ESTIMATION OF EVAPOTRANSPIRATION USING SEBAL ALGORITHM AND LANDSAT-8 DATA - A CASE STUDY IN A MEDITERRANEAN PISTACHIO ORCHARD

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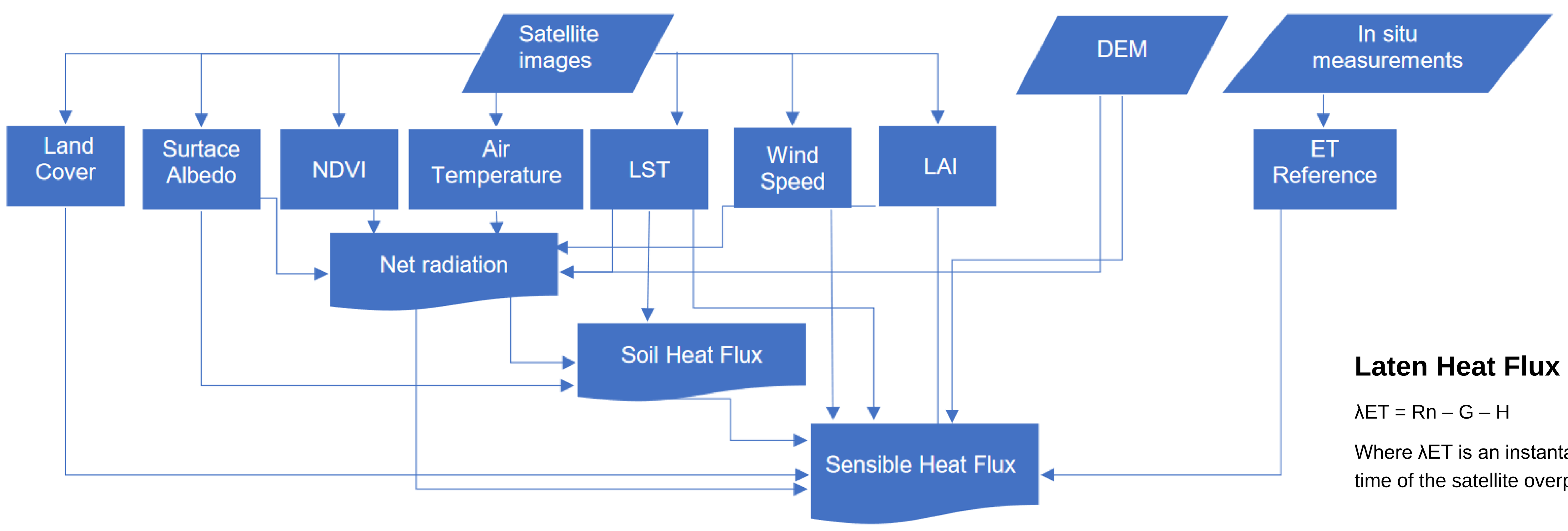
1. Abstract:

Evapotranspiration (ET) is one of the key variables in hydrological cycle and surface energy balance (SEB), especially for irrigated agricultural regions. According to climate models, global temperature is expected to rise which leads to changes in precipitation and ET that respectively add water and remove it from the water cycle. Thus, global warming will change the balance between water supply and water demand by shifting energy and water balance and eventually bring on water and food security. Although numerous methods have been developed to quantify ET as a critical prerequisite for water management and increasing water consumption efficiency, estimating ET accurately is still challenging. Measuring actual ET or directly determine ET for a specific point and time and it can be expensive and time consuming. Hence, ET estimation models by satellite data are used to overcome the limitations. Surface Energy Balance Algorithm for Land (SEBAL) is a one-source energy balance model, and it is one of widely used models for estimating ET in large farms. However, it has different efficiency depending on the type of crops and environmental conditions.

Objective: Evaluating the daily ET accuracy obtained by **SEBAL Algorithm** using six **Landsat 8 Operational Land Imager (OLI) images** in comparison with in-situ flux tower measurements in a **Mediterranean young pistachio tree orchard** in Lleida (North-East of the Iberian Peninsula) from March to December 2022.

2. Google Earth Engine-SEBAL model application



Laten Heat Flux (λET):

λET = Rn – G – H

Where λET is an instantaneous value for the time of the satellite overpass (W m^{-2})

Instantaneous ET:

$$ET_{inst} = 3600\frac{\lambda ET}{\lambda}$$

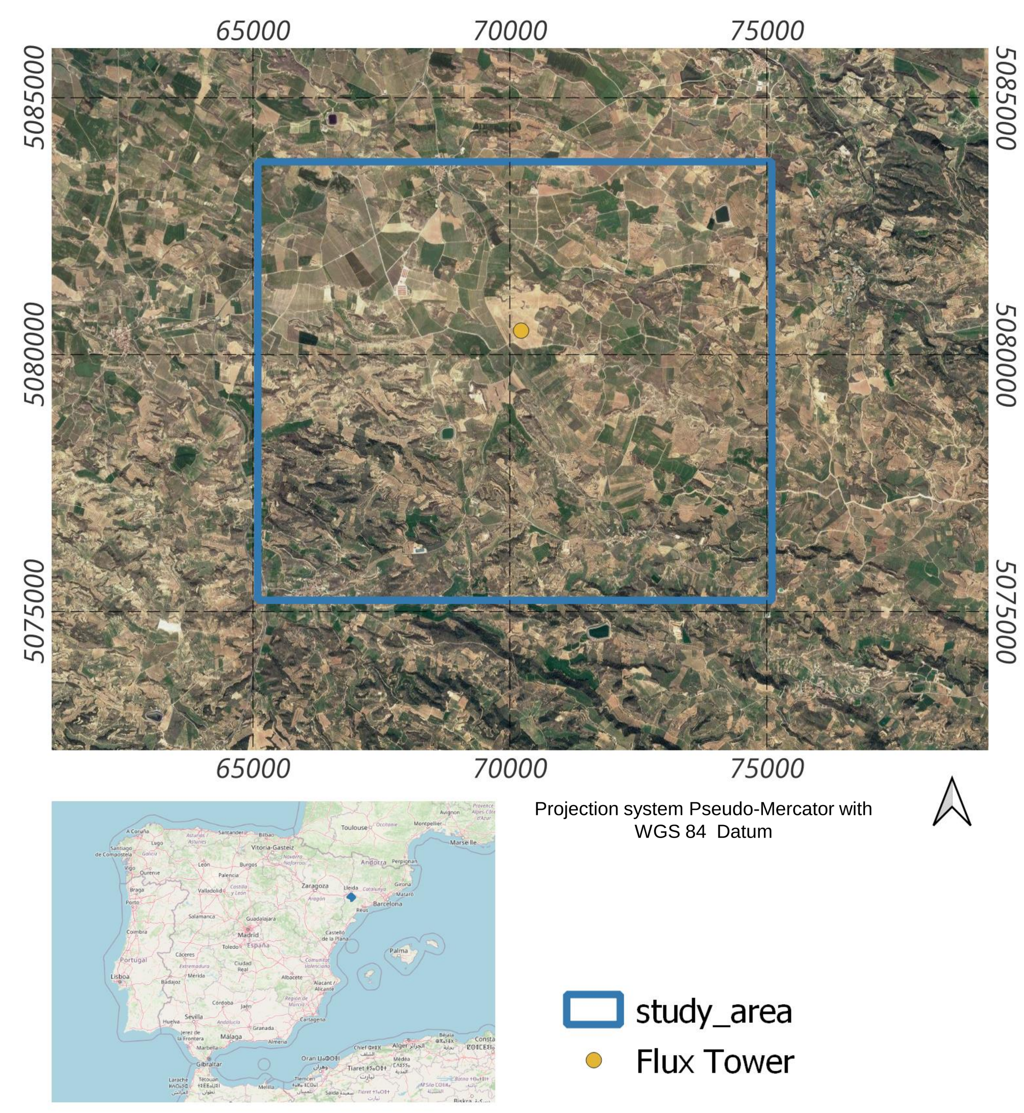
Where ET_{inst} is the instantaneous ET (mm hr^{-1}), 3600 is the time conversion from seconds to hours, and λ is the laten heat of vaporization.

Daily ET:

$$ET_{d-X} = \beta + \frac{1}{\lambda} + \frac{\lambda ET_t}{X_t}$$

where λET_t is the instantaneous latent heat flux at the time-of-day t, λ is the latent heat of vaporization, Xt and Xd are the values of solar radiation at the "acquisition" time t and the daytime total, respectively, and β is a correction to account for potential systematic biases in the upscaling method (Cammalleri et al., 2014).

3. Study area and data



Data:

•**Remote sensing data➔** Landsat 8 top-of-atmosphere (TOA) reflectance (Collection 2, Tier 1), Landsat 8 surface reflectance (Level 2, Collection 2, Tier 1) ERA5-Land, Dynamic World V1, SRTM Digital Elevation

•**In-situ data➔** from the flux towers.

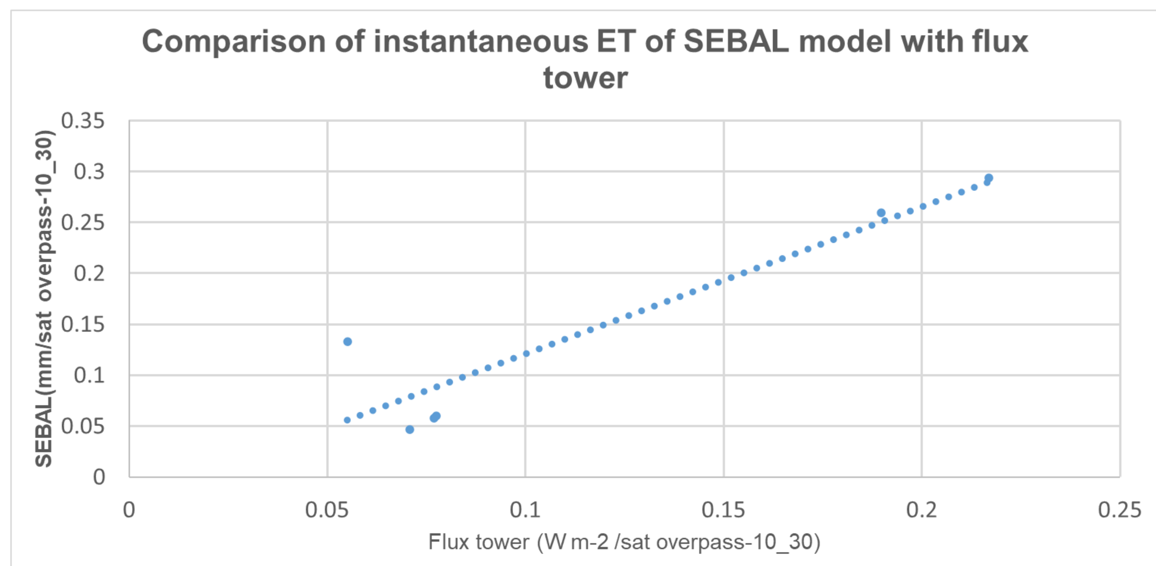
Flux tower was installed in a young pistachio tree orchard in April, 2022. The Flux tower measures CO2 and water fluxes as well as standard meteorological data (wind speed and direction, solar radiation, net radiation surface temperature, PAR, soil heat flux, among others) at 20Hz, 1 minute and 5 timepsteps.

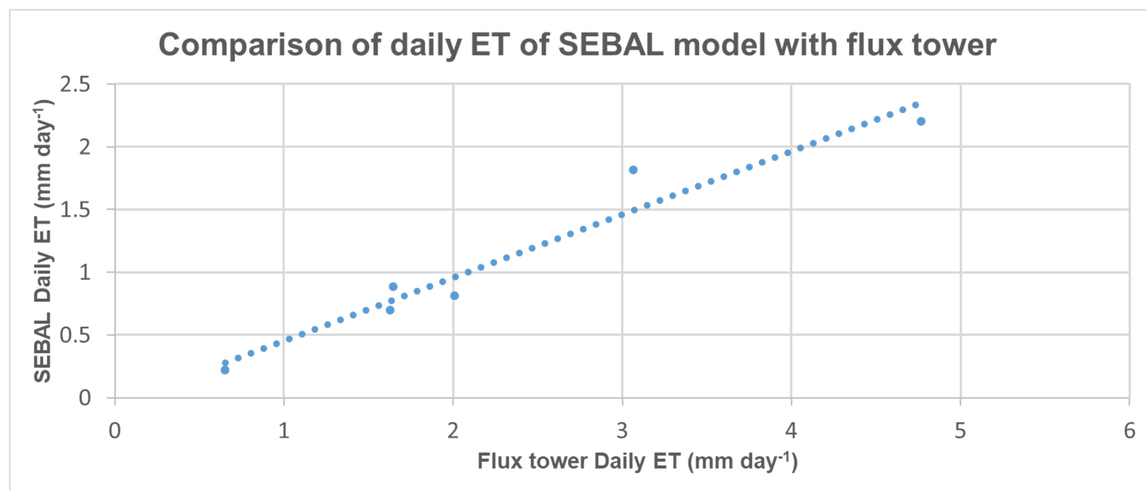
Sites and Periods:

Site: Mediterranean young pistachio tree orchard in Lleida (North-East of the Iberian Peninsula)

Periods: from April to December, 2022

4. Results





	instantaneous ET (mm)	daily ET (mm)
R²	0.85	0.94
RMSE	0.055	1.36

5. Conclusions and future research

Estimation of crop ET and also the crop water requirements are essential for improving water- use efficiency in agriculture. The SEBAL algorithm efficiency needs to be evaluated in different climate types and crops. In this study, the accuracy of the SEBAL algorithm for Mediterranean young pistachio tree orchard in Lleida obtained using six Landsat 8 Operational Land Imager (OLI) images was compared with in-situ flux tower. The results showed that the R^2 and RMSE in the estimation of daily ET for pistachio plant at about 0.94 mm hour^{-1} and 1.36 mm day^{-1}, respectively, and the R^2 and RMSE for instantaneous ET are 0.85, 0.055, respectively. Overall, the results proved that the SEBAL algorithm can be an appropriate method for estimating the pistachio ET.

Further efforts recommend focusing on evaluating SEBAL model for different crop types and also in farm garden lands or horticulture and forestry areas.

References

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