EGU24-19078, updated on 12 Feb 2025
https://doi.org/10.5194/egusphere-egu24-19078
EGU General Assembly 2024

Carbon Sequestration and Water Use Efficiency on almond orchards. Towards a remote sensing-based approach to monitor GPP

Clara Gabaldón-Leal[1], **Álvaro Sánchez-Virosta**[1], Carolina Doña[1], José González-Piqueras[1], Juan Manuel Sánchez[1], and Ramón López-Urrea[2]
[1]Institute for Regional Development (IDR), University of Castilla-La Mancha, Remote Sensing and GIS group, Spain (cgabaldonleal@gmail.com)
[2]Desertification Research Center (CIDE), CSIC-UV-GVA, Valencia (Spain)

Climate change projections indicate a significant increase in greenhouse gas (GHG) emissions, leading to elevated temperatures, extreme weather events, and water scarcity, particularly in regions like southern Europe. Agriculture, forestry, and other land use activities contribute to 22% of these emissions, but they also offer the potential to act as carbon sinks, supporting the transition to a climate-neutral economy as outlined in the Paris Agreement. The concept of carbon offset involves compensating for emissions by reducing, avoiding, or sequestering an equivalent amount of CO_2. Practices such as carbon credits could provide new economic incentives through participation in the voluntary carbon market.

Hence, it is crucial to develop reliable methods to quantify carbon dynamics in terrestrial ecosystems, focusing on the relationship between carbon energy parameters; Net Ecosystem Exchange (NEE), Ecosystem Respiration, and Gross Primary Productivity (GPP). In Spain, the rise in irrigated almond orchards, particularly in the La Mancha region, highlights the need to understand ecosystem Water Use Efficiency (WUE) as a crucial parameter for sustainable crop management. The study employs Eddy Covariance (EC) flux towers to measure NEE, ET, and GPP, providing valuable insights into WUE and contributing to carbon cycle assessments and climate change mitigation strategies.

This study spanned six almond growing seasons (2017-2022) in two different drip-irrigated almond orchards locations in Albacete (SE Spain). These orchards, meeting minimum fetch requirements, exhibited a notable carbon-fixing capacity, comparable to other natural and agroecosystems. Seasonal variability and environmental influences were evident throughout the six-year study. In this study, we also modelled WUE as a function of remote sensing vegetation indices, such as the Normalized Difference Vegetation Index (NDVI) and meteorological data.

Seasonal variability, age and density of almond orchards significantly influence on the observed GPP and NEE. Almond orchards captured more CO_2 than that released between April and October. The maximum monthly GPP values observed by EC was 263.7 g C m^{-2}. Besides, the combination

NDVI and ET proved effective in estimating GPP, with a regression coefficient (R^2) of 0.78. Modelled WUE, incorporating 'NDVI, potential evapotranspiration (ET_o), and air temperature (Tair),' strikes an optimal balance between explanatory capacity and simplicity. While showing promise with determination coefficients of 0.88 and 0.86, caution is advised due to the limited sample size, necessitating future further validation with larger datasets. Nevertheless, this approach could be a valuable tool for stakeholders addressing efficient water use challenges in agriculture. This study highlights the importance of quantifying carbon uptake and ecosystem water use efficiency by almond orchards as a strategy for mitigating climate change.