APPLICATION OF SATELLITE-BASED METHODS FOR ESTIMATING EVAPOTRANSPIRATION IN THESSALIA PLAIN, GREECE

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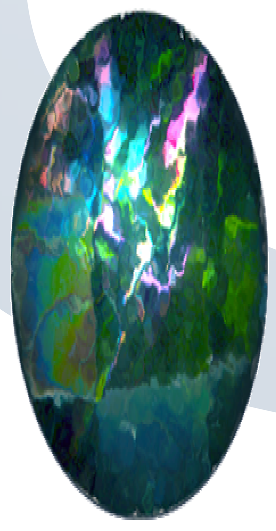
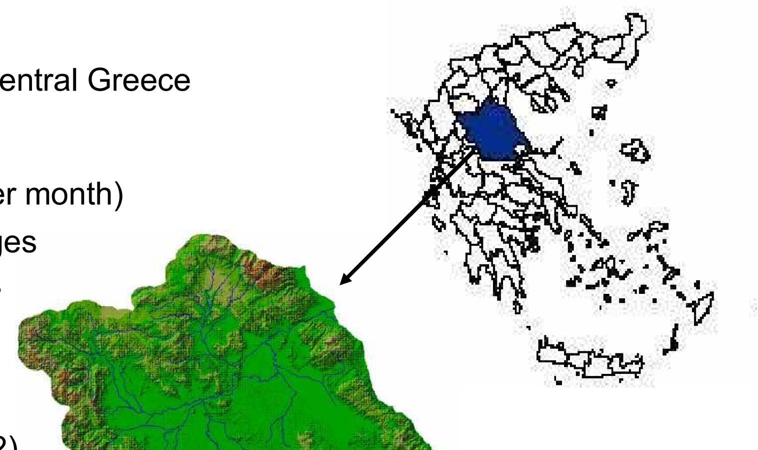


1. Abstract

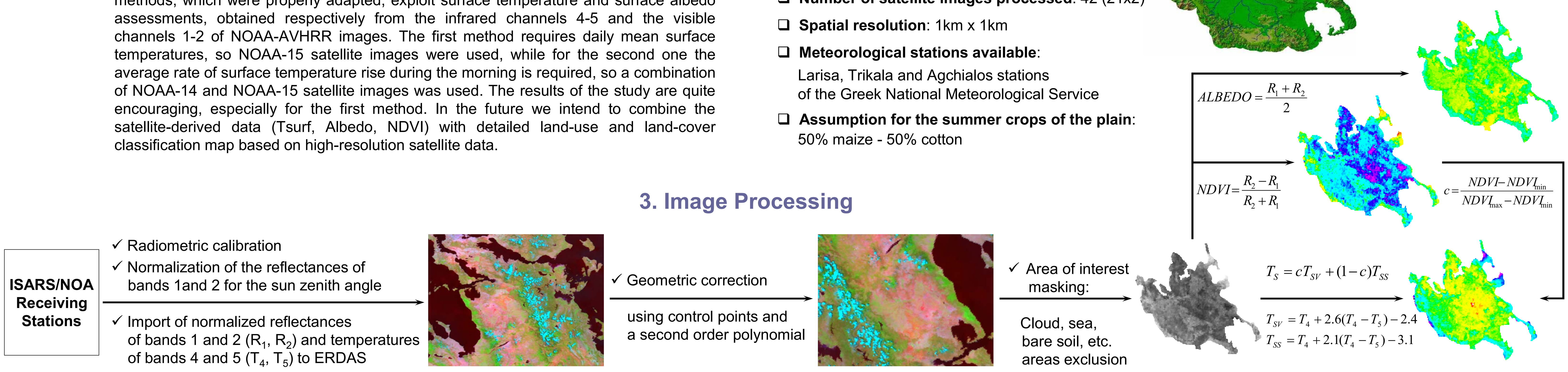
Estimation of evapotranspiration using both meteorological ground-based measurements and satellite-derived information has been widely studied during the last few decades and various methods have been developed for this purpose. In our application, we estimated the regional daily actual evapotranspiration during the 2001 summer season (June-August) over Thessalia plain in Pinios river basin. It is an area of intensive agricultural activity. Satellite data were accounted for those days that were available. For this case study, two different methods were applied and compared to the conventional and well-known FAO Penman-Monteith method. Satellite data, adequately processed (radiometric calibration, sun illumination conditions correction and geometric correction), were used in conjunction with ground data from the three nearest meteorological stations. The methods, which were properly adapted, exploit surface temperature and surface albedo assessments, obtained respectively from the infrared channels 4-5 and the visible channels 1-2 of NOAA-AVHRR images. The first method requires daily mean surface temperatures, so NOAA-15 satellite images were used, while for the second one the average rate of surface temperature rise during the morning is required, so a combination of NOAA-14 and NOAA-15 satellite images was used. The results of the study are quite encouraging, especially for the first method. In the future we intend to combine the satellite-derived data (Tsurf, Albedo, NDVI) with detailed land-use and land-cover classification map based on high-resolution satellite data.

2. Case Study

- **Study area**: Pinios River basin, Thessalia plain, Central Greece
- **Data period**: 2001 summer season (June-August)
- **Days for which ET was estimated**: 21 (7 days per month)
  The satellite data used make up a data set of images uniformly distributed in the time frame of the study.
- **Satellites used:** NOAA-AVHRR 14 and 15
- **Receiving stations**: ISARS/NOAA
- **Number of satellite images processed**: 42 (21x2)
- **Spatial resolution**: 1km x 1km
- **Meteorological stations available**:
  Larisa, Trikala and Agchialos stations
  of the Greek National Meteorological Service
- **Assumption for the summer crops of the plain**:
  50% maize - 50% cotton

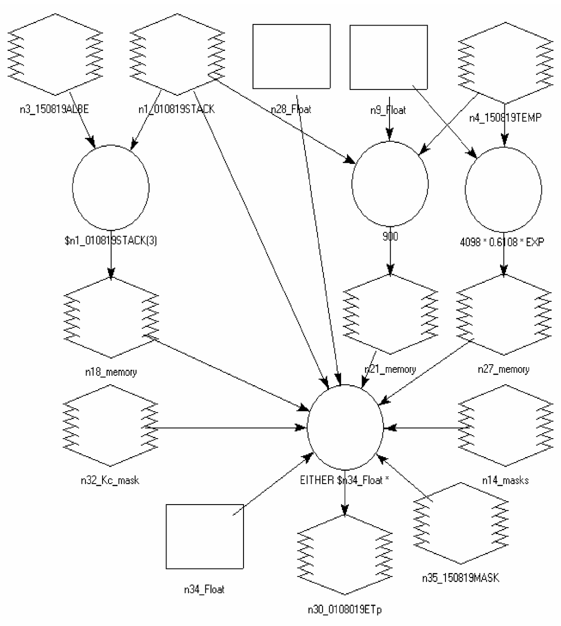


3. Image Processing



4. Methodologies

4.1 FAO Penman-Monteith Method

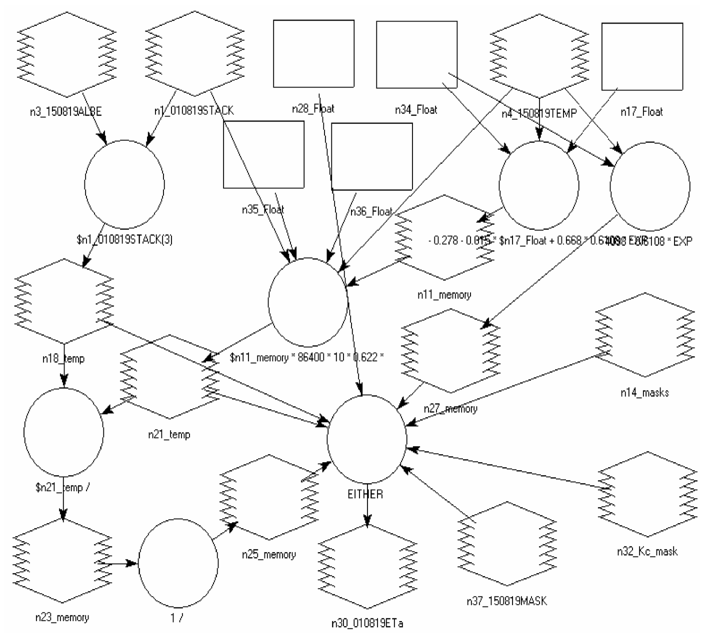


$$ET_p = K_c \frac{0.408\Delta R_n + \gamma f(u)(e_s - e_a)}{\Delta + \gamma(1 + 0{,}34 u_2)}$$

$$f(u) = \frac{900}{T + 273.15} u_2$$

where:
- K_c crop coefficient
- Δ slope vapor pressure curve
- R_n net radiation
- γ psychometric constant
- f(u) wind function
- u_2 wind speed at 2m height
- e_s-e_a saturation vapor pressure deficit
- T mean daily air temperature at 2m height

4.2 Granger Method



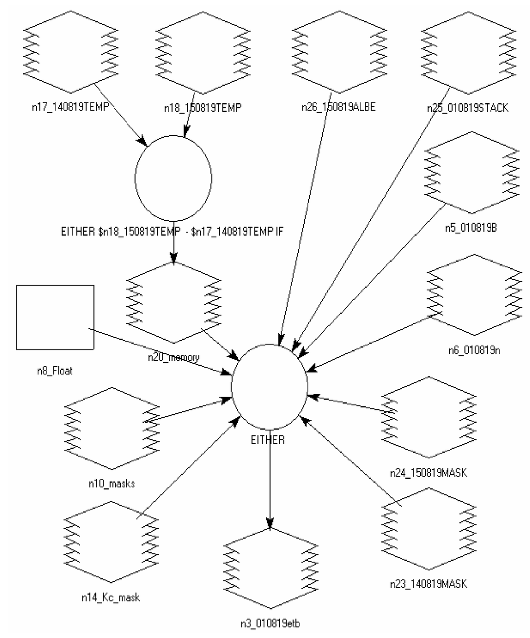
$$ET_a = \frac{0.408\Delta R_n + \gamma f(u)(e_s - e_a)}{\Delta + \frac{\gamma}{G}}$$

$$f(u) = 0.622 \frac{\rho_\alpha}{\rho_w} P C_{at}$$

$$G = 1/(1 + 0.028\exp(8.045D))$$

where (additionally):
- G relative evaporation (ratio of actual to potential evaporation)
- ρ_α,ρ_w densities of air and water
- P atmospheric pressure
- C_{at} the atmospheric conductance (parameter related to the wind speed and the vegetation height)

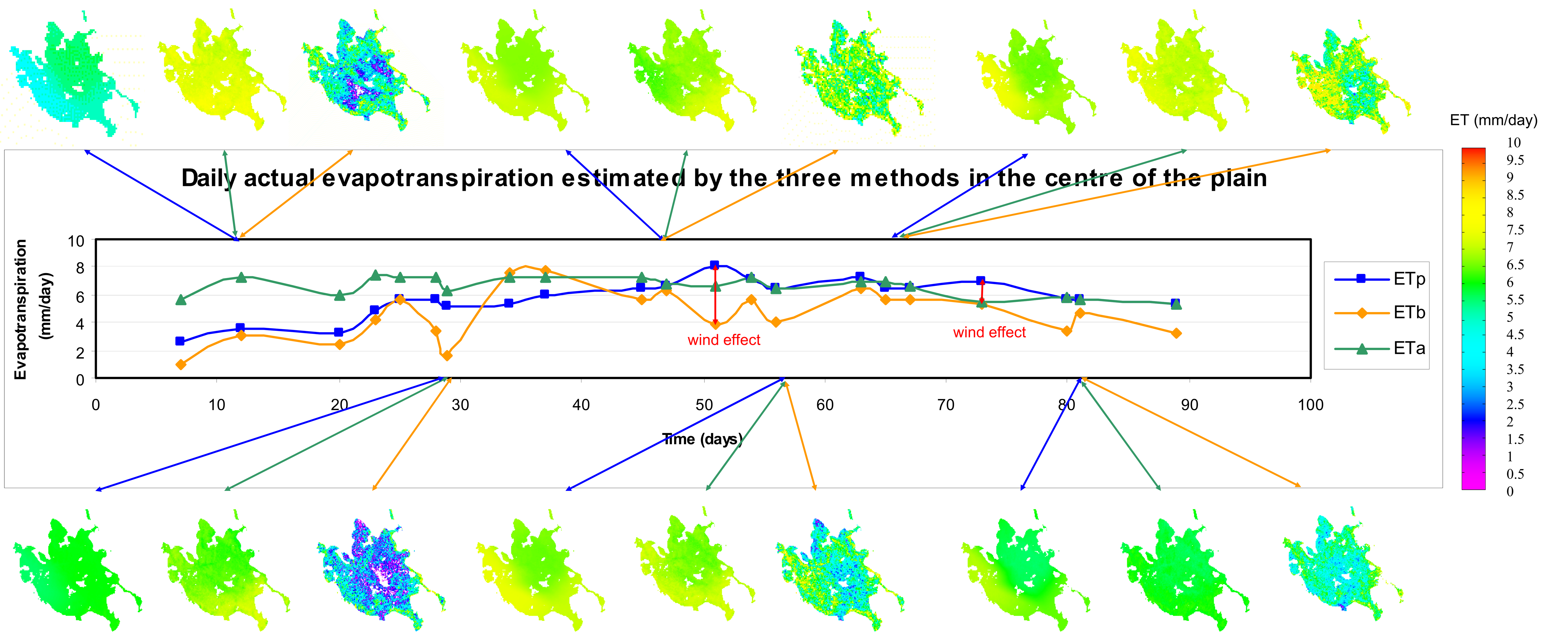
4.3 Carlson and Buffum Method



$$ET_b = R_n - B\left(\frac{\Delta T}{\Delta t}\right)^n$$

where (additionally):
- ΔT/Δt average rate of temperature rise during the morning (e.g. between 8 and 10 local time)
- B, n constants depending on surface roughness, wind speed, reference height and vegetation.

5. Results



6. Conclusions

Granger Method

- This method is generally keeping the same trend with the FAO Penman-Monteith method, apart from the days with relative high wind speed values, where an inverse gradient is observed.
- It overestimates the evapotranspiration during the development of the crop, but this is systematic and decreasing as the crop grows.
- After this first stage, the evapotranspiration is estimated with very high accuracy giving values similar to FAO Penman-Monteith estimates, although the model's response to the influence of the wind factor remains inverse.

Carlson and Buffum Method

- This method is obviously less stable and reliable since it depends mainly on the temperature rise during the morning.
- On the other hand it is much simpler and requires less input data.
- It often follows the trend of FAO Penman-Monteith method and usually gives a good estimation of the evapotranspiration during the development of the crop.
- However it has a significant number of outliers.

7. Contact Information

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8. References

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