"Faidherbia-Flux": a collaborative observatory for ecosystem services and GHG balance in a semi-arid agro-silvo-pastoral system (Senegal)

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Tree sap flows & Root Hydraulic Redistributions:

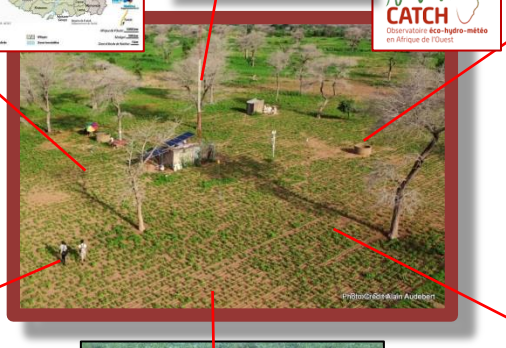
Seven Faidherbia trees (in a range of sizes) were equipped with 65 TTD sap flow systems in the trunk, the tap and lateral roots and 20 pairs of thermocouples for direction and zero flow assessment. Three wells were also equipped with automatic soil humidimeters and tensiometers down to the water table. The goals are to quantify tree transpiration and water status, and to study root hydraulic distributions from the soil water table to the superficial layers. Leaf water potential and girth growth are assessed on the same trees (Do et al., 2022).

Eddy Covariance for CO_2, H_2O and energy balance:

We set up three eddy-covariance towers above (i) the whole mosaic ecosystem (20m), (ii) millet (3m) and (iii) peanut (3m) and monitored energy, CO_2 balance and evapotranspiration since 2018 (Rahimi et al., 2021, Lembrechts et al., 2020 and 2022).

Deep roots turnover and decomposition:

Six deep (8m) pits were dug down to the water table and equipped with automatic root scanners and minirhizotrons to monitor the tree and crop root growth, according to soil depth and distance to trees. In addition, crop and tree roots decomposition was studied with litterbags in pits (Siegwart et al., 2022).



Drone (UAV) & yield estimation:

We scanned the plots with drone flights using very high resolution visible, multispectral and thermal IR bands at five dates per year during 5 years. Drone images confirm higher yield below or close to Faidherbia trees, with at least 30m of influence. A simple model based on NDVI allowed to draw a plot yield map and to estimate the plot yield (Roupsard et al., 2020). In parallel, remote sensing is applied at the landscape scale (Leroux et al., 2020, 2022).

Soil greenhouse gas (GHG) balance:

Eight automatic gas chambers were installed under and far from the trees and connected to a Picarro 5 gas analyser (CO_2, H_2O, N_2O, CH_4, NH_3). Soil respiration and plant photosynthesis are monitored all year long and GHG balances are quantified (Duthoit et al., 2020). The same display was replicated in a savanna in the Ferlo.

Infiltration, vegetation cover and ecohydrology:

20 PVC tubes of six m depth have been set up into the soil along a toposequence of 250 m according to the micro-topography and the Faidherbia: 10 piezometers follow hourly the static level of the phreatic aquifer (range -5 to -3m) and 10 tubes for the soil humidity survey are scanned by a TDR. The soil infiltration is measured with the automatic BEST method. Soil water balance is modelled with Hydrus 1-D (Faye et al., 2020; Diongue et al., 2022).

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