ALTOS

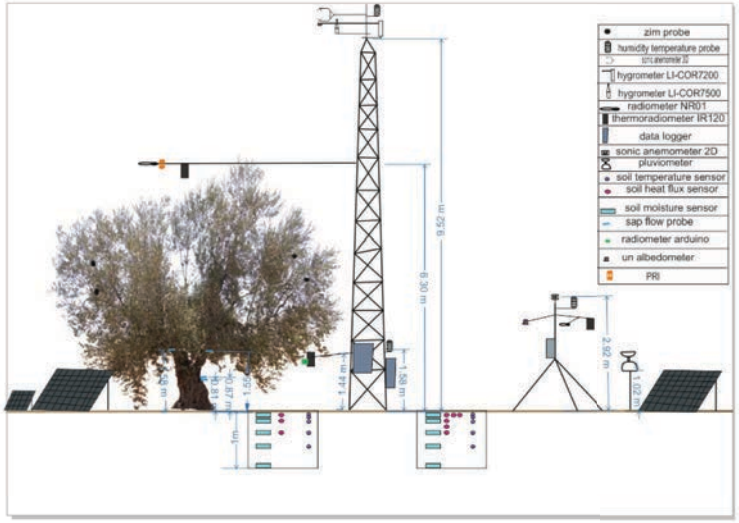
Task 2.2 Monitoring Heterogeneity

Canopy scale heterogeneity

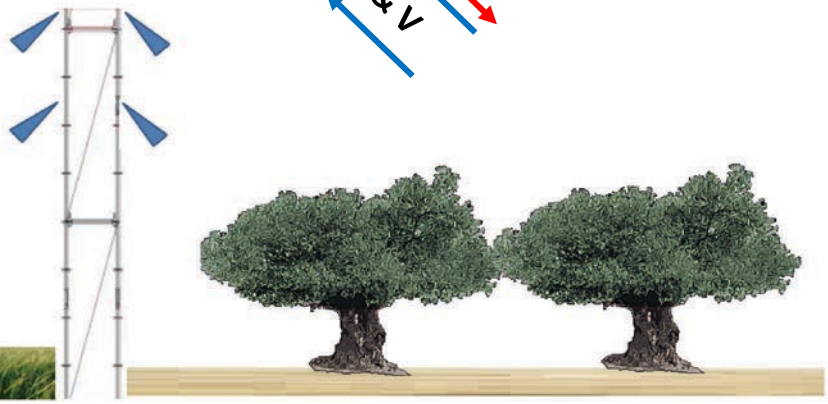
- Row crops (Vineyard, Apple orchard), isolated trees (Olive), complex vegetation with understorey, in rainfed conditions or various irrigation types (drip mostly)
- Energy budget observations accounting for variability in soil and leaf temperatures (SPARSE4)
- Water budget observations linked with drip irrigation and the ecophysiological aspects of tree functioning (incl. hydraulic lift etc)
- In-situ RS (VIS/PIR/TIR, Radar) + LR (S3), HR (S2, S1, L8) and VHR (e.g. Pleiades) satellite RS data > ET, E+T inversion using (py)TSEB and SPARSE EB models, amongst others

Row crops (SP)

Isolated Tree TU, MO



Transmitter/receiver
C & L bands



Task 2.2: characterization of spatial heterogeneities .

• Canopy scale heterogeneity induced by row and multi-strata structures and / or drip irrigation.

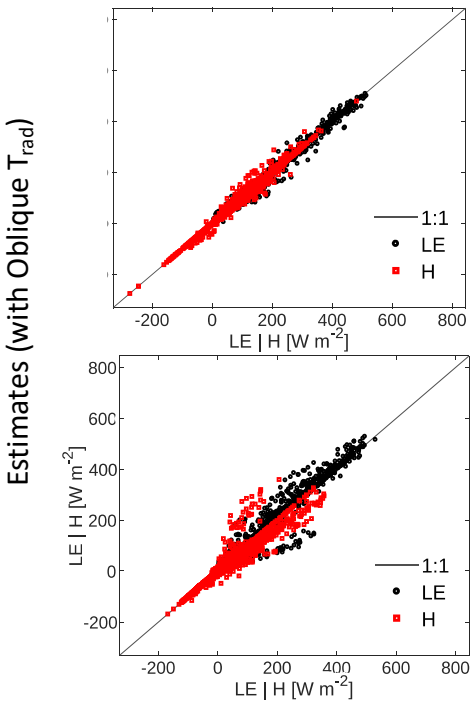
o Targets: water fluxes in discontinuous canopies, subsurface hydraulic redistribution.

o Methodological innovations: joint use of sap flow sensors (installed in both tree roots and trunks), eddy-covariance devices and in-situ remote-sensing to characterize the 3D functioning.

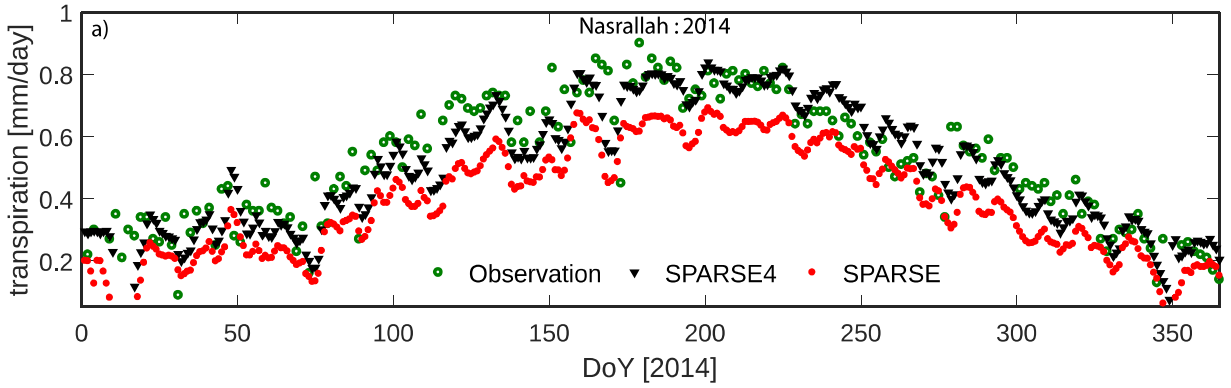
-> A new energy budget model to account for directional TIR data: target = shaded/unshaded soil/vegetation temperatures/fluxes

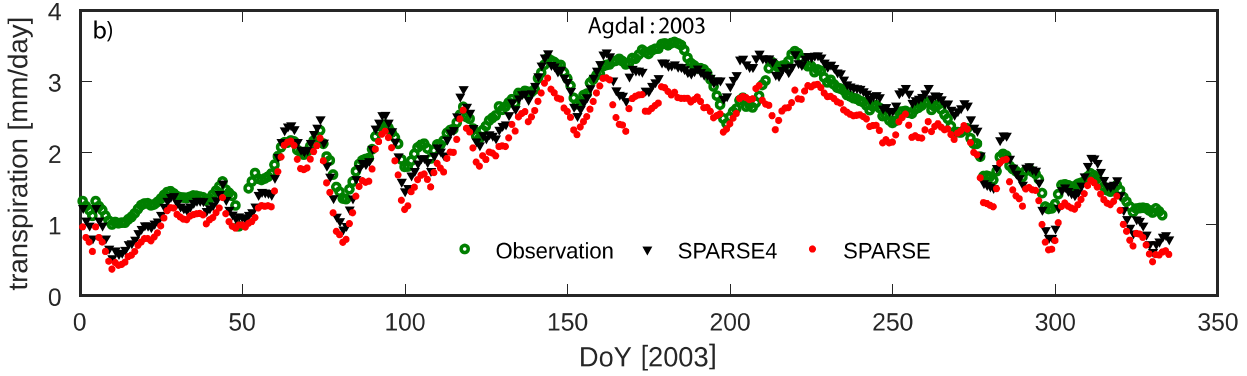
-> sap flow sensors in both tree roots to be installed in Taous olive tree site in June 2021

Estimates (with Nadir T_{rad})



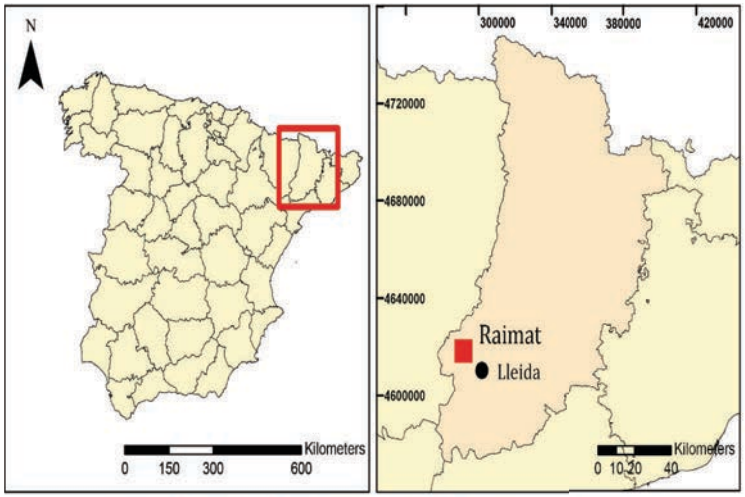
Observed (green o) and simulated (SPARSE: red ●, SPARSE4: black ▼) transpiration

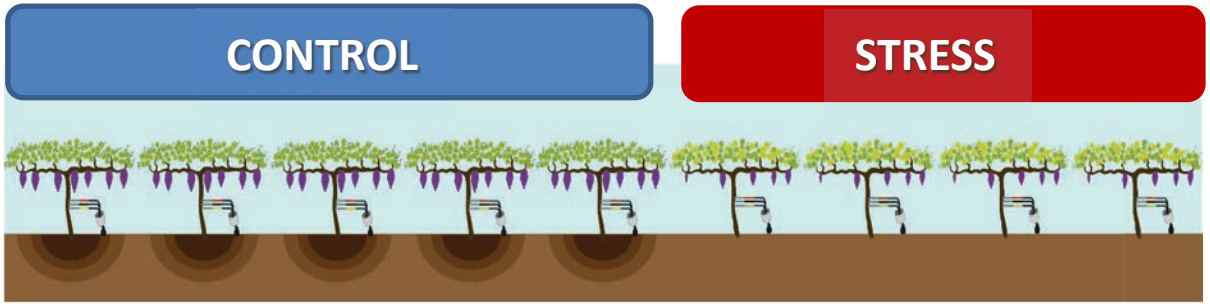




MATERIALS & METHODS

- Year : 2020
- Vineyard in the proximities of Raimat, Lleida. (41°41’19.40” N; 0°29’37.16” E, 280 m elevation)
- Planting distance 3 x 1.7 m
- Drip irrigated 21 year old vines





9 sap-flows

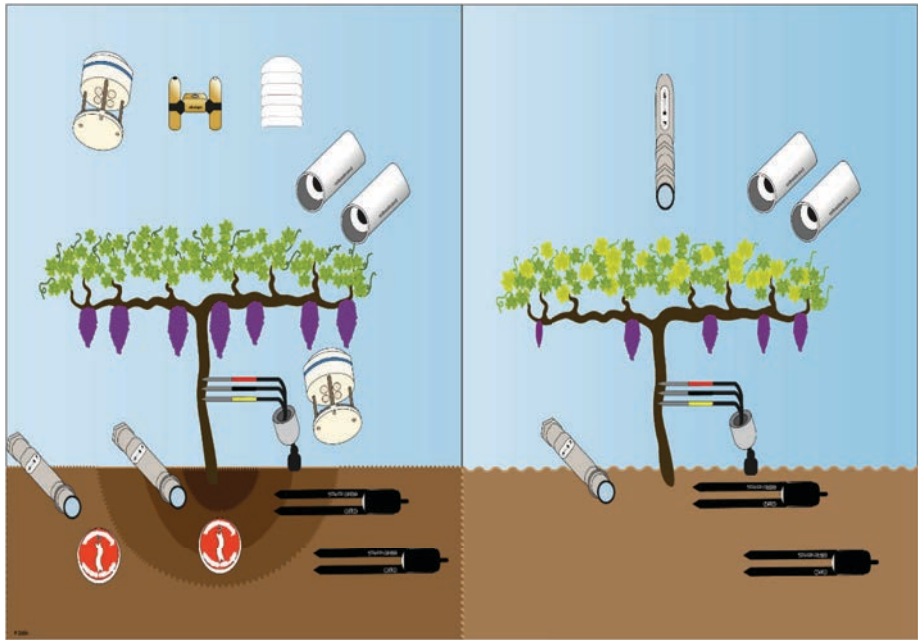
MATERIALS & METHODS

Continuous sensors

- Two sonic anemometers (Decagon DS2)
- Net radiometer (Apogee)
- Soil heat flux plates (HFP)
- 4 Infrared sensors for canopy temperature (Apogee)
- 3 Infrared sensor for soil temperature (Calex)
- 9 Sap flow sensors (Compensated heat pulse)
- Temperature and relative humidity (Decagon VP4)
- Soil moisture sensors (Decagon)

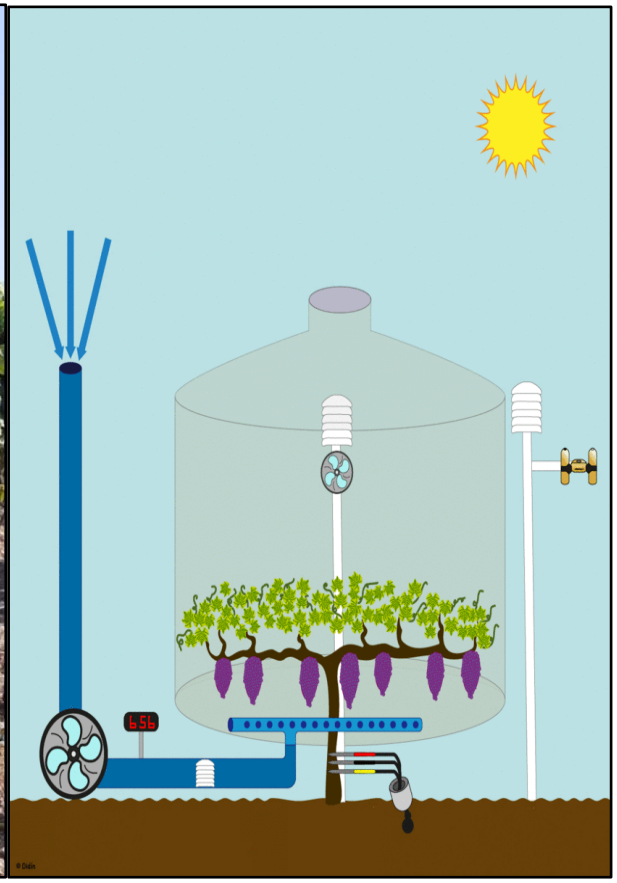
Field measurements

- LAI (LAI-2200) and FAPAR (LP-80)
- Stem Water potential (Schoelander)



MATERIALS & METHODS

Whole canopy gas exchange system (balloon)



MATERIALS & METHODS

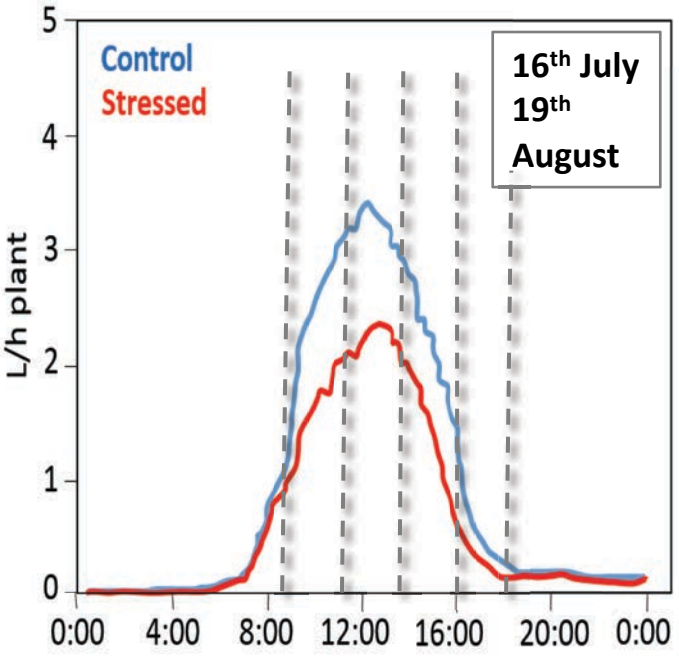
Cameras on-board the UAV:

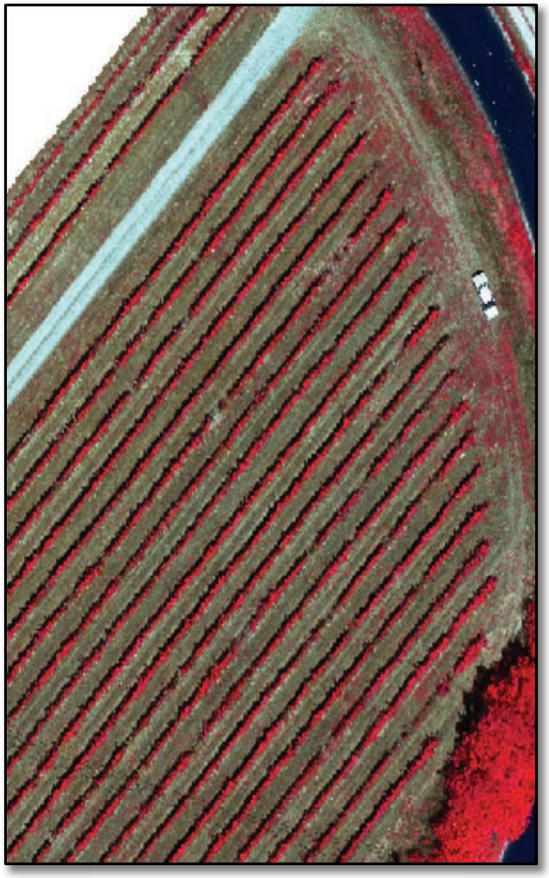
Multispectral + Thermal +RGB Spatial resolution 3-5 cm

Image acquisition:

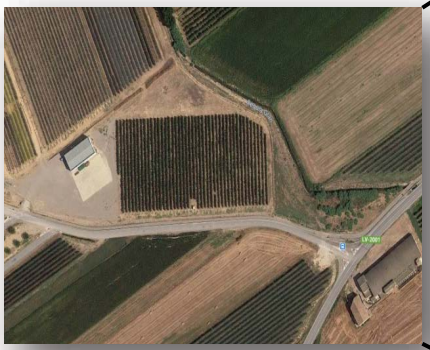
5 Midday flights -> 25th June / 6th July / 16th July / 29th July and 19th August of 2020

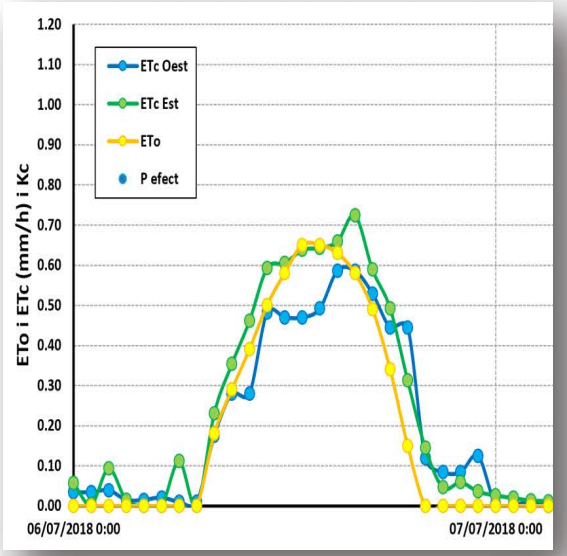
2 Diurnal flights (5 flights)

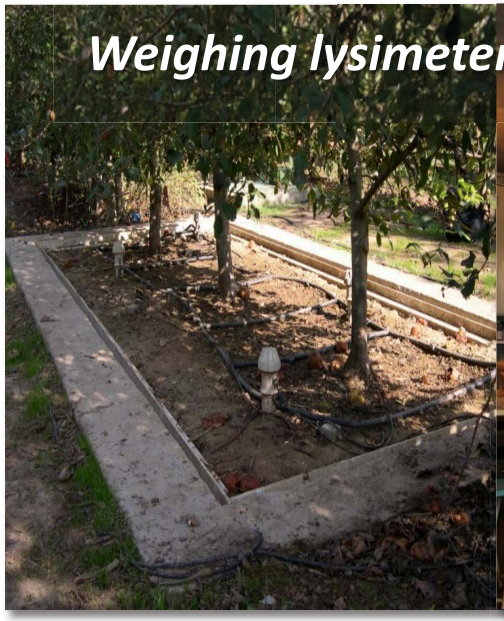




Apple orchard







UNICA

Task 2.2:
Characterization of spatial heterogeneities

Study area: Orroli site

Activities:

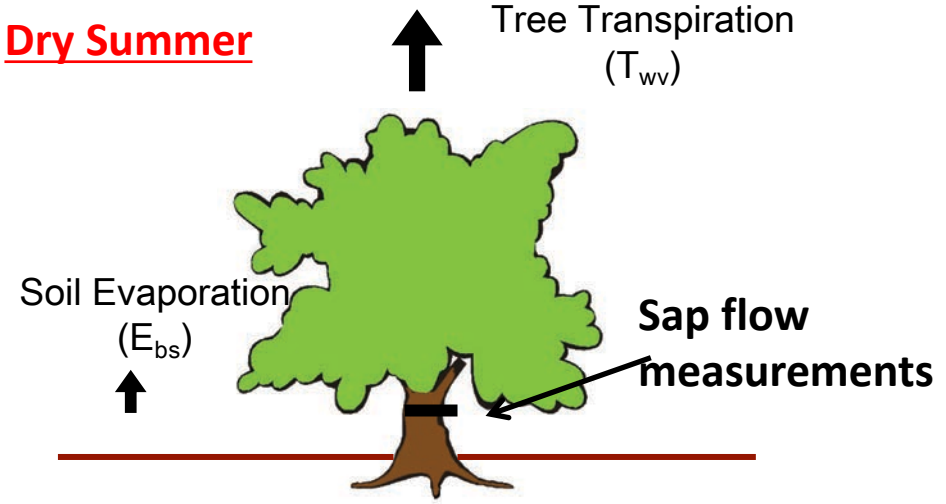
-Evaluation of water fluxes and subsurface hydraulic redistribution for the heterogeneous ecosystem of Orroli

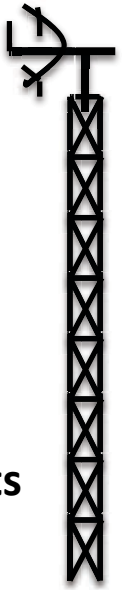
Methods:

-Joint use of Eddy covariance measurements, remote sensing data, root and stem sapflow, geoelectrical measurements

Measurements of water fluxes with the joint use of sap flow (in both tree root and stems) and eddy covariance devices

Dry Summer

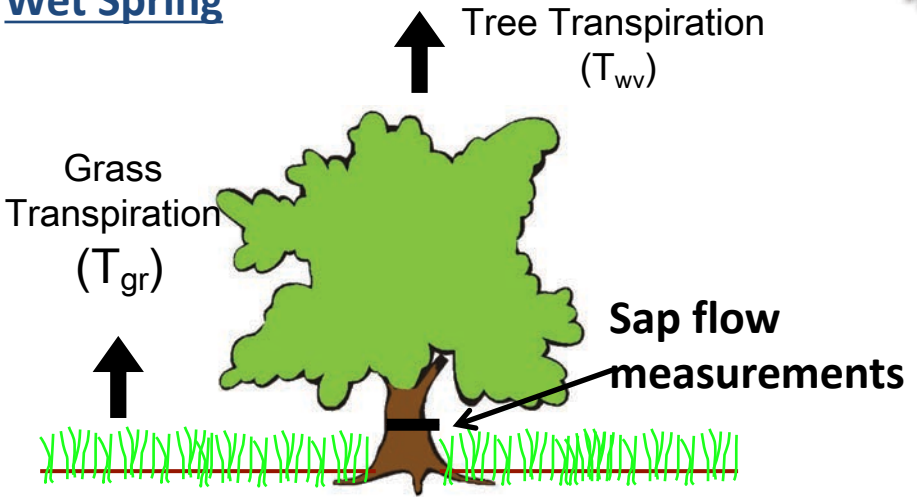


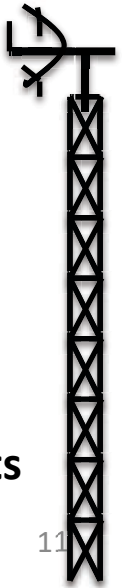


EC tower

$$ET = E_{bs}\, f_{bs} + T_{wv}\, f_{wv} + T_{gr}\, f_{gr}$$

Wet Spring

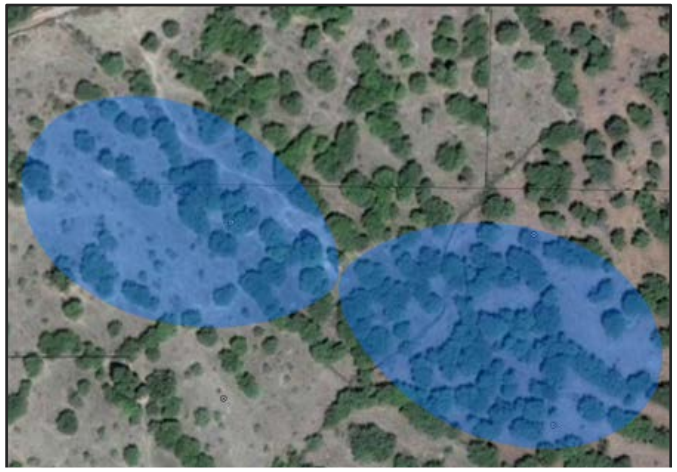


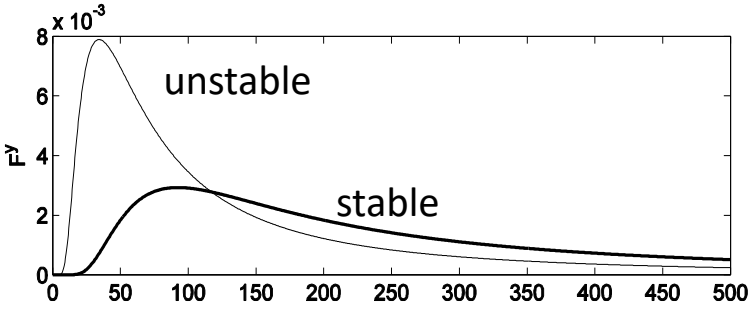


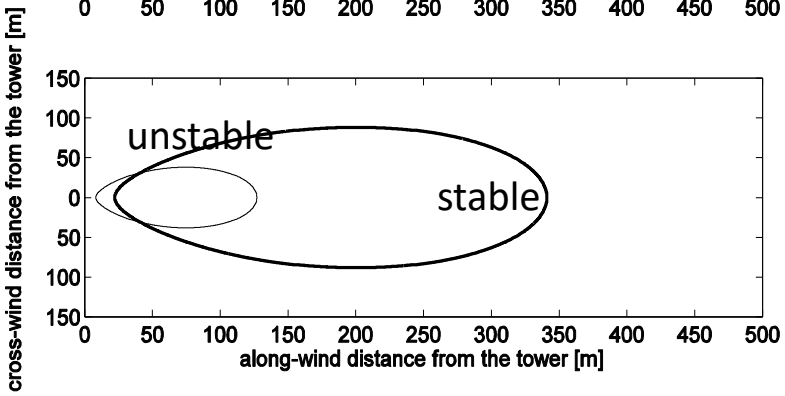
Evaluation of Evapotranspiration (ET) components

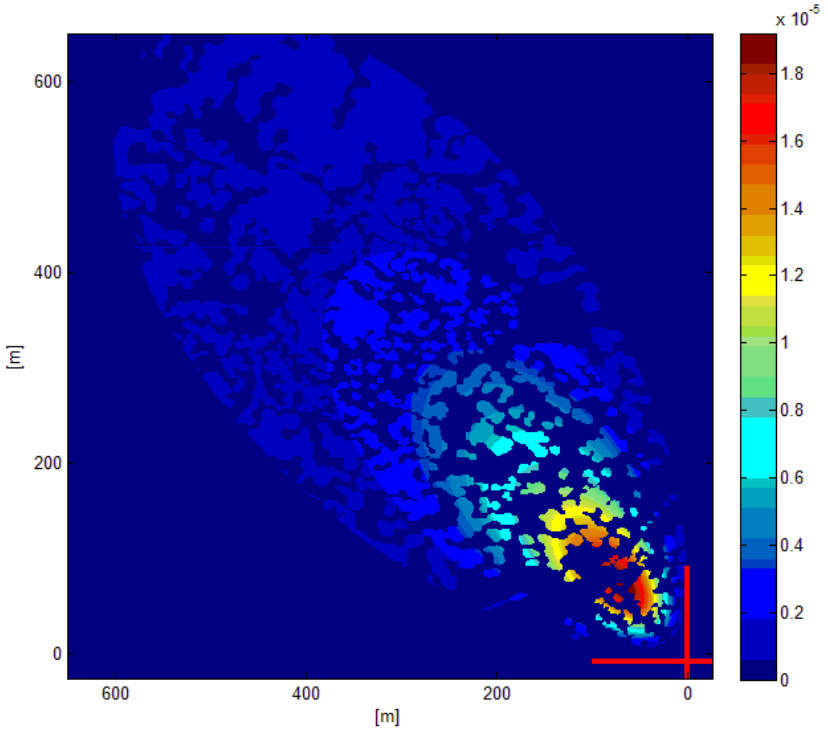
Combined use of a footprint model and satellite information

$$ET = T_{sf} F_{fp,wv} + E_{bs} f_{bs} + T_{gr} f_{gr}$$









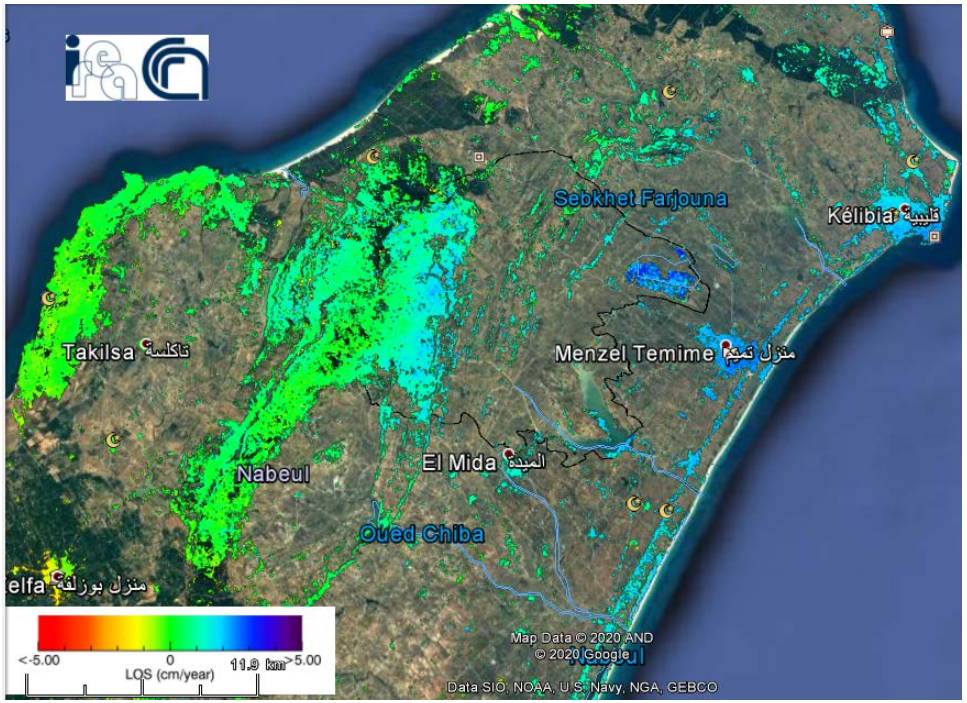
$$F_{fp,wv} = \sum_{i=1}^{N} \sum_{j=1}^{M} f_{ij} \xi_{ij} \Delta x \Delta y$$

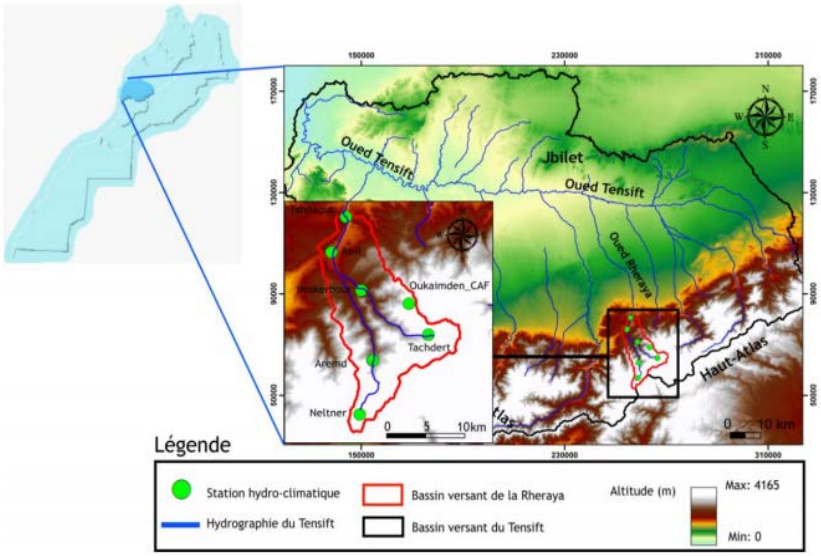
f_{ij} Source Area Function

ξ_{ij} fraction of woody vegetation into ij-cell

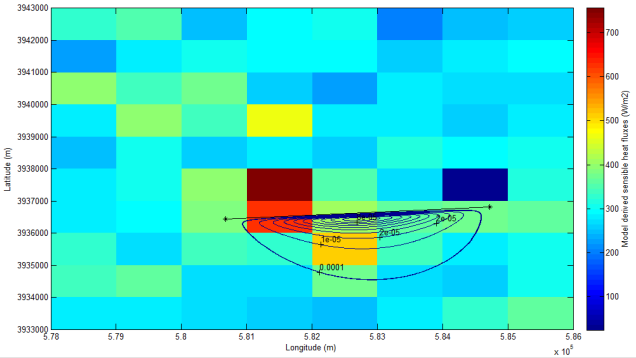
Landscape scale heterogeneities

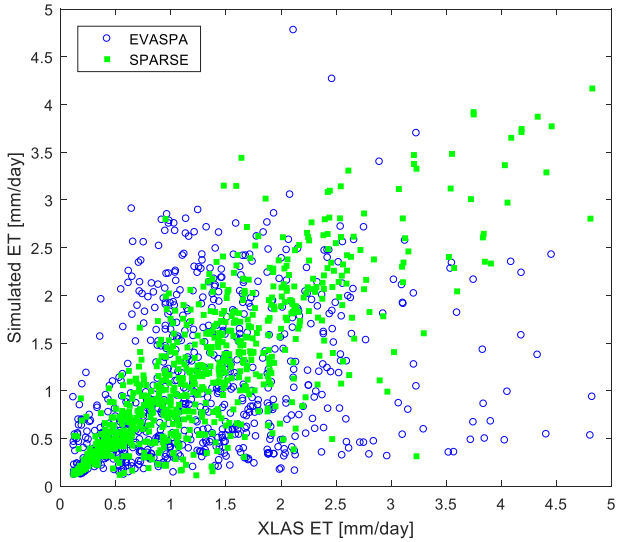
- Tensift: Energy budget methods in complex topography
- Kamech: Estimation of erosion rates (SAR interferometry)
- Merguellil: Monitoring key phenological stages of orchards (flowering)

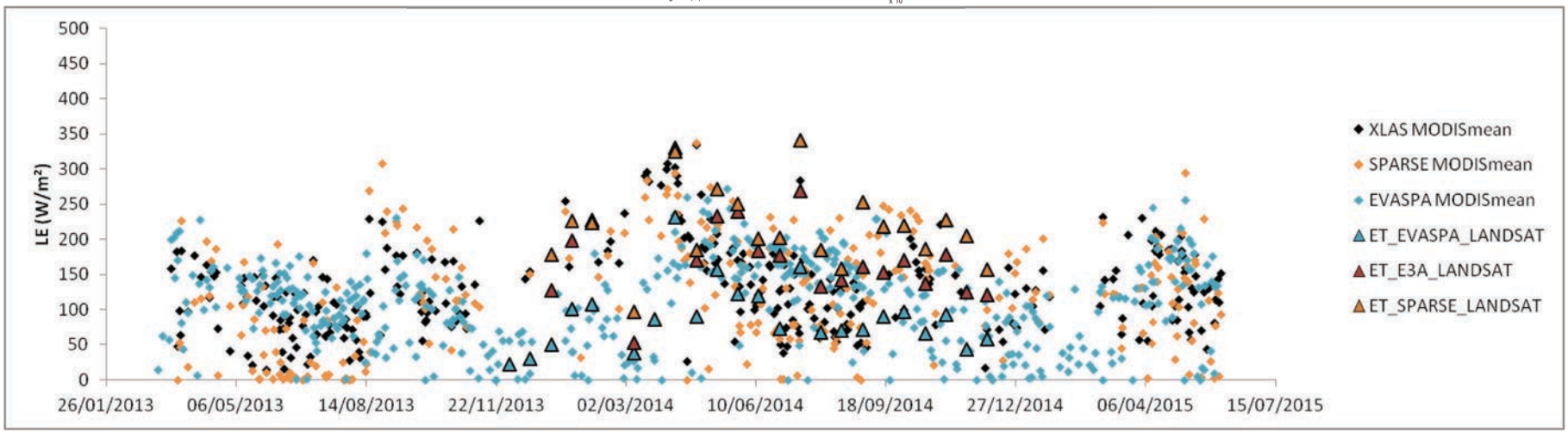




• Landscape scale heterogeneities induced by soil, topography and canopies.
o Targets: water fluxes in heterogeneous landscapes.
o Methodological innovations: joint use of eddy covariance data at sub-catchment scales (few tenths of hectares), of scintillometry data across field transects, and of remote sensing data with embedded metric to kilometric resolutions à analysis of spatiotemporal dynamics.
-> SPARSE and EVASPA energy budget models forced with L8 and MODIS surface temperatures, compared with XLAS longterm meas.







Task2.2: Canopy scale heterogeneity induced by row and multi-strata structures and/ or drip irrigation (Merguellil catchmement Downstream)

Objectives :

- Creation of a database of olive and almond trees
- Characterization and recognition of trees under different cropping conditions In solo or in association (with other trees or crops, cereals),
  - with regular or irregular spatial patterns in terms of intertange distance, size, age, and heightn, diameter canopy.
  - irrigated /rainfull fields

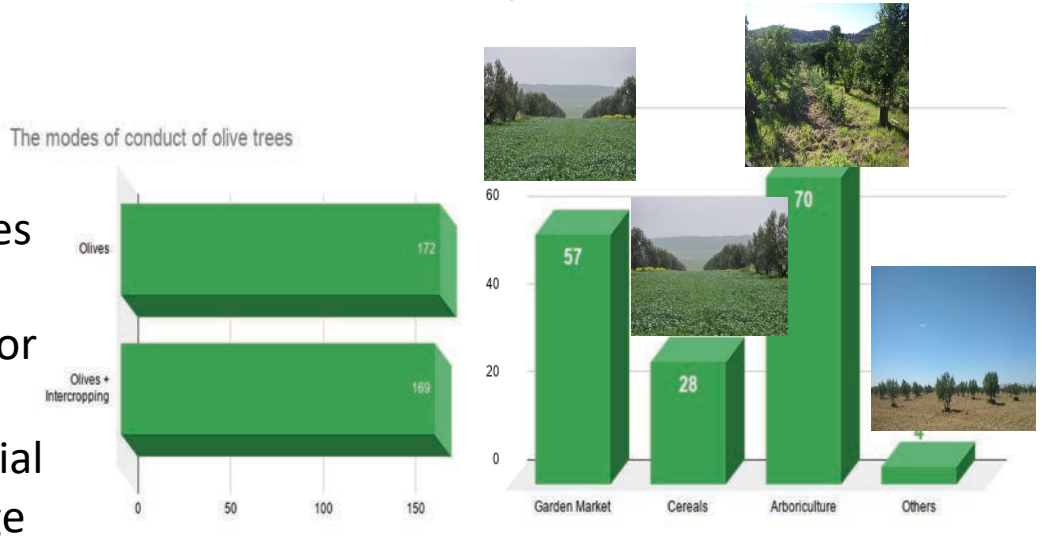


Figure 1. Associations of olives trees

Inter range

Methodology

- In this task we combine ground truth data and interviews with stackholder farmers (Figure 1)
- and the spatial recognition of trees based on the classification of four Pleiades-1A imagery acquired recently in Merguellil area, complementarity with **task 1.2 results)**

Rainfull / irrigated

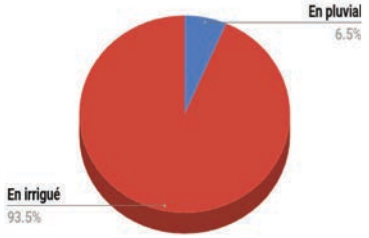


Figure 2 : Conduct mode (Irrigated /rainfull

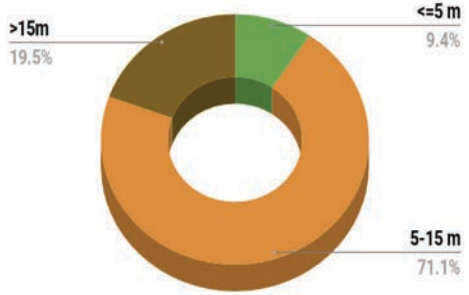


Figure 3 : Spatial pattern

Task 2.2: Task2.2: Canopy scale heterogeneity induced by row and multi-strata structures and/ or drip irrigation (Merguellil)

- **Detection of the flowering period of peach trees in the Kairouan plain (Figure 3)**

  ➔ **7 Field missions: February - March 2021** ➔ During these field campaigns, we observed **42 plots** spread over the entire watershed (Figure 4.).

Figure 3. Spatial distribution of the plots observed (Google Earth image)

Constraints

Data collection has been started since February 2020 and was suspended in March 2020, January 2021 and May 2021 due to the situation related to COVID-19.

- We have no observations of Flowering in 2020.
- In 2021, we monitored the flowering of peach trees but we did not have Pleiades images during this period and with the Sentinel-2 images we can't detect the flowering date of Peach trees (Figure 4)

➔A Pleiades image campaign should be planned for the year 2022 for the detection of flowering of peach trees.

We had late acquisitions of PLEIADES images this year to follow the flowering period of peach and olive trees (The first image acquired on 25/04/2021)

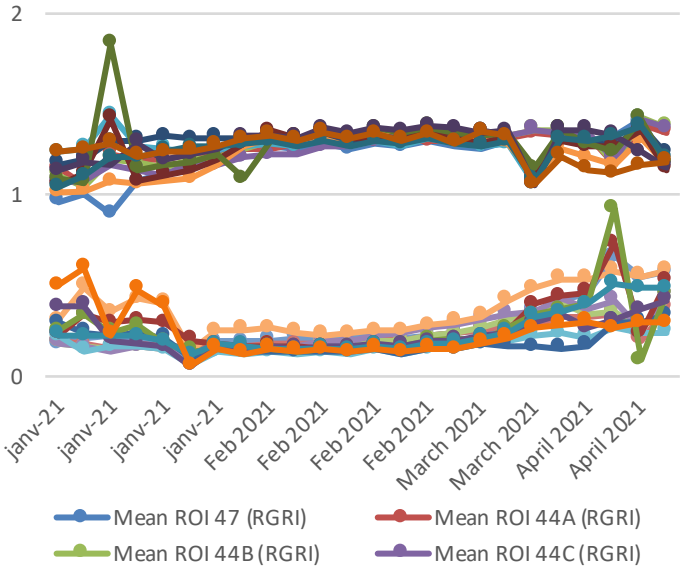


Figure 4. Evaluation of NDVI / RGRI Sentinel 2 profiles for the peach test plots Jan 2021 ➔ April 2021

Activities	Period	Study areas	Team
Validation of the seasonal evolution of T (TSEB) in grapevines (under different water status) with saps-flows -> very high-resolution imagery and IRT sensors	2020 2021	Vineyard (Lleida) -> 2020 & Apple (Lleida) -> 2021	C Jofre J Bellvert M Pàmies A Pelechá O García-Tejera

SUPCOM Contribution in WP2

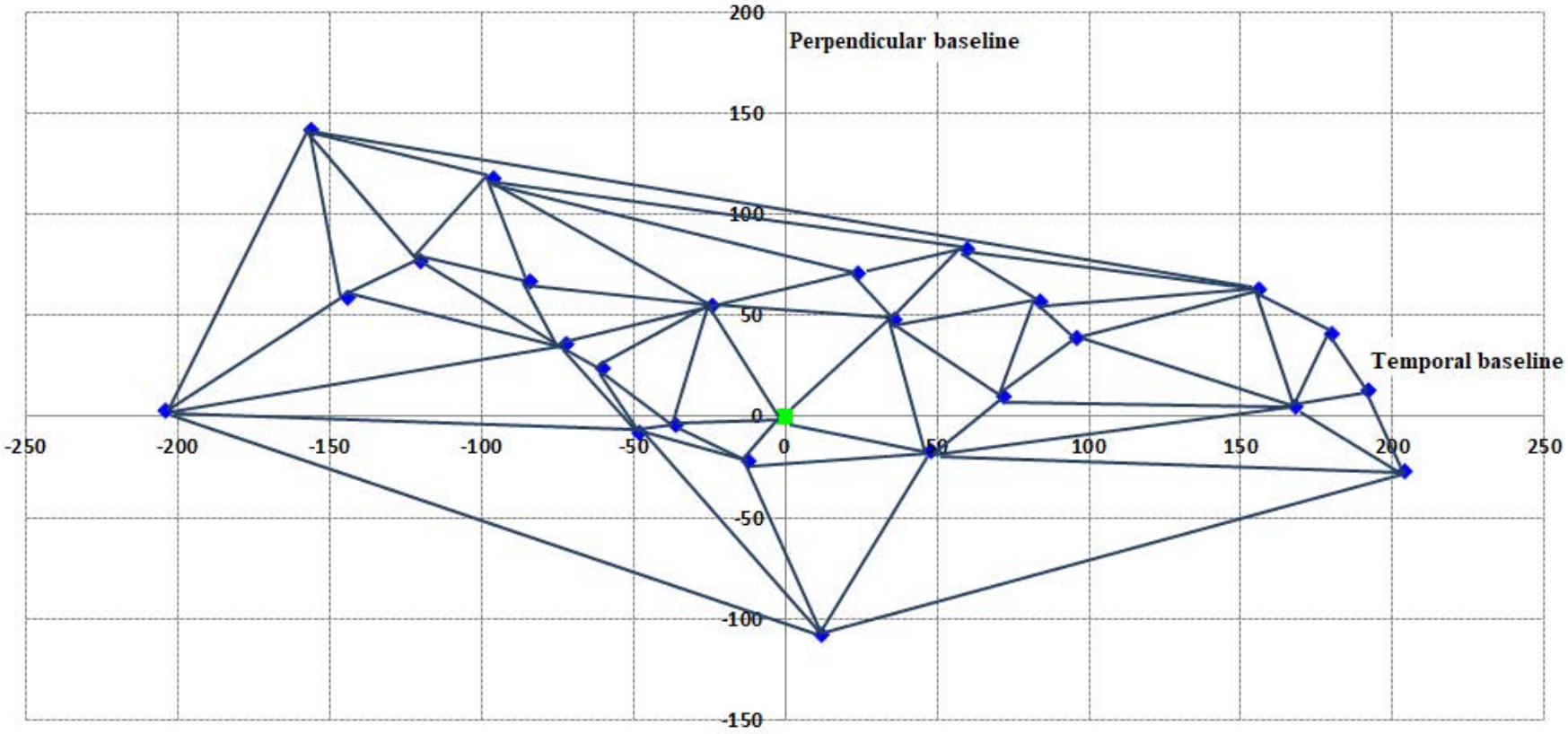
Post-flood Soil Displacement Monitoring In Lebna watershed Using Parallel Small BAseline Subset (P-SBAS) Interferometry

Objective

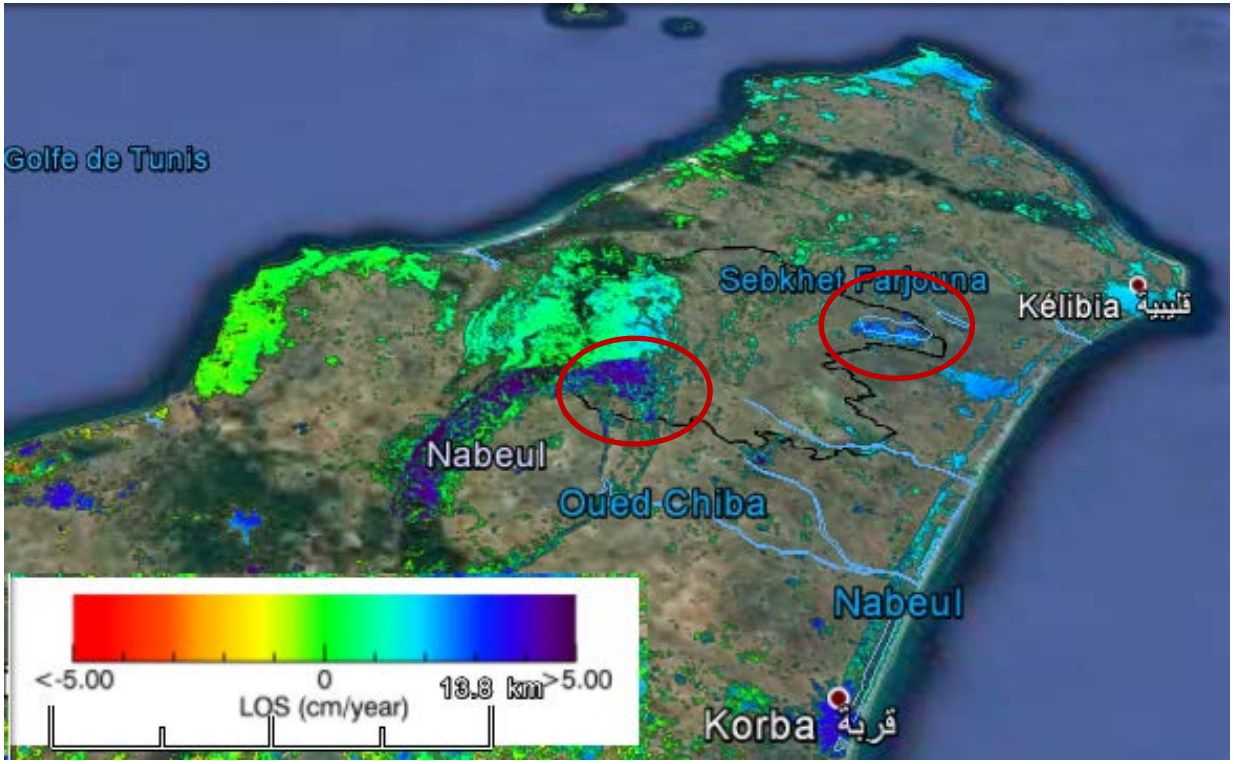
monitoring the soil movements that occur after flooding events using advanced multi-temporal differential interferometric Synthetic Aperture Radar (SAR) technique.

Methodology

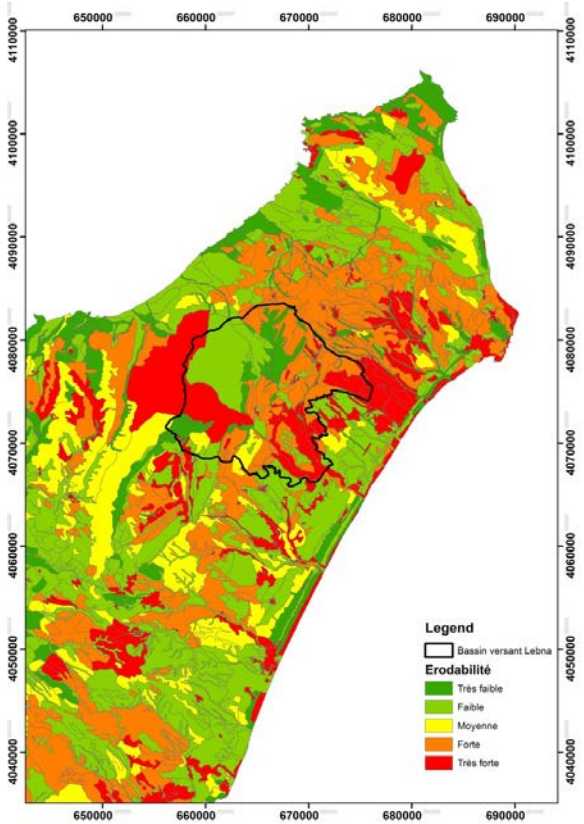
Acquisition period	Number of Sentinel-1 SLC images	Super master
21/08/2017-16/08/2018	26	24/01/2018
20/09/2018-02/11/2019	28	12/04/2019



Results



P-SBAS result for Lebna watershed study region: maps of displacements velocity in the line of sight direction September 2018 to November 2019



The erodability classes maps for the considered the Lebna watershed(using FAO method (1998))

The mean soil displacements velocity map for the period September 2018 to November 2019, shows that the mountain of "Djebel Sidi Abderrhamane" in Lebna watershed is highlighted in dark blue which corresponds to rapid displacements in the LOS direction of the satellite.

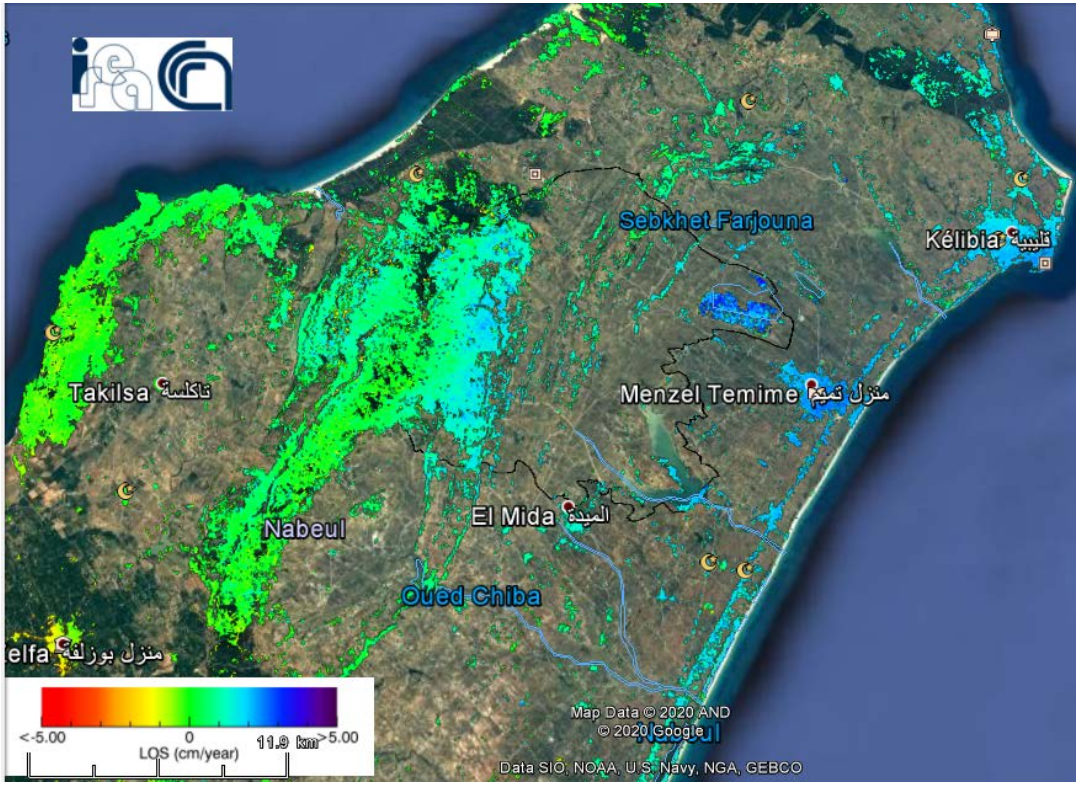
Results

This displacement is related to the accumulated floodwater after heavy rainfall on 22, September, 2018. In fact, the annual average rainfall in Lebna watershed, over the last decade, was 97mm. However, the extreme precipitation that was recorded only during one day (22, September 2018), was around 300mm. This extreme rainfall event in "Cap Bon" peninsula has not been recorded since 300 years. Furthermore, the region of "Djebel Sidi Abderrhamane" is the site of collection and concentration of water and this is susceptible to lead to post-flood ground surface displacement and erosion.

The soil in this area is mainly marley and clay which means that the existence of floodwater increases the risk of erodability. This conclusion is confirmed by the existence of medium and high erodability classes exactly in "Djebel Sidi Abderrhamane" region

Results

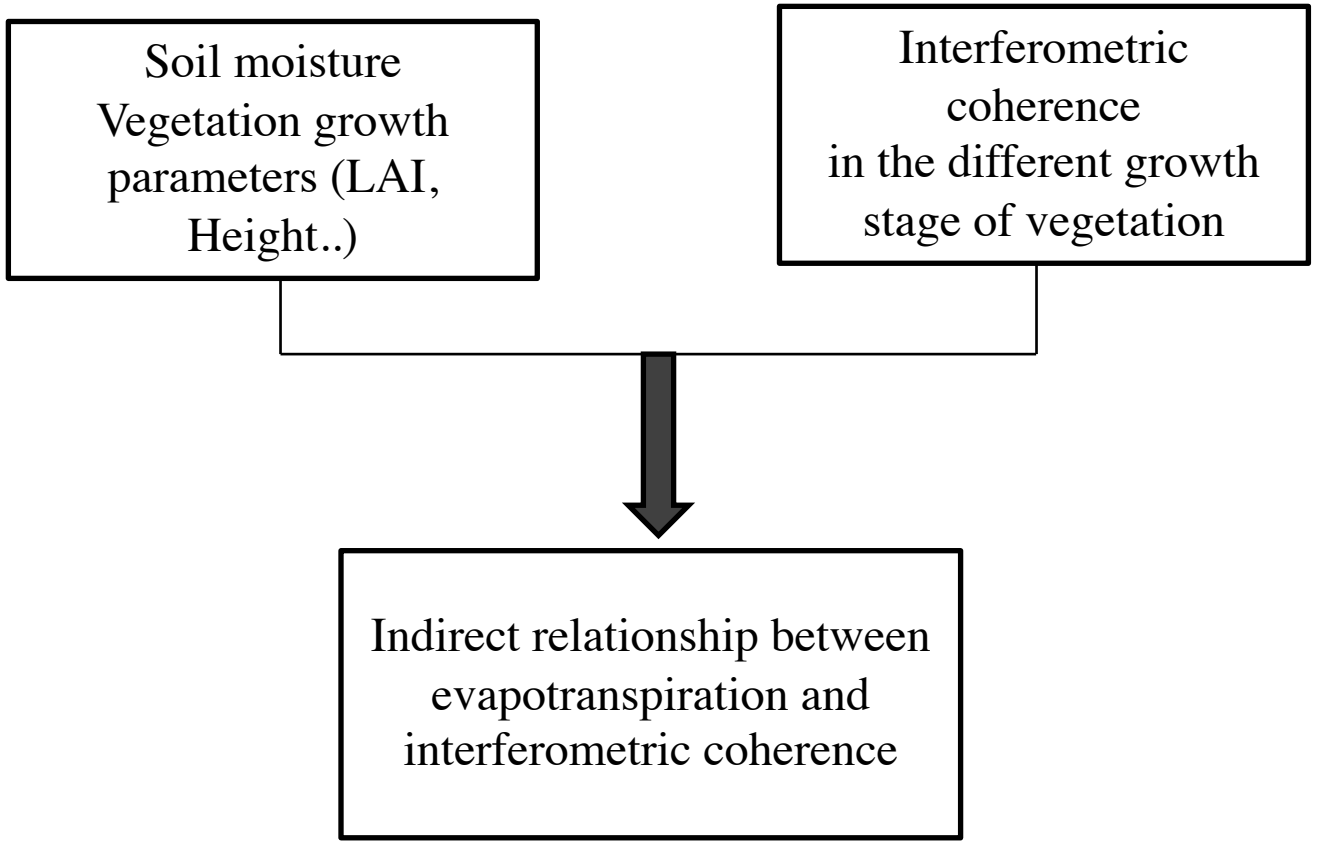
This map corresponds to the velocity map one year before the flooding event, we can notice that there is no remarkable movement of the ground surface in the considered region. This reinforces the inference that links the triggering of soil movements in this area to the flooding event. It is also important to note that there was no reported flooding event in the study region during the period August 2017 to August 2018. This indicates that the addressed P-SBAS soil deformation study highlights the resulting flood impacts on the spatial structures and soil properties.



P-SBAS result for Lebna watershed study region: maps of displacements velocity in the line of sight direction August 2017 to August 2018

Perspectives

Monitoring the evapotranspiration using the interferometric coherence



Issues and challenges :
Topography

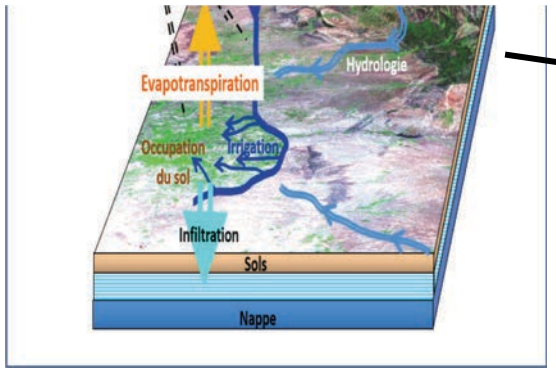
Incoming radiation Rn can dramatically change from one point to another

Sun exposure effect

Air temperature can dramatically change with altitude

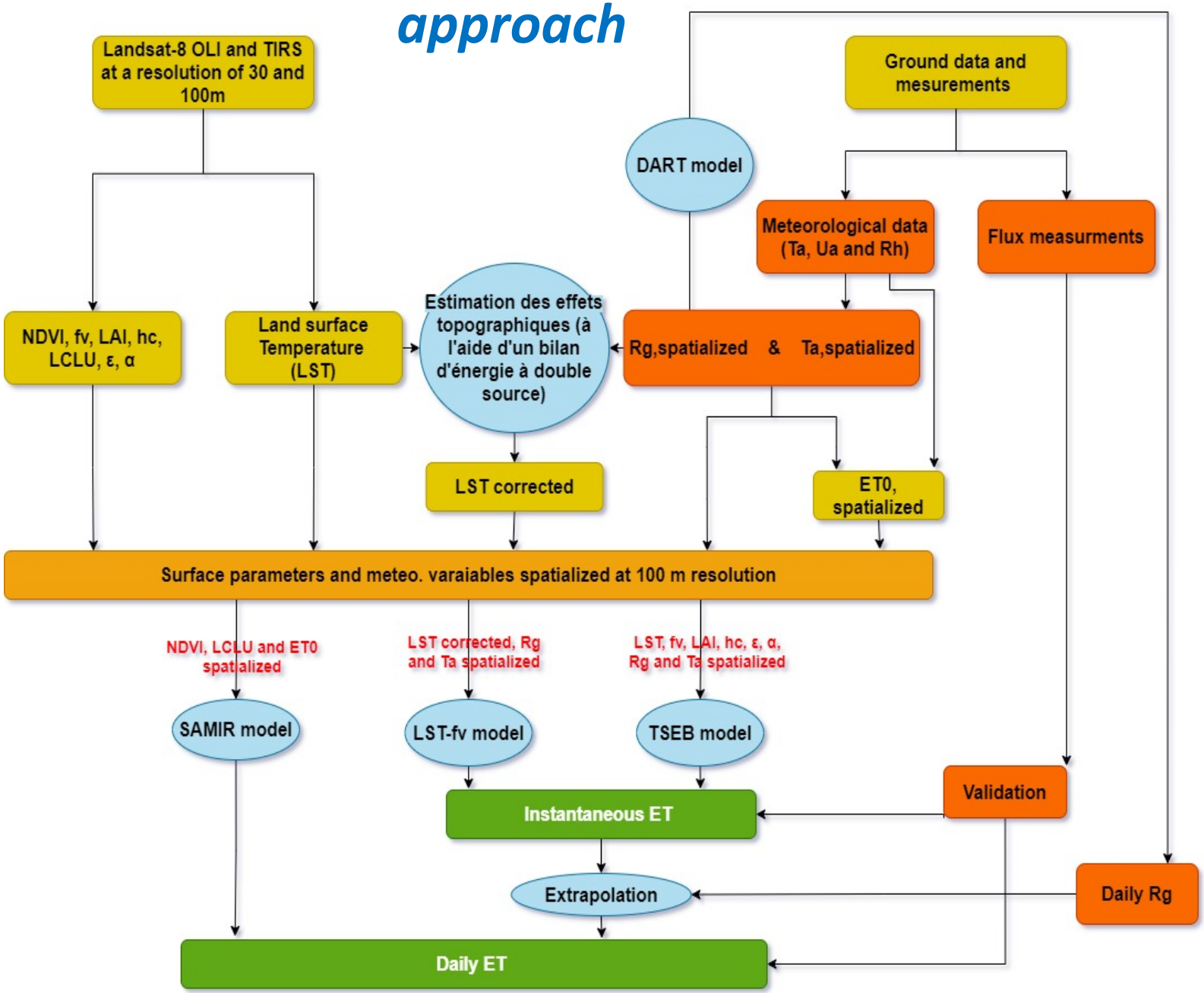
Altitude effect

Relatively flat area

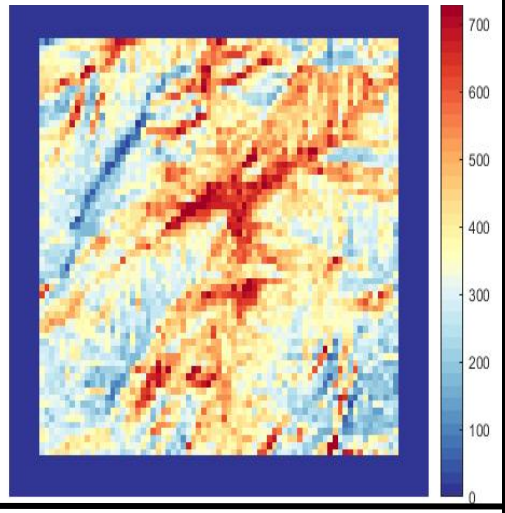
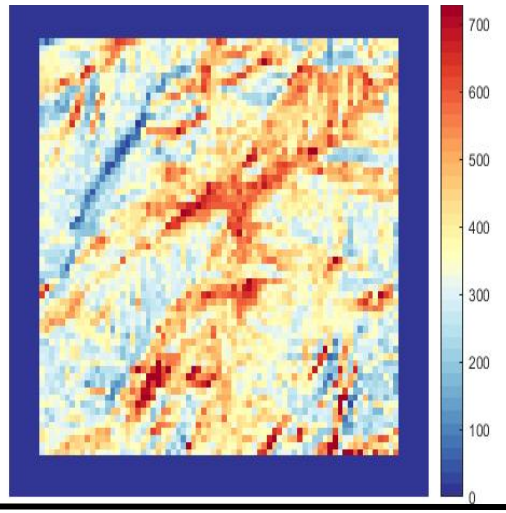
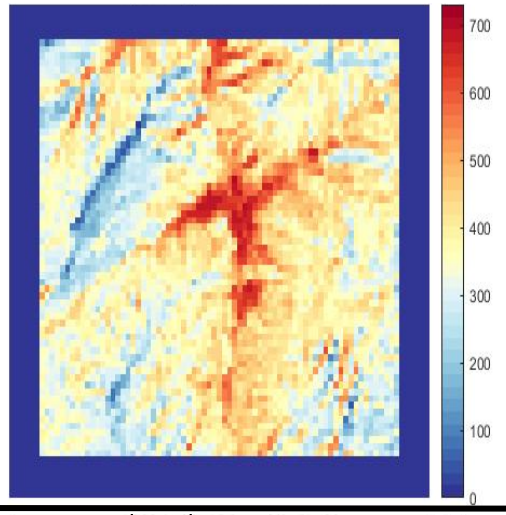
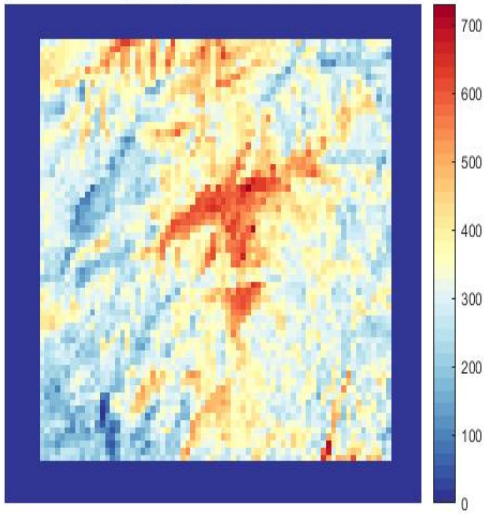
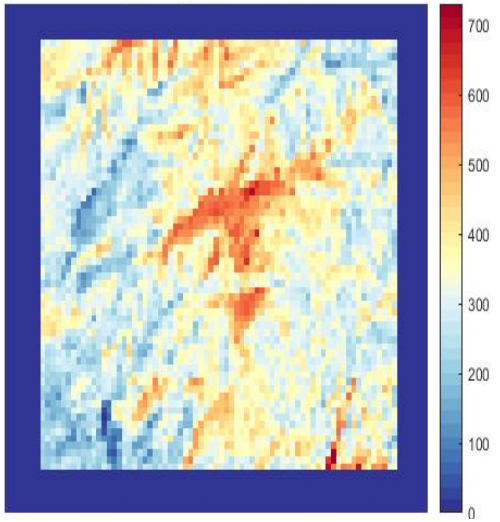
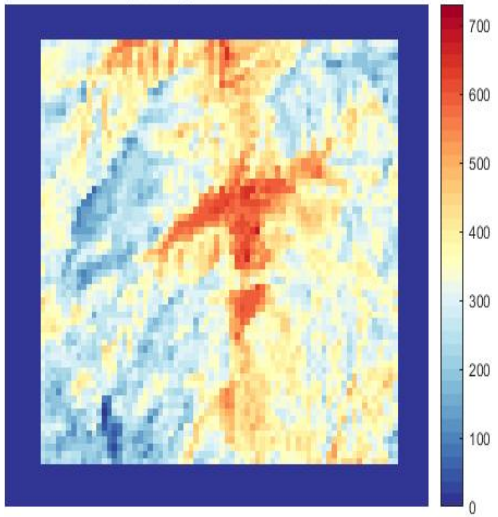


- **Incoming radiation Rn ≈ cte**
- **T° air ≈ cte**

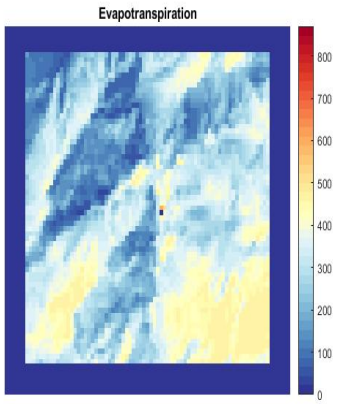
Methodological approach

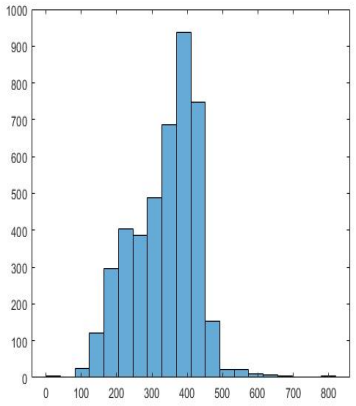


Application of the triangle method

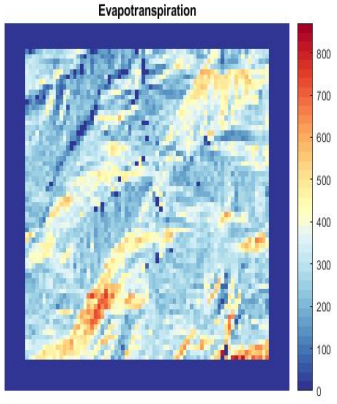
	Rg + Ta distributed	Ta uniform +Rg distributed	Ta distributed + Rg uniform
05-09-2016			
25-05-2016			

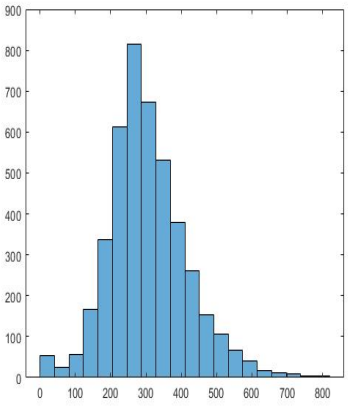
Application of the TSEB_PT_Richardson model



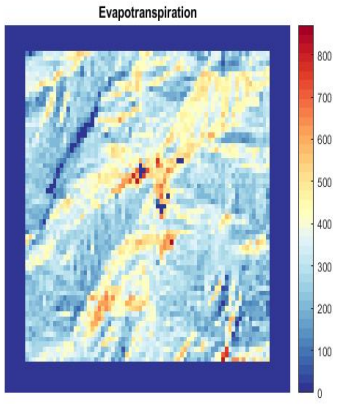


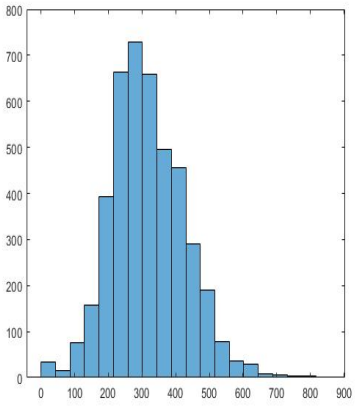
Rg uniform + Ta uniform





Ta uniform + Rg distributed





Rg + Ta distributed

D2.2.1 [Task 2.2]: dataset @ Month 15 to be included into project clustered database
D2.2.2 [Task 2.2]: 2 submitted publications about data analysis @ Month 21.