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Use of Remote Sensing techniques to assess Actual Crop Water consumption

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Introduction

Water management is an important issue in the Middle east and North africa region, where precipitation is scarce and the irrigated agriculture is a major consumer of water.

Water productivity and conservation are vital in various crop production systems. The energy balance modeling can efficiently offer specific measurements of the water consumed across a large region or single field.

Material and Method

The model used is based on SEBAL (Source Energy BALance model, Bastiaanssen 1998). The Actual Evapotranspiration is estimated as a Residual of the surface energy equation : LE=Rn−G−H (1) where

LE is latent energy consumed by ET(w/m2);

Rn is net Radiation (W/m2);

G is sensible heat flux conducted into the soil (W/m2)

H is the sensible heat flux conducted into the air.

To calculate crops Evapotranspiration we use 4 sources of data:

1. A raw Landsat 7/8 satellite image
2. A gridded high resolution climate reanalysis data (Temperature, relative humidity and wind)
3. Downward surface solar radiation from MSG satellite
4. Digital Elevation Model SRTM at 90 m resolution

The total evapotranspiration is estimated from equation (1) represents ET at the time of satellite image acquisition. The instantaneous Eta is extrapolated to daily and longer periods using average weather conditions (from the high resolution reanalysis), evaporative fraction and net available energy (Rn – G). The relations used to estimate the evaporative fraction and daily ET are shown in Equations 2 and 3.

EF = LE / (Rn-G) (2)

ETa24 = 86400x10 3 /λ.ρ (3) where ρ is the density of water and λ is the latent heat of vaporization of water

Results

The model was applied on UAE to assess the water consumed by the different crops at the national level (Figure 1)

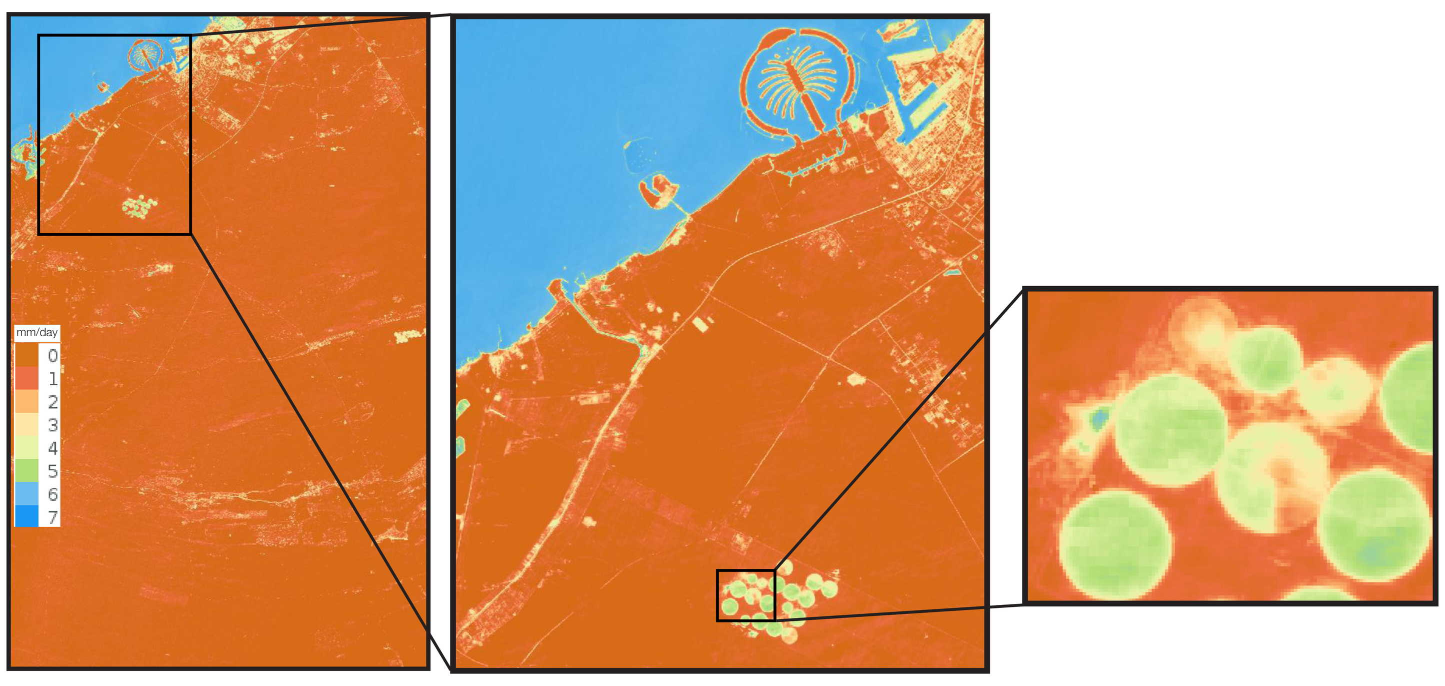
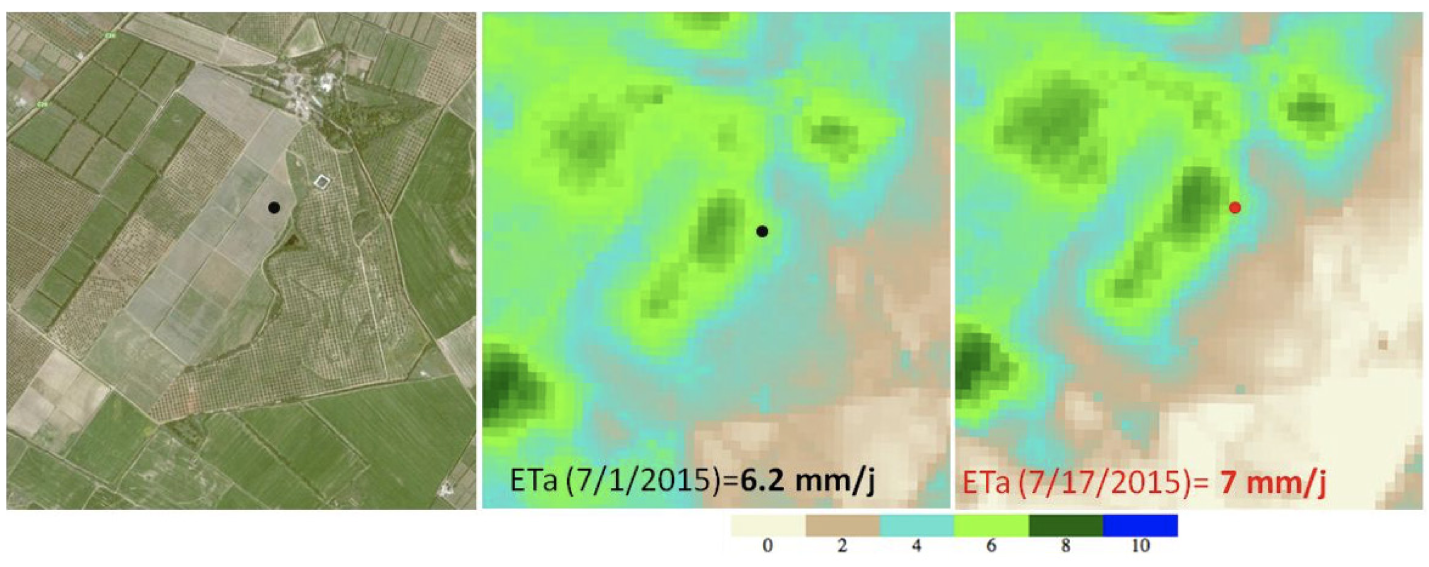


Figure 1: Actual Evapotranspiration in UAE using SEBAL model and 30m Landsat 8 data driven by 2km climate reanalysis of the Weather Research and Forecasting model WRF for the 2m air temperature and relative humidity, Surface solar radiation and the 10m wind speed. The Actual ET are calculated here in mm/day.

At the farm level, SEBAL Actual ET was compared to the Actual Transpiration of the plants were observed using Sapflow meters. Following is an example of application to a grape field in Tunisia (Figure 2).

A. Farm level variability



B. Plot level variability

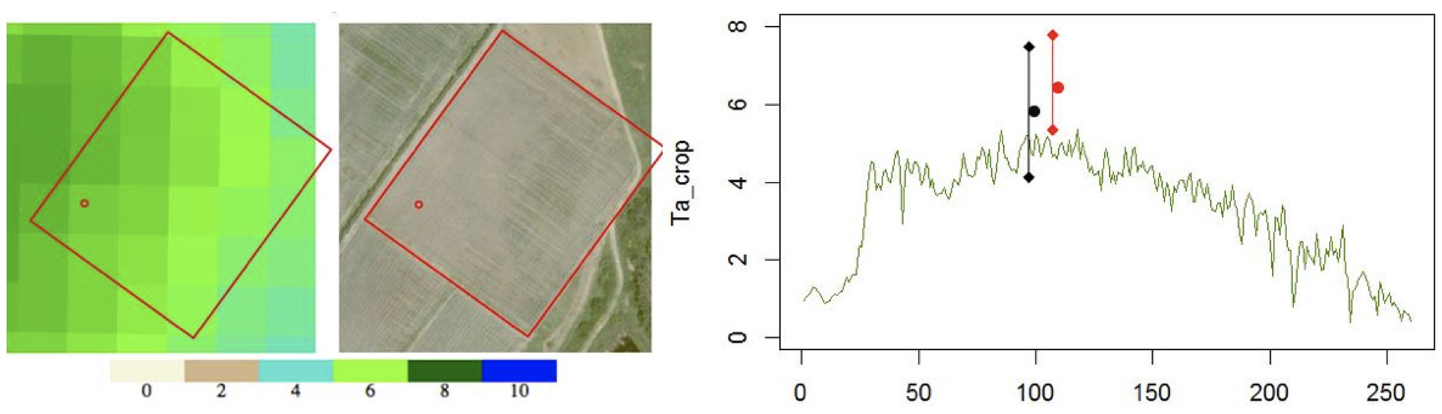


Figure 2: Actual evapotranspiration of grape canopy using surface energy balance model at the farm level (A) and at the plot level (B). Crop water consumptions estimated from Landsat 8 images (30 m spatial resolution) are compared to plant net transpirations measured using HRM sapflow meter (Ta_crop, mm/d). Black and red dots, and standard deviation bars correspond to July 1st and July 17th measurements, respectively.

Our preliminary results showed high correlation between the modeled and the observed Transpiration. For scaling up this methodology, we are gathering different observations from flux tower instruments to compare the actual ET modeled by SEBAL and the observations.

Conclusion:

The satellite data combined with modeling techniques can be used in ecosystem process models to compute water use and irrigation requirements. The modeling system we suggest can estimate spatially varying water requirements within a given field or at a national Level. The availability of thermal infrared imagery from landsat enables the surface energy balance to be applied at the field scale, which provide a valuable tool to improve understanding of crop evapotranspiration and enables improved management of scare freshwater supplies at scales ranging from individual fields to entire basins.

At the field scale, SEBAL can assist growers in selecting the optimum timing and amount of water to apply for irrigation in order to conserve water through improved irrigation efficiency.

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