Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Carbon dioxide and water vapour fluxes of tropical pasture and afforestation

Sebastian Wolf, Werner Eugster, Nina Buchmann

Institute of Agricultural Sciences, ETH Zurich, Switzerland, ✉ sewolf@ethz.ch

Introduction

Tropical ecosystems play an important role for the global carbon and water cycle. They account for 60% of terrestrial GPP, contain 40% of the carbon stored in the terrestrial biosphere and are a major constituent of the land-atmosphere water exchange. With ongoing deforestation and land-use change, the tropics are increasingly influenced by agro-ecosystems and pastures. It is not yet fully understood how the carbon and water cycles in the tropics respond to land-use change.

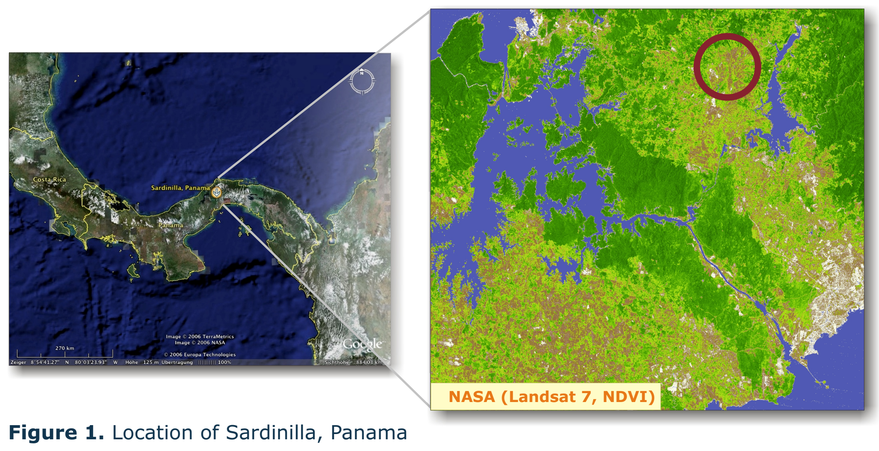

Figure 1. Location of Sardinilla, Panama

Approach

We performed comparative measurements of CO_2 and H_2O vapour fluxes in a tropical C_4 pasture and an adjacent afforestation with native tree species in **Sardinilla**, **Panama** from **2007 to 2009** (Fig. 1), using the **Eddy Covariance method** (Fig. 2):

- 9°19’ N, 79°38’ W, 26.5° C, 2289 mm, Dry season Jan. to April
- Land-use history: logged 1953, 2 years cropland, afterwards pasture, partly afforestation 2001

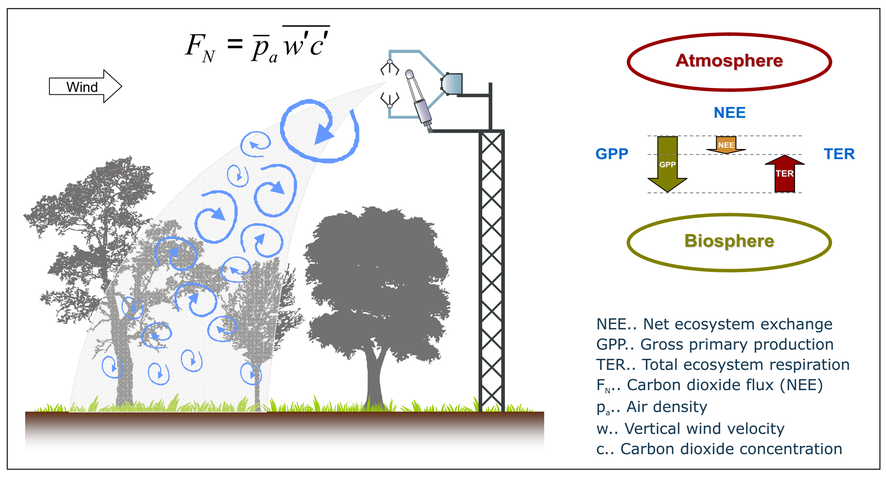

Figure 2. Eddy Covariance method

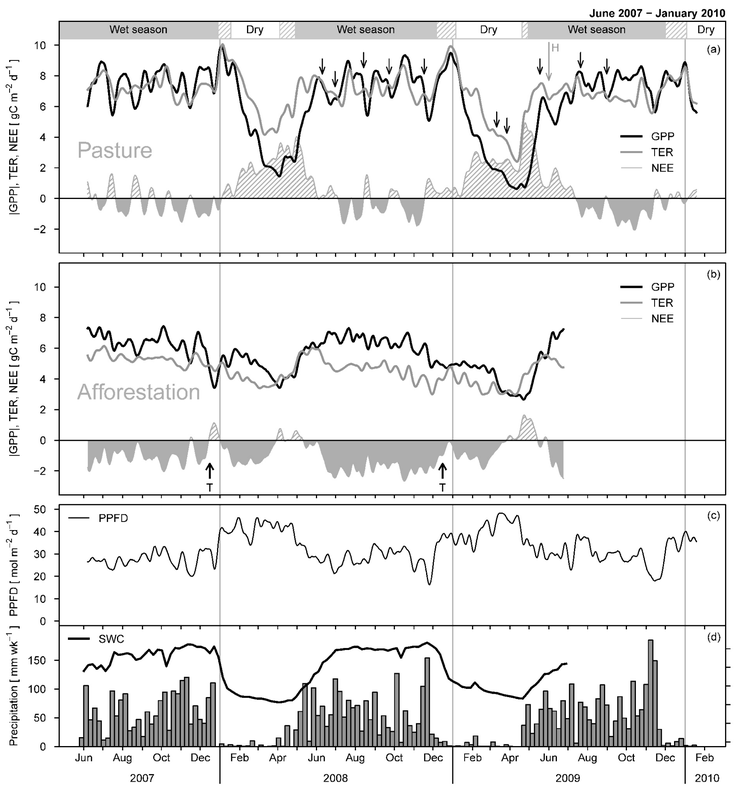

Figure 3. Daily total GPP, TER and NEE

Results

Pronounced seasonal variations in CO_2 and H_2O fluxes (Fig. 3) were closely related to radiation, soil moisture, and plant physiology. The shallow rooting depth of grasses compared to trees resulted in a higher sensitivity of the pasture to seasonal drought.

Substantial carbon sequestration was observed in the afforestation during 2008 (–442 gC m^{-2}; Fig. 4+5). In contrast, the pasture was a strong carbon source in 2008 and 2009 (260 gC m^{-2}), associated with overgrazing and seasonal drought. Daily evapotranspiration (ET) was lower in the pasture (2.6 mm d^{-1}) compared to the afforestation (3.0 mm d^{-1}), however, the differences were relatively small (Fig. 6).

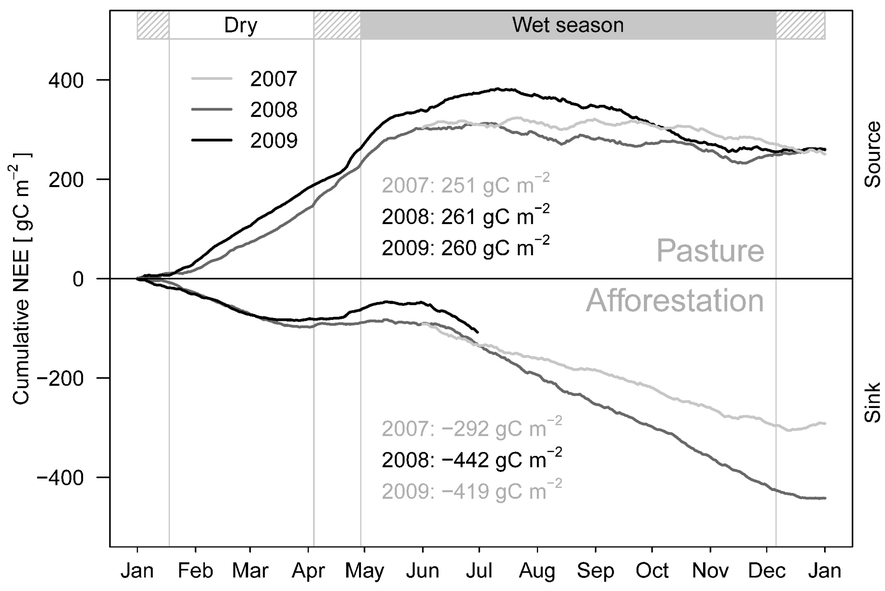

Figure 4. Cumulative annual net ecosystem exchange (NEE) from 2007 to 2009

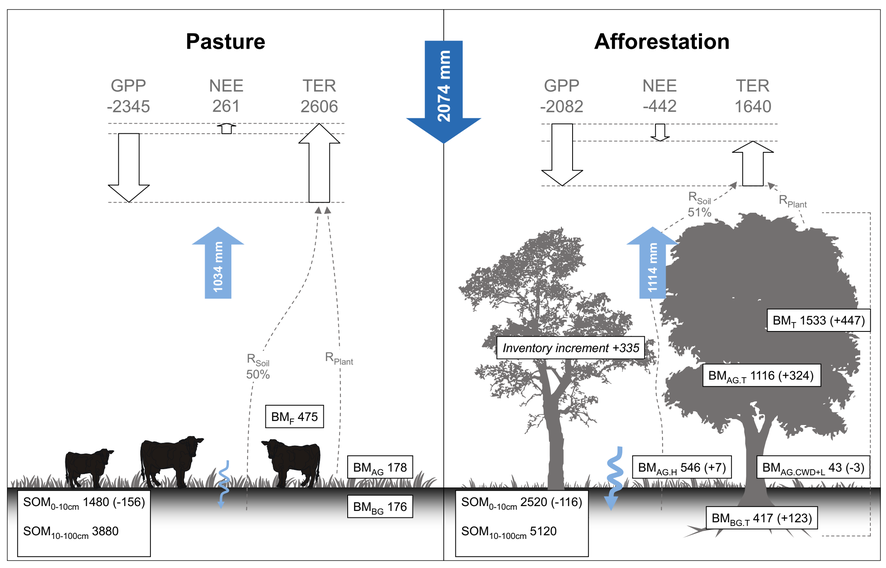

Figure 5. Carbon & water fluxes, and carbon stocks in 2008

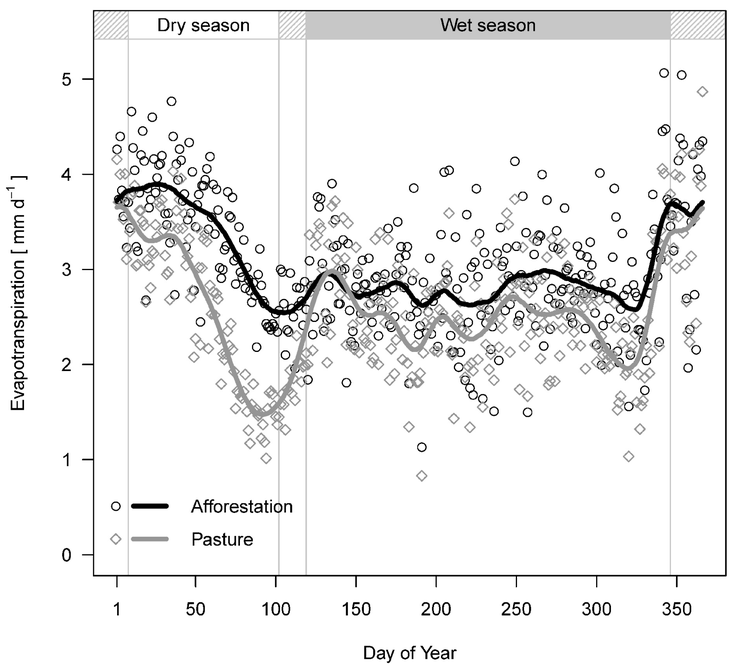

Figure 6. Mean annual course of daily total ET

References

Wolf S, Eugster W, Potvin C, Buchmann N (2011) Strong seasonal variations in net ecosystem CO_2 exchange of a tropical pasture and afforestation in Panama. *Agricultural and Forest Meteorology* 151(8): 1139–1151

Wolf S, Eugster W, Potvin C, Turner BL, Buchmann N (2011) Carbon sequestration potential of tropical pasture compared with afforestation in Panama. *Global Change Biology* 17(9): 2763–2780

Wolf S, Eugster W, Majorek S, Buchmann N (2011, in press) Afforestation of tropical pasture only marginally affects ecosystem-scale evapotranspiration. *Ecosystems* doi:10.1007/s10021-011-9478-y

Conclusions

Tropical **afforestation can sequester large amounts of carbon** while high stocking densities in combination with seasonal drought can result in reduced productivity and **carbon losses from tropical pasture**. The land-use change from pasture to afforestation reduces the seasonal variability of CO_2 and H_2O fluxes and enhances the ecosystem resilience to seasonal drought. **Annual ecosystem-scale ET was only marginally affected**.

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