmental Observatories, https://www.tereno.net). Here, the exchange of energy and matter fluxes between spruce forest and atmosphere were monitored by an ICOS-associated eddy-covariace tower (DE-RuW) since 2010. A second station (DE-RuC, http://www.europe-fluxdata.eu) was installed within the newly established clearcut in 2013. Due to game (boar and deer) pressure, 2 hectares of the clearcut were additionally fenced. CO_2 budget and albedo results from the first four growing periods after the clearcut were presented by Ney et al. in 2019 (doi: 10.1016/j.agrformet. 2019.04.009). Here, we give an update covering the first ten growing periods.

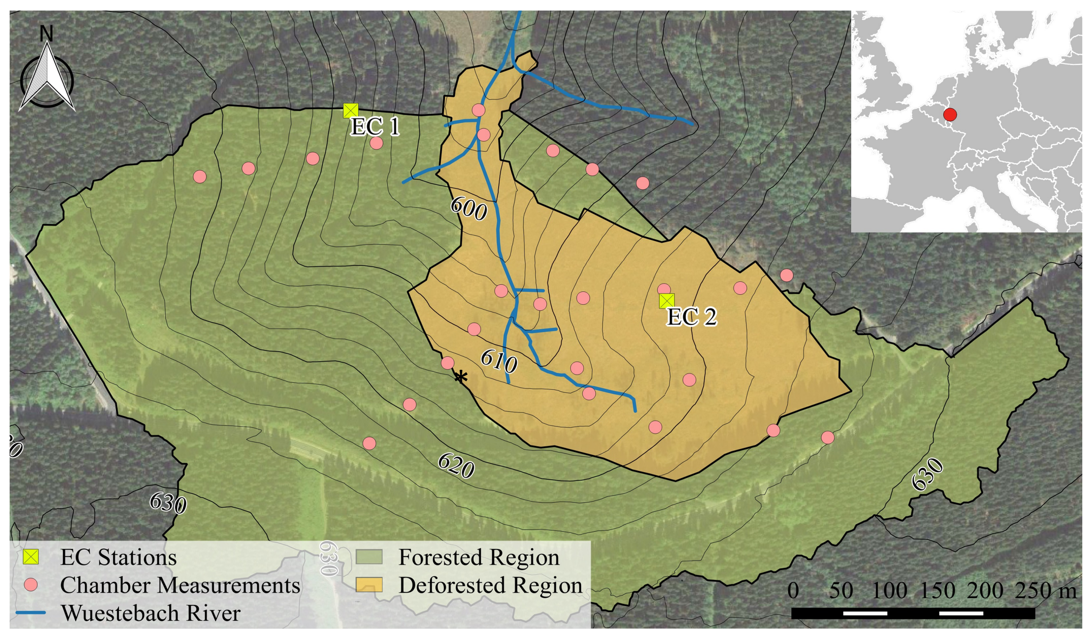

Fig. 1: Map of the Wüstebach catchment with locations of the measurements after partial deforestation in September 2013.

Tree growth

We recorded the species, height and partly the diameter of all spontaneous regrowth trees in the deforested area in a 10 m corridor both inside and outside the fence. Regrowth was strongly dominated by Rowan (*Sorbus aucuparia* L., >1200 trees), a pioneer species propagated through their berries by birds that was present with at least one adult tree already before the deforestation. The next two important species were Spruce and Birch (*Betula pendula* Roth), the seeds of both of which are propagated by wind. Rowan grew approximately linearly and almost twice as fast as spruce, and twice as fast inside the protective fence than outside. Birch and Spruce showed an accelerating growth pattern and were less affected by game grazing.

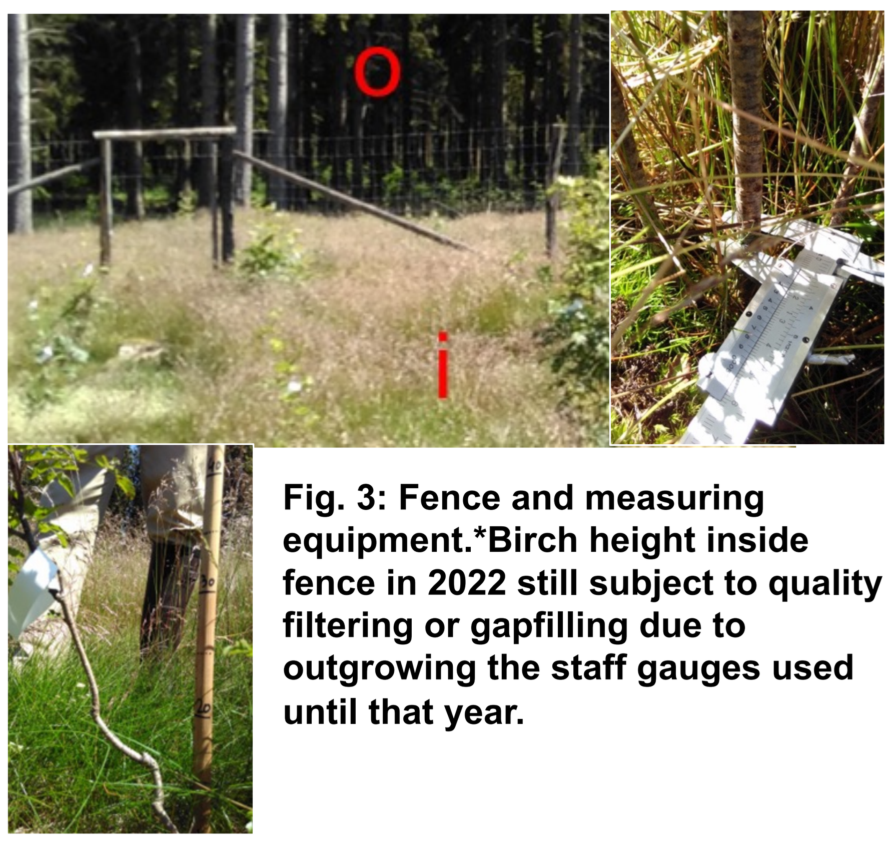

Fig. 3: Fence and measuring equipment.*Birch height inside fence in 2022 still subject to quality filtering or gapfilling due to outgrowing the staff gauges used until that year.

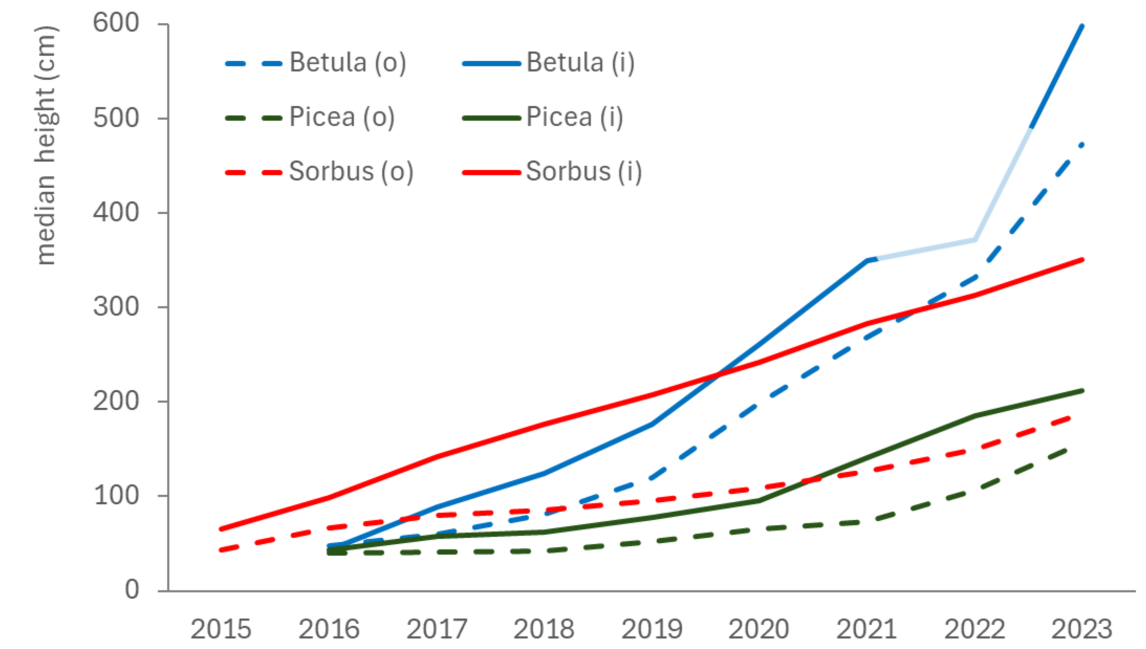

Fig. 2: Height of the 3 most abundant clearcut tree genera after each growth season inside (i) and outside (o) of the fence*.

Carbon fluxes

Regrowing vegetation on the initially almost bare clearcut turned it from a source back into a sink of atmospheric CO_2 eight years after the deforestation. Using the ratio of respiration to GPP and the ratio of the two ecosystem's peak GPP to each other, we attribute the NEP delta between clearcut and forest mostly to a relative (but not absolute) surplus in respiration on the clearcut.

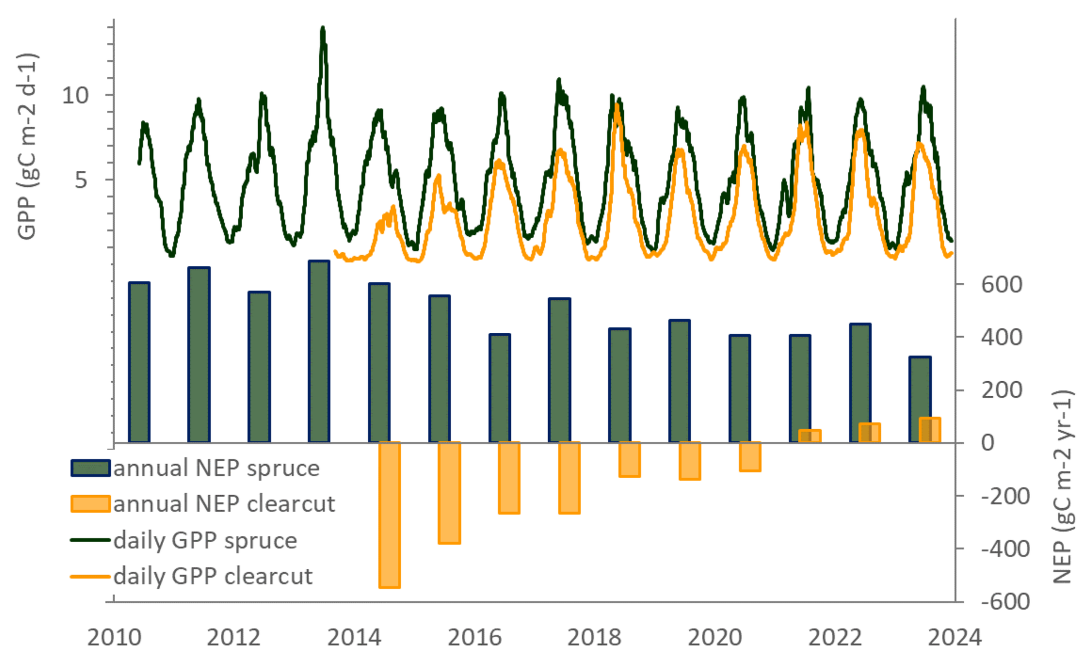

Fig. 4: Annual net ecosystem production NEP (bottom) and 30-day rolling average daily gross primary production GPP.

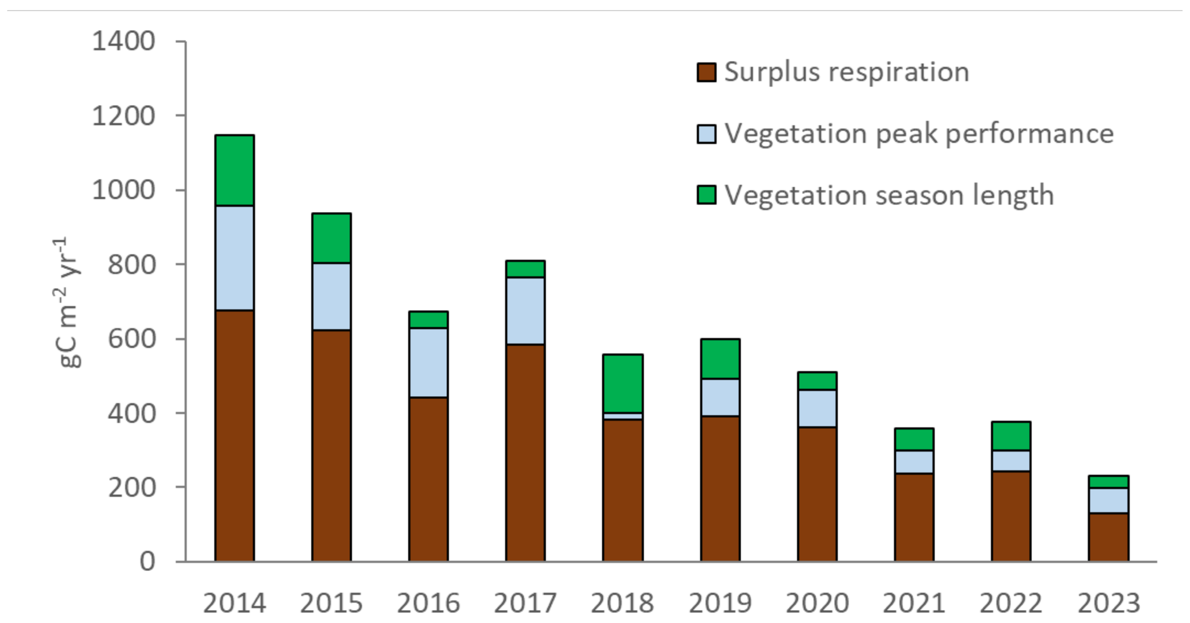

Fig. 5: Attributed contribution of respiration, peak GPP capacity, and growing season length to ∆NEP of Fig. 4.

Synthesis - Outlook

We found mostly positive correlations between the interannual variation of height growth of the most abundant tree species, and carbon fluxes GPP and NEP. All results presented here are preliminary and part of two ongoing student thesis assignments. After additional quality control and gap-filling, we plan to extend the analyses for tree diameter and estimated biomass, soil respiration, and newly installed dendrometers at few selected clearcut trees. While all results shown here are for GPP and TER partitioned according to the daytime method (Lasslop et al. 2010), which were rescaled to match gap-filled NEP in Fig. 5, results from the nighttime method (Reichstein et al. 2005) show a similar general pattern across all tree species and method dependency will be examined more closely in the future.

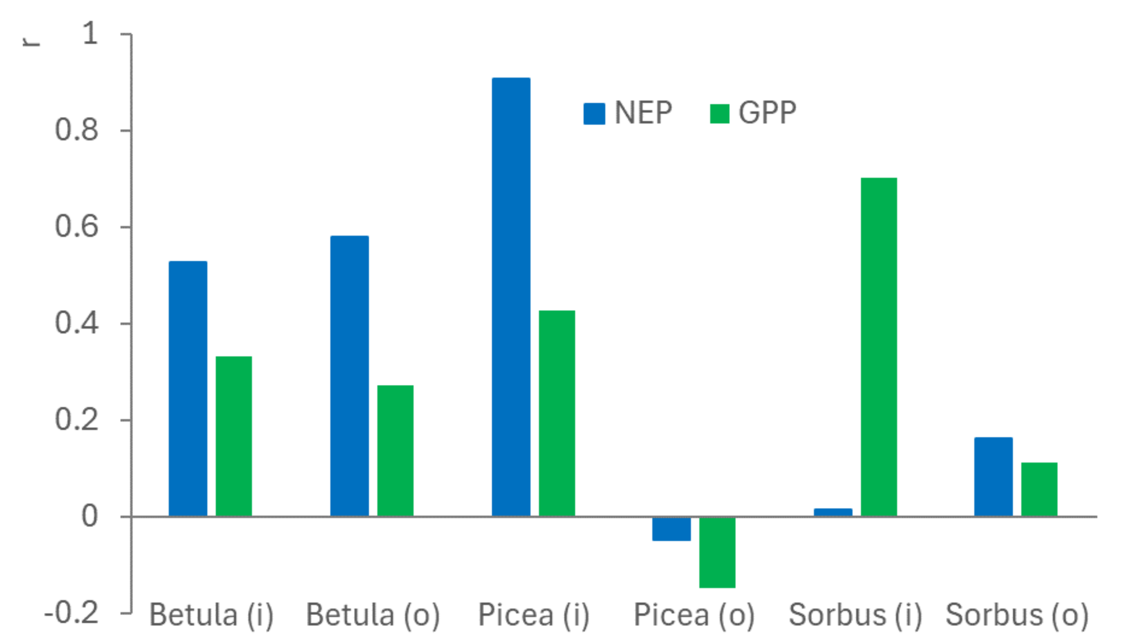

Fig. 6: Correlation coefficients between annual growth and growing season (April – October) carbon flux.

References

Ney et al. 2019, Agric. Forest Meteorol. 274:61, doi:10.1016/j.agrformet. 2019.04.009
Lasslop et al. 2010, Global Change Biol. 16:187, doi:10.1111/j.1365-2486.2009.02041.x
Reichstein et al. 2005, Global Change Biol. 11:1424, doi:10.1111/j.1365-2486.2005.001002.x