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Evapotranspiration estimation using Sen-ET SNAP Plugin for study area in Bulgaria

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Abstract

Accurately measuring the amount of water (e.g., evapotranspiration—ET) and energy (e.g., of latent and sensible heat) that are exchanged at the Earth's surface is crucial for various applications in fields such as meteorology, climatology, hydrology, and agronomy. Having reliable estimations of these fluxes, particularly of ET, is considered essential for effective natural resource management. The distributed ET models are important tool for policy planning and decision-making in terms of calculating the water productivity in agricultural crops. However, the model calibration and validation present a crucial challenging task. The Sentinel-2 and Sentinel-3 satellite constellation contains most of the spatial, temporal and spectral characteristics required for accurate, field-scale actual evapotranspiration (ET) estimation. The one remaining major challenge is the spatial scale mismatch between the thermal-infrared observations acquired by the Sentinel-3 satellites at around 1 km resolution and the multispectral shortwave observations acquired by the Sentinel-2 satellite at around 20 m resolution. The Sen-ET SNAP Plugin bridges this gap by improving the spatial resolution of the thermal images. We have implemented the model for Purvomaj municipality study area in Bulgaria.

Introduction

This publication comprises some results from Dragon-5 project “ID.57160:Monitoring Water Productivity In Crop Production Areas From Food Security Perspectives”.

Accurate and spatially distributed estimates of evapotranspiration (ET) are increasingly important with the growing global population and economy putting strain on fresh water resources and food supplies. The utility of ET maps has been demonstrated in a variety of applications, ranging from water rights management, through drought and food shortage monitoring, to more efficient use of land and water in agriculture and crop stress assessment.

The aim of this study is to predict and map the ET in Parvomay municipality (Fig. 1), located in the Upper Thracian Lowland, utilizing satellite data from Sentinel-2 and Sentinel 3. This ET map will be used in further steps in the Dragon-5 project, as input data for calculation and analysis of the water productivity on a regional level. For that purpose we have utilized the SenET plugin that has been developed by ESA. The SenET plugin is working with SNAP platform. We have briefly compared the results achieved from SenET plugin with Landsat L3 Provisional Actual Evapotranspiration.

Figure 1. Parvomay Municipality, the study area in Bulgaria, is located in the Upper Thracian Lowland, in the southern part of the country. The area is dominated by winter wheat, maize and sunflower

Methods and Materials

The Sen-ET plugin relies on data sources from Copernicus. Its main inputs are derived from optical data collected by the Sentinel-2 MSI sensor, thermal data obtained from the Sentinel-3 SLSTR sensor, and meteorological data from the ERA-5 dataset. The Sentinel-2 MSI optical data is used to characterize the biophysical state of the land surface at 20 m resolution. The MSI data is also be used to sharpen the lower resolution SLSTR data (Fig. 2). Since the land surface temperature (LST) is acquired at around 1 km spatial resolution, it is sharpened to 20 m using another Sen-ET operator before being used within the evapotranspiration (ET) model. The land-surface energy fluxes are always modelled at the time of S3 overpass. This is because changes in vegetation are not as dynamic as the changes in LST. The meteorological data is essential for establishing the atmospheric conditions that drive factors like air temperature and modulate elements such as wind speed, affecting the energy exchange between the surface and the atmosphere. This meteorological information is sourced from fields within the ECMWF ERA-5 reanalysis dataset. The main output of the Sen-ET plugin are the four modelled instantaneous land-surface energy fluxes: sensible heat flux, latent heat flux, ground heat flux and net radiation. The fluxes represent conditions at the time of Sentinel-3 overpass and are in Wm-2. The latent heat flux is also converted to daily ET, in mm/day, representing the total daily ET on the day of Sentinel-3 overpass (Fig. 3). We have briefly compared the results achieved from SenET plugin with Landsat L3 Provisional Actual Evapotranspiration (Fig. 4).

Results

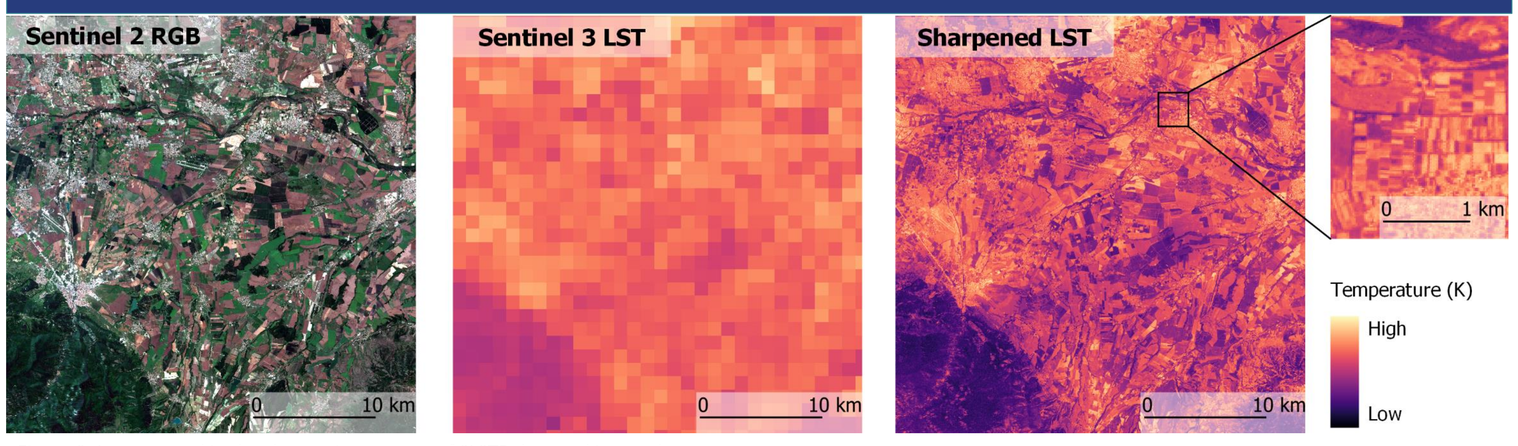

Figure 2. Images used in the sharpening process of SLSTR data and its results.

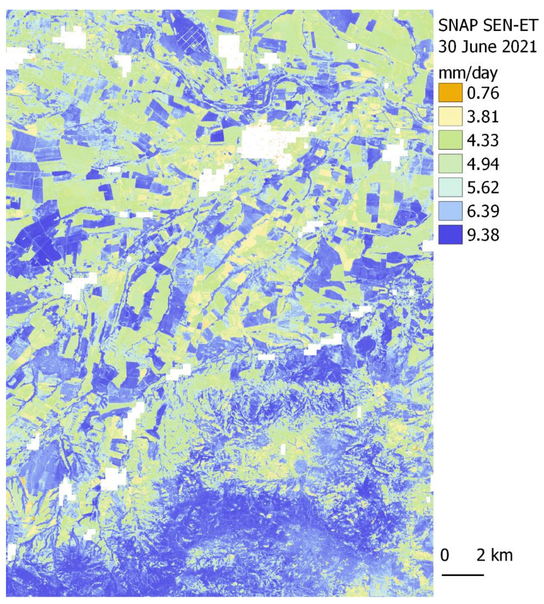

Figure 3. Evapotranspiration map, 30 June 2021

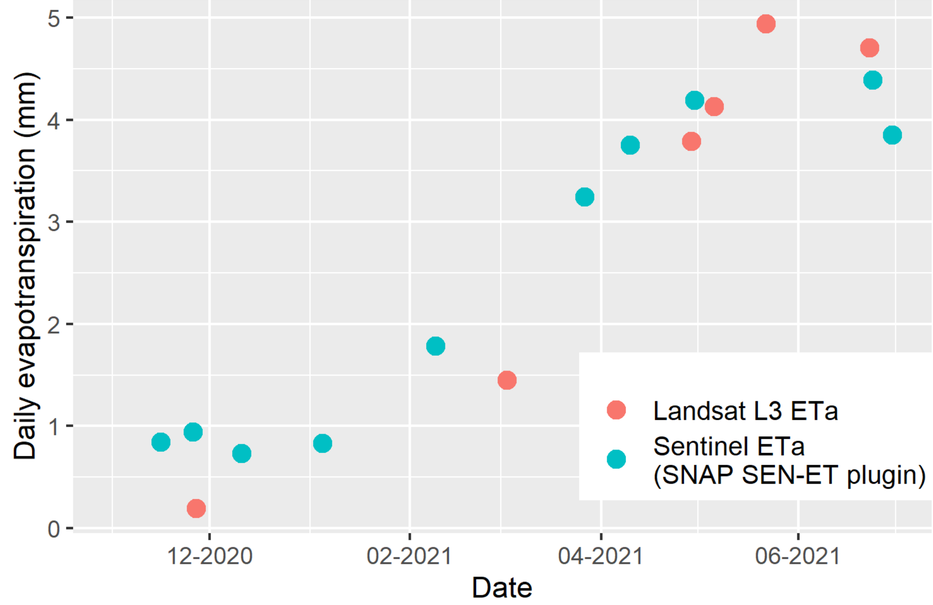

Figure 4. Comparison of daily ET in a winter wheat plot between Landsat L3ETa and Sentinel ETa