Instituto Superior de Agronomia
Data Science Hackathon Workshop 2023
06 October 2023

The experience on multidimensional data on agricultural water management.

Research work lines developed in the Agricultural Engineering section/ISA.

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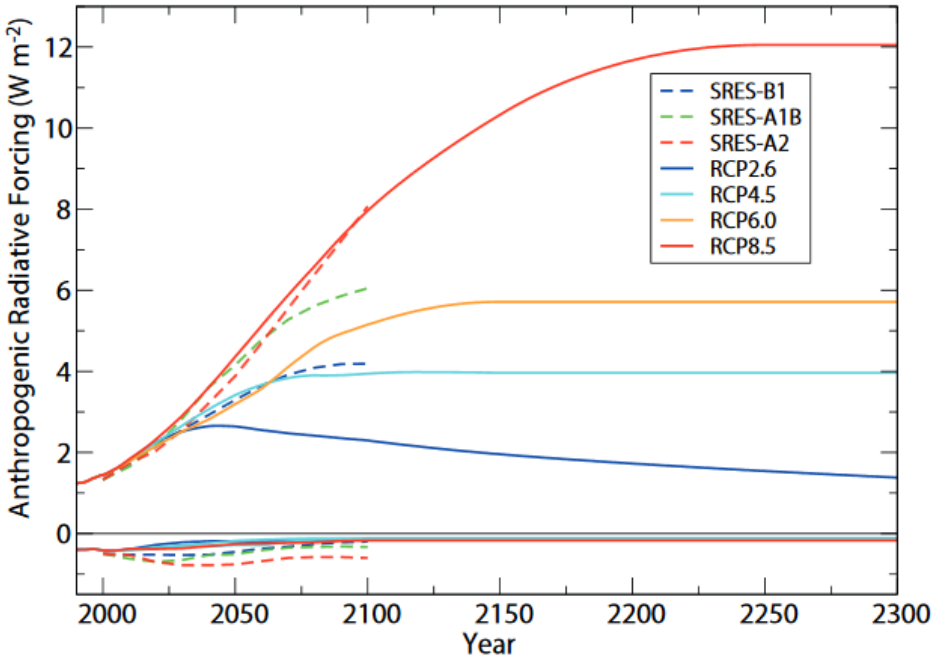
Data use and management in irrigation modeling

- Within the scope of several national and international projects, the Agricultural Engineering section have adopted several data management tools, namely in the following research areas:
  - Climate change impacts on irrigation;
  - Water accounting;
  - Precision irrigation.

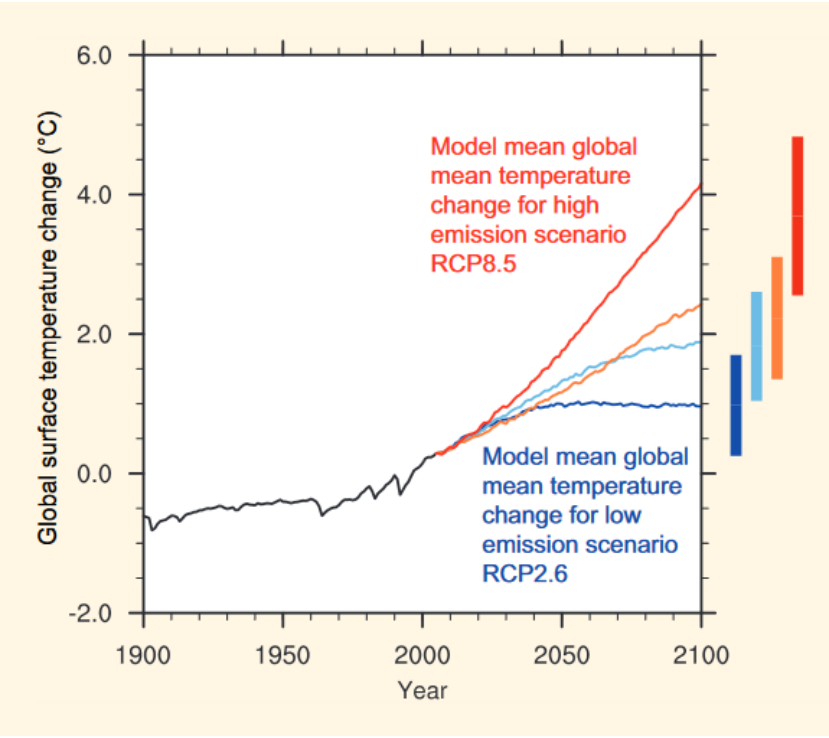
Time series of climate change scenarios

Climate change impacts assessment
- Crop irrigation requirements -

Future climate projections



RCP – Representative concentration pathways



		2046-2065		2081-2100	
	Cenário	**Média**	**Variação provável**	**Média**	**Variação provável**
Alterações na temperatura média global em meados e no final do século XXI relativamente a 1986-2005 (°C)	RCP2.6	1.0	0.4 a 1.6	1.0	0.3 a 1.7
	RCP4.5	1.4	0.9 a 2.0	1.8	1.1 a 2.6
	RCP6.0	1.3	0.8 a 1.8	2.2	1.4 a 3.1
	RCP8.5	2.0	1.4 a 2.6	3.7	2.6 a 4.8

Source: IPCC, Fifth Assessment Report (AR5)

Climate data in irrigation decision-making

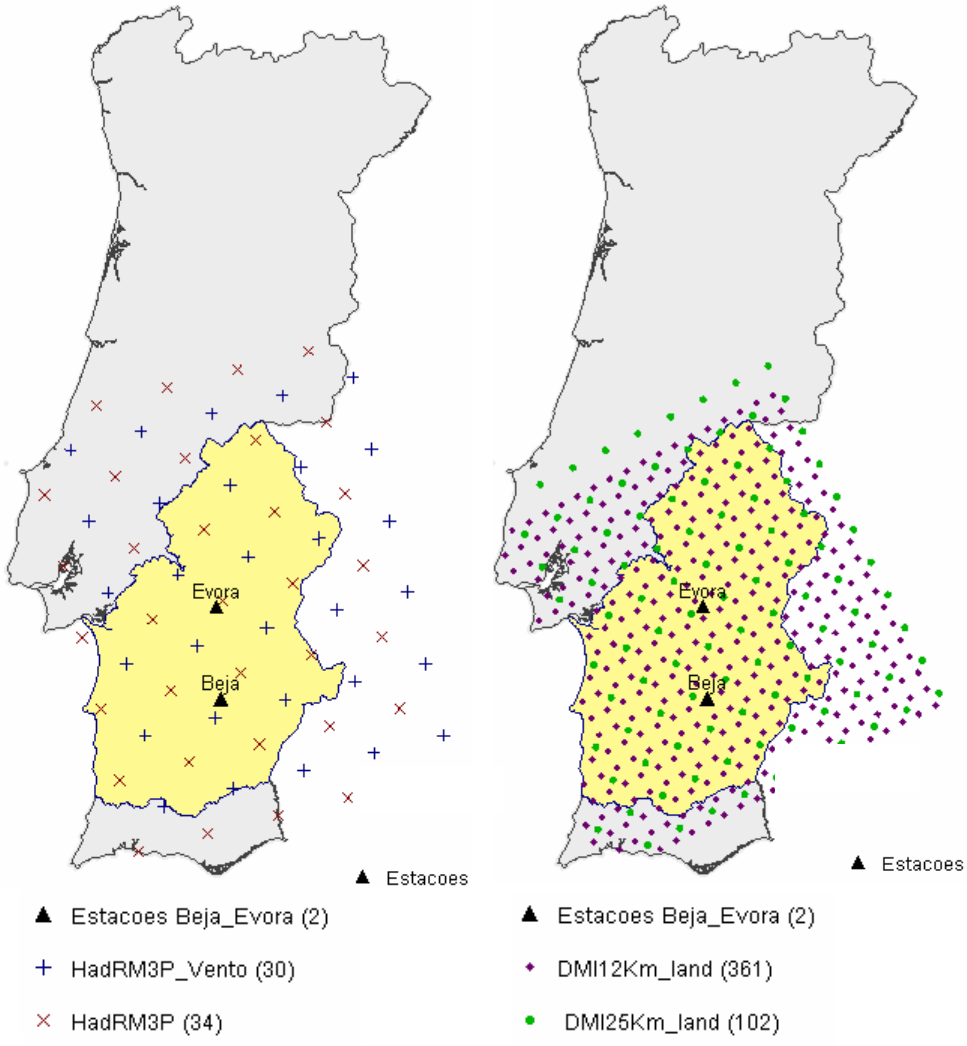
- In the past irrigation decision-making (e.g. systems design) was based on historical meteorological data series (tip. 30 years);
  - It was assumed that observed climate data correspond to a sample of a distribution whose parameters remain constant over time.

- With climate change this simplification is no longer valid;
  - It is necessary to use both observed climate series and climate change scenarios data series;

Climate change scenarios data

Climate change scenarios data produced by Regional climate models (RCM):

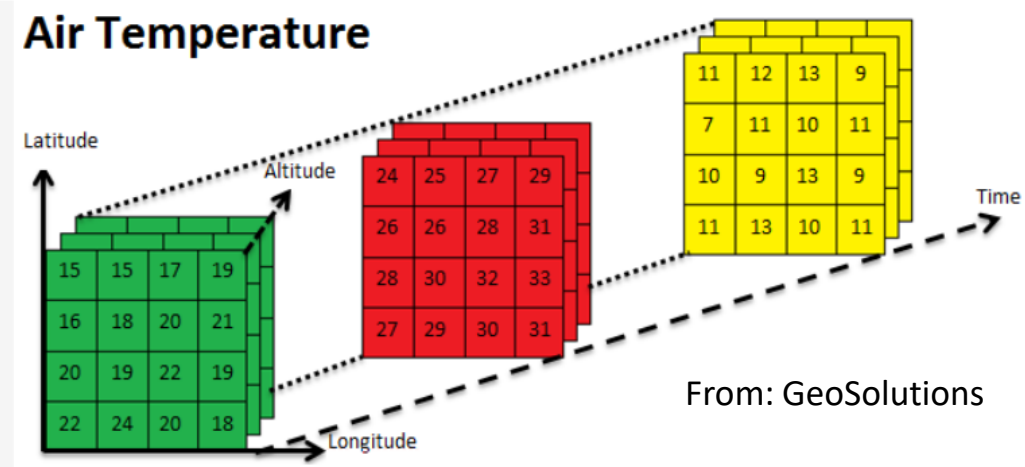
- Spatially distributed temporal data series (gridded data);
- Large volumes of data: 30 years of daily data for several CC scenarios (e.g. RCP 4.5; RCP 8.5) and periods (e.g. 2041-2070; 2071-2100);



- Due to the uncertainty in modelling future CC scenarios, it is necessary to use an ensemble of models and emissions scenarios.

Climate change scenarios data

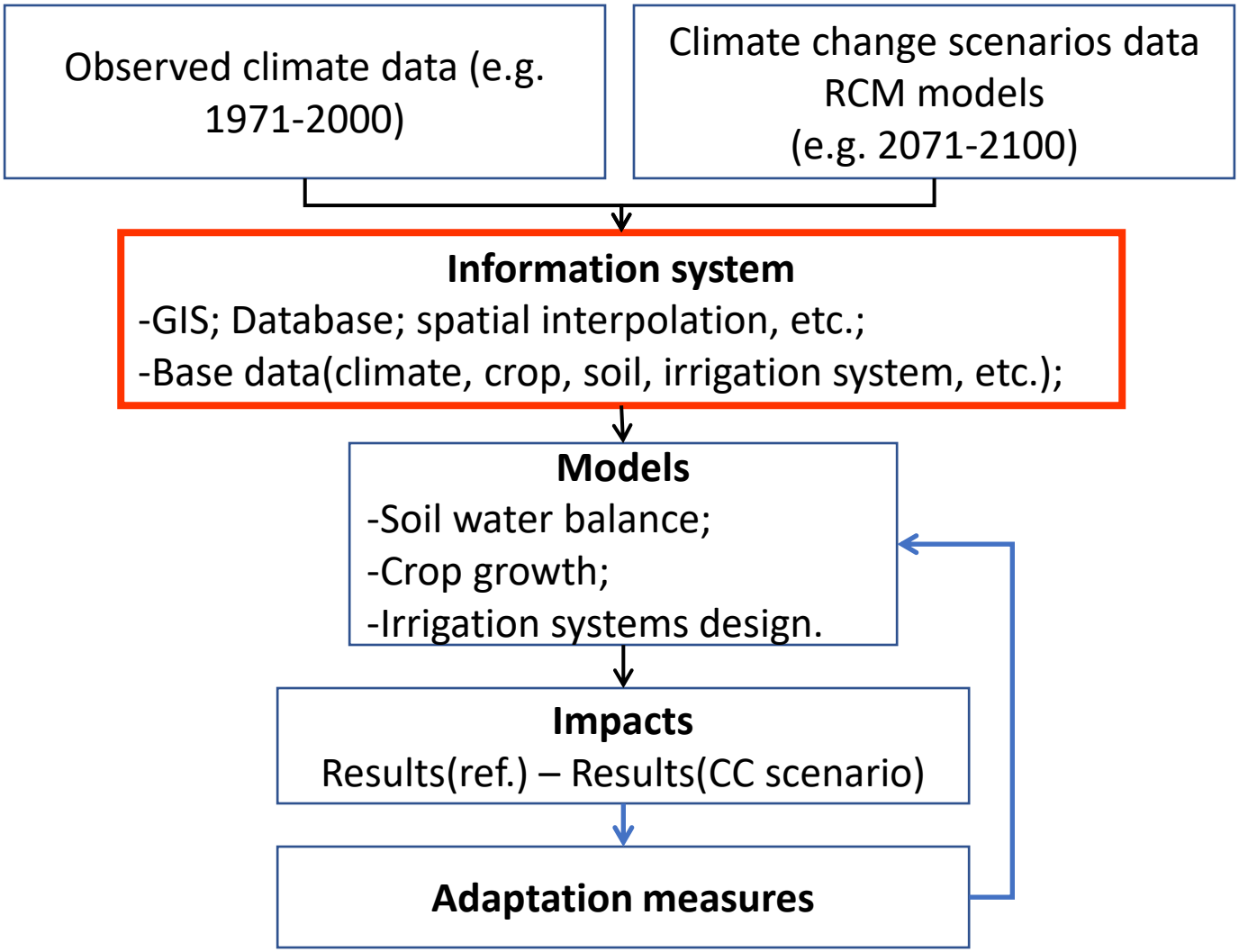
- The RCM models data are available in:
  - IPCC Data Distribution Center;
  - IS-ENES Climate4Impact portal,
  - Copernicus Climate Change Service (C3S);
  - Research projects: PRUDENCE, ENSEMBLES, CORDEX, CMIP5, CMIP6;
- NetCDF files – multidimensional arrays (Panoply, Python, R)



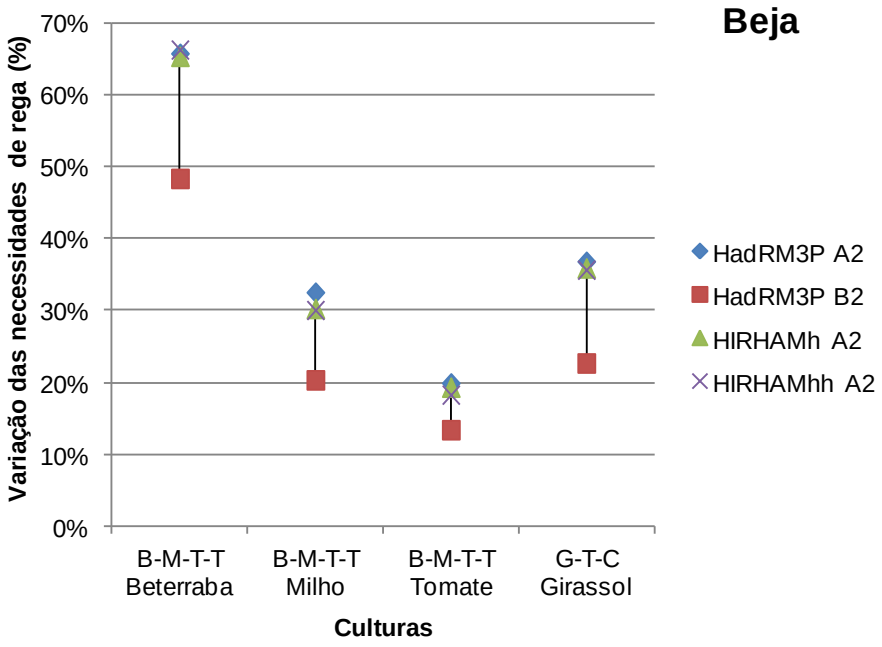
From: GeoSolutions

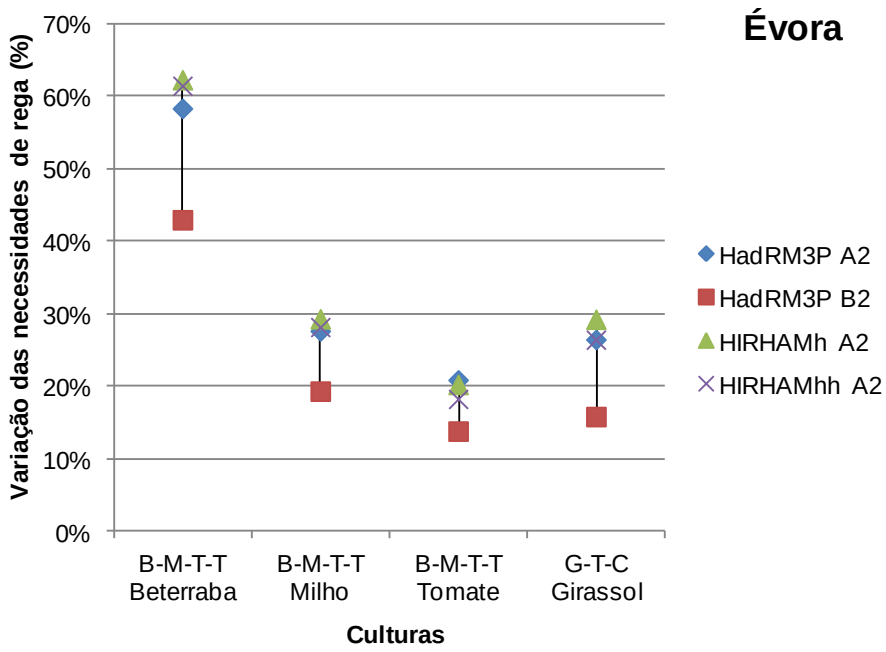
- Considerable deviations between RCM model simulations and historical data observed at weather stations.
  - Climate models bias correction (precipitation);

Impacts assessment methodologies



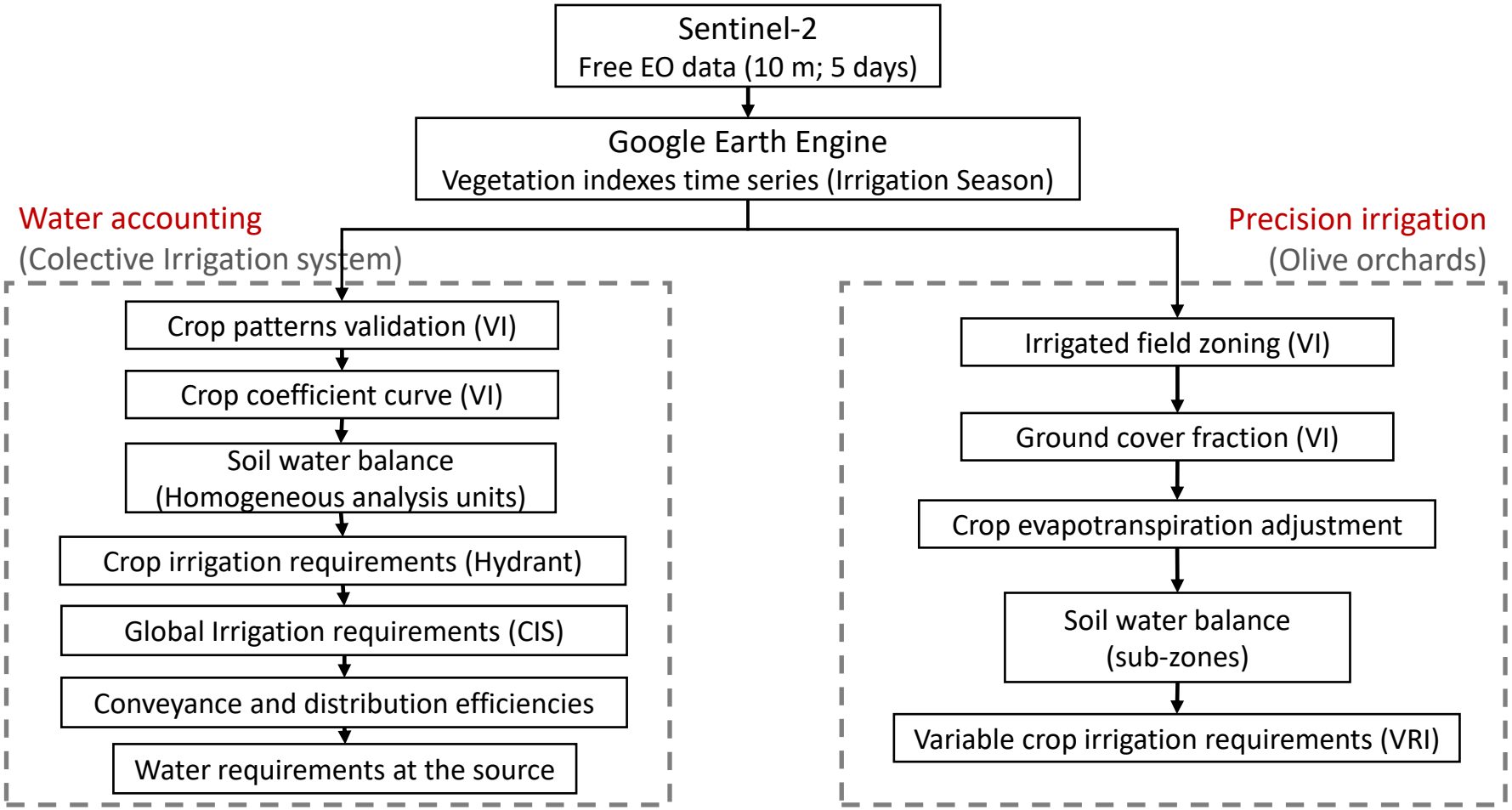
Irrigation requirements variation for the considered CC scenarios





Irrigation water management methodologies based on free and open access Sentinel-2 data.

Developed methodologies



Irrigation water management methodologies based on free and open access Sentinel-2 data.

Water accounting

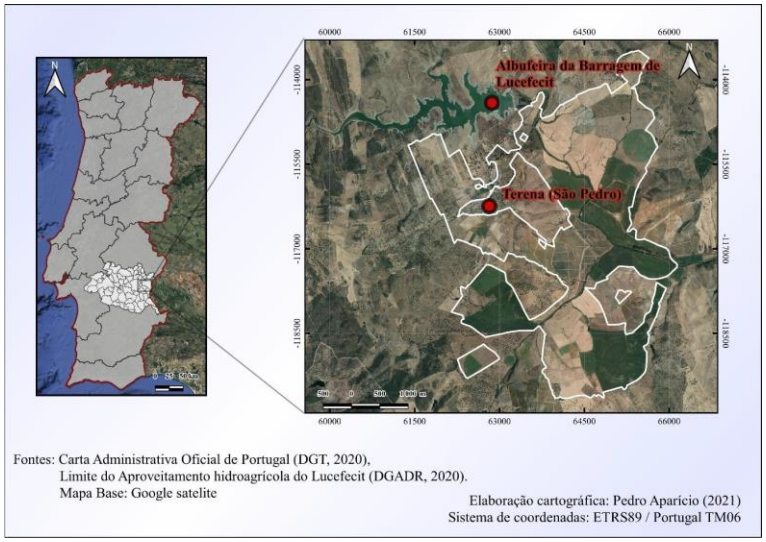
Context

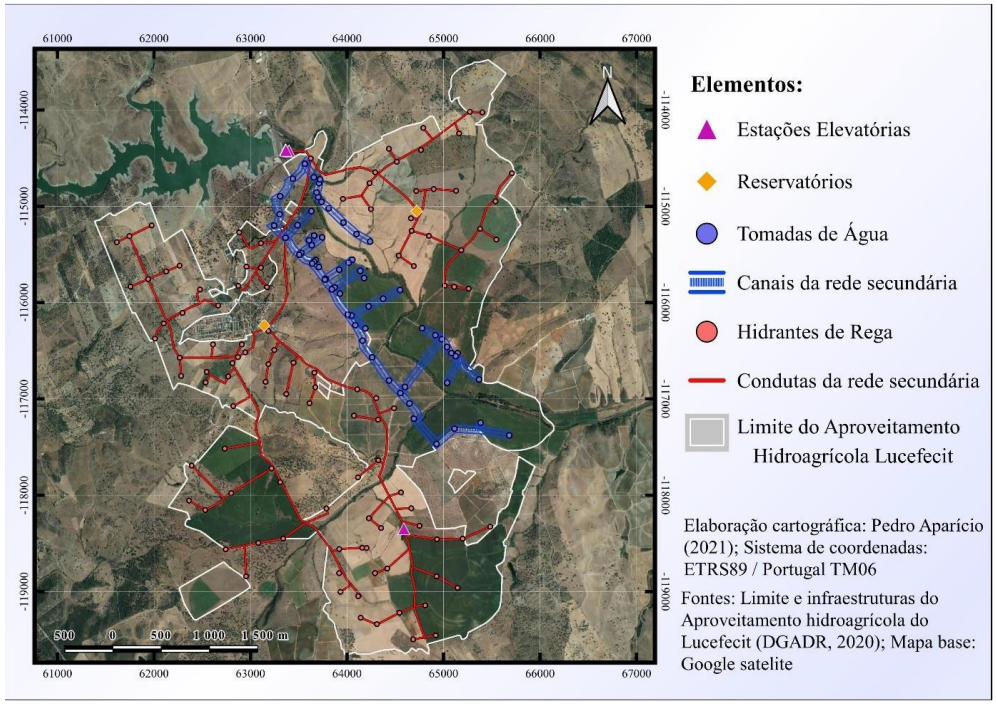
The lack of reliable and up-to-date base information/data about the crop pattern, its spatial distribution and respective growth cycles, prevents the accurate characterization of global irrigation requirements and their comparison with the volumes effectively used at the CIS level.

Main objective

Estimate the water requirements at the source of the Lucefecit collective irrigation system using Sentinel-2 images.

Case study: Lucefecit colective irrigation system



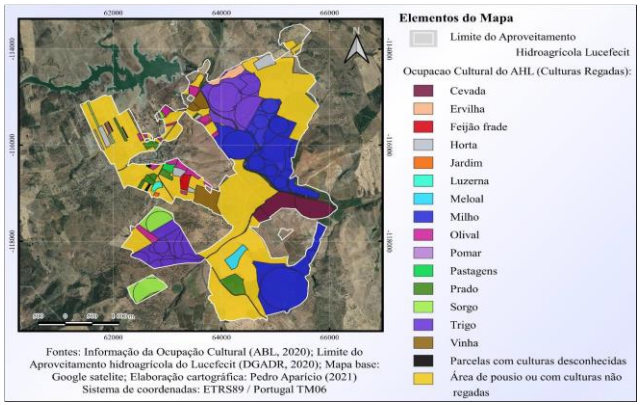


- Irrigated Area 1175 ha;
- 211 ha open channels;
- 964 ha pressurized network.

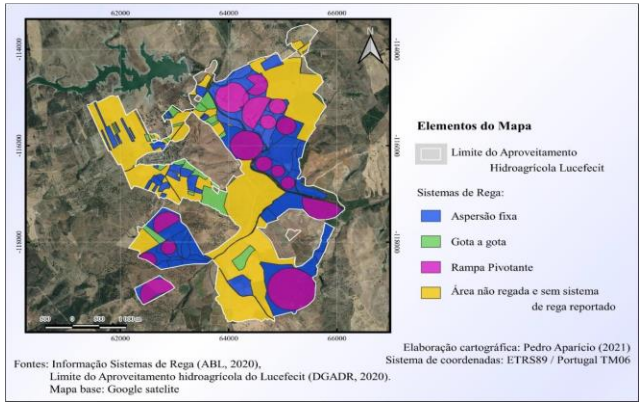
Source: Aparício, P.P., Rolim, J., Cameira, M.R., 2022. (Abstract) Estimação das necessidades globais de rega do aproveitamento hidroagrícola do Lucefecit com o recurso a imagens Sentinel-2. In: IX Congresso Nacional de Rega e Drenagem, 18 a 20 de outubro de 2022, Beja, Portugal.

GIS - Crop pattern, irrigation systems and soil maps (2020)

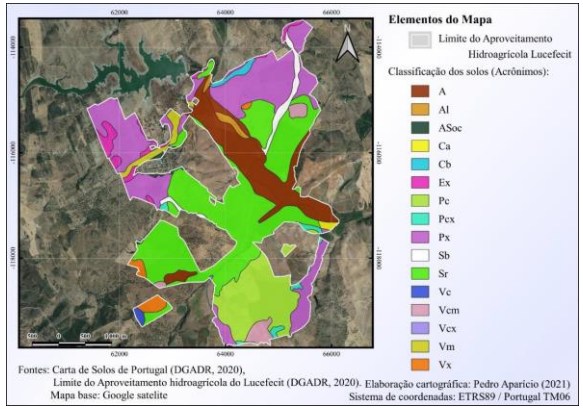
Crop pattern:



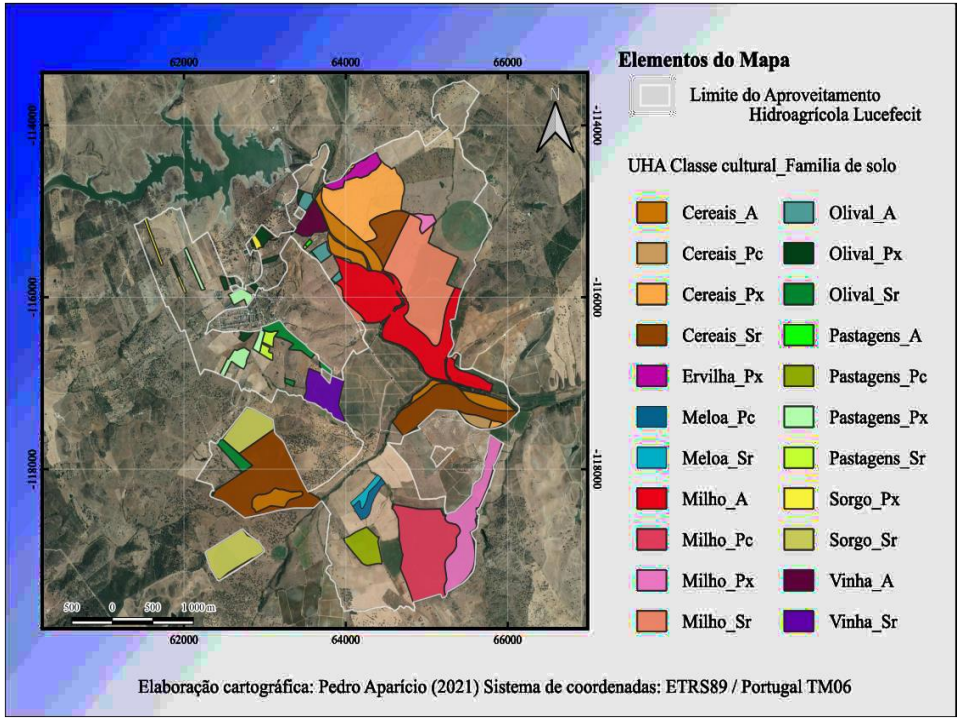
Irrigation systems:



Soils:

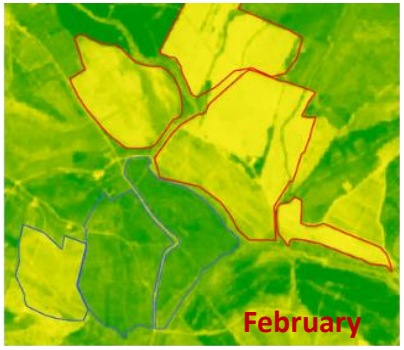


Homogeneous units of analysis

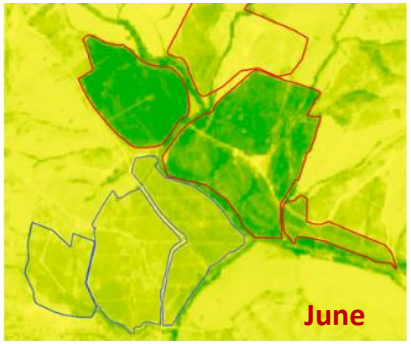


22 UHA

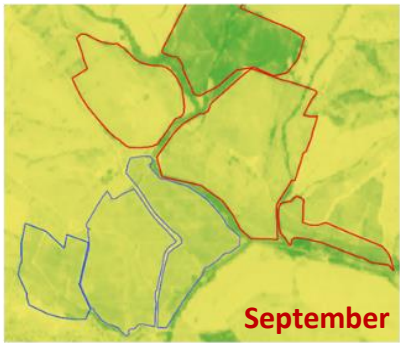
Crop data validation

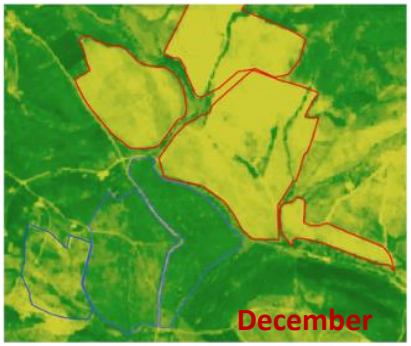


a)

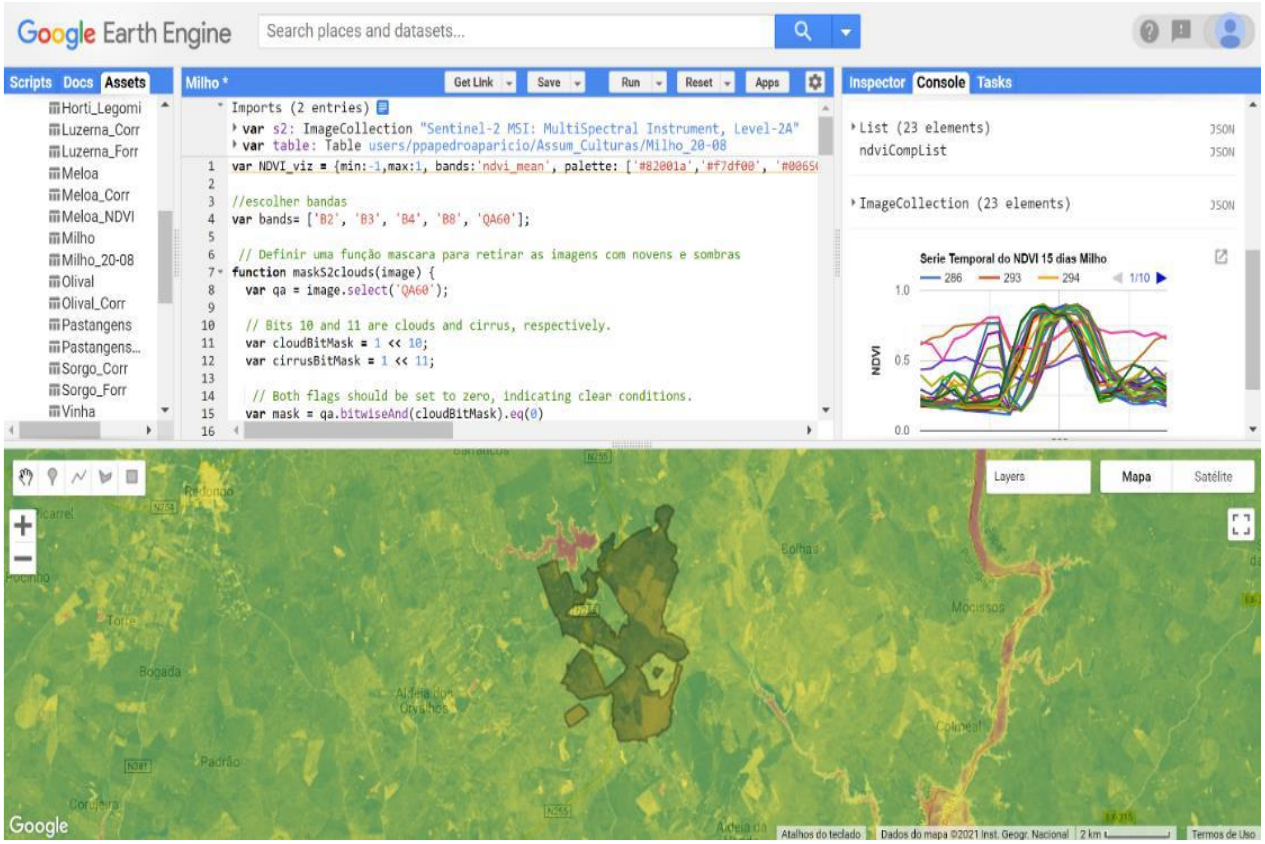


b)

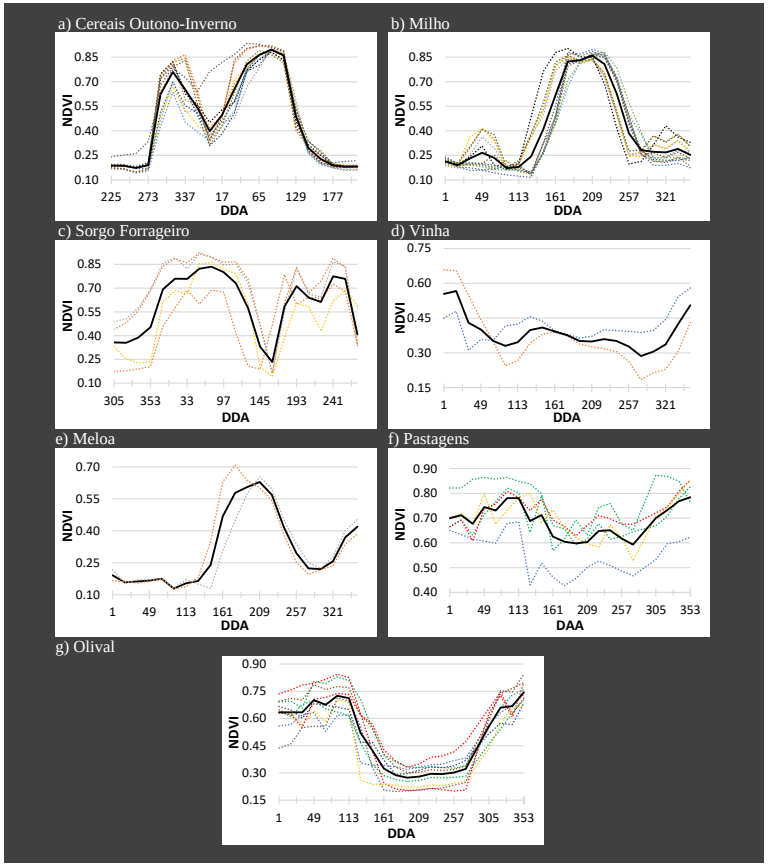


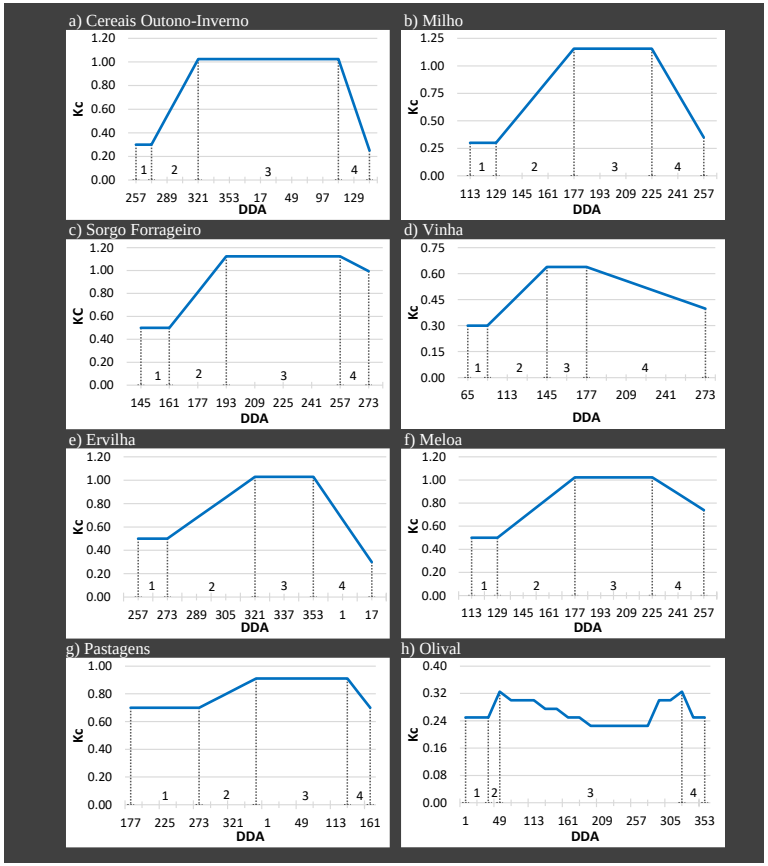


Retrieving of VI time series with Google earth engine

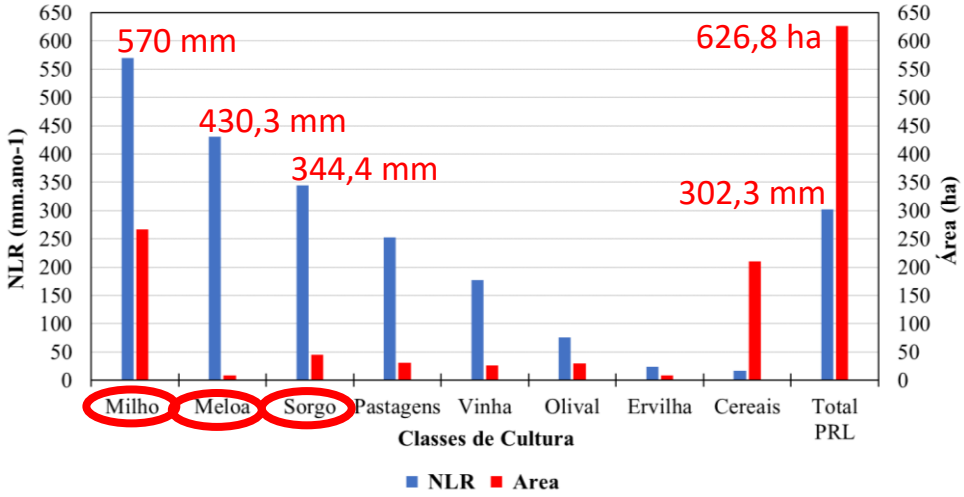


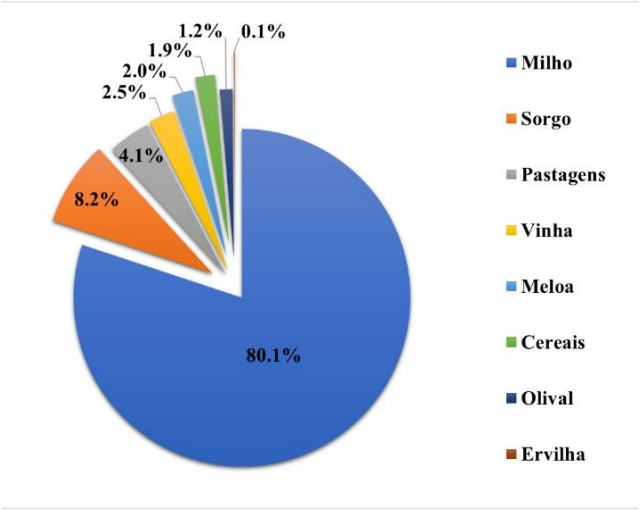
Crop phenology and Kc curves



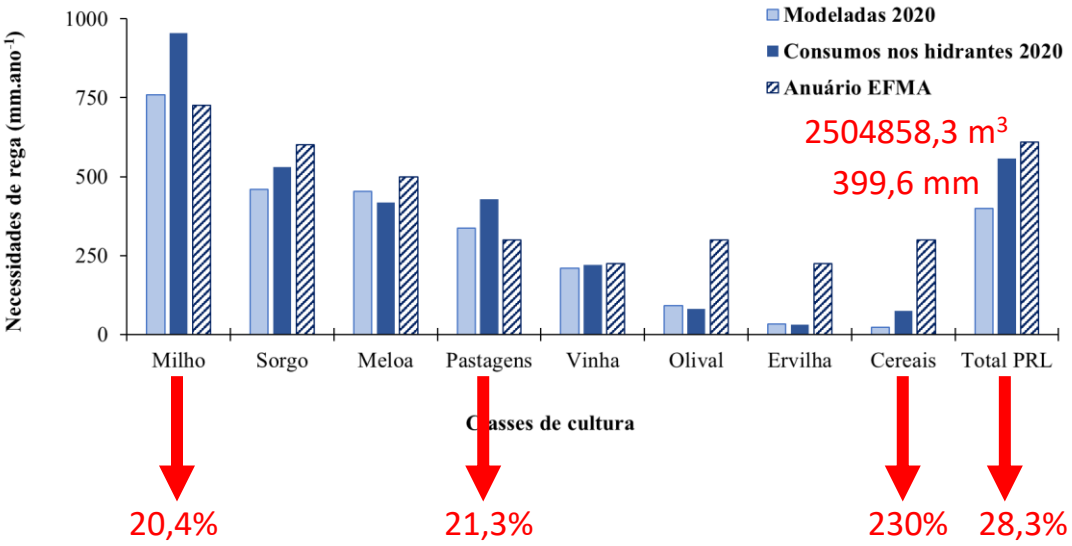


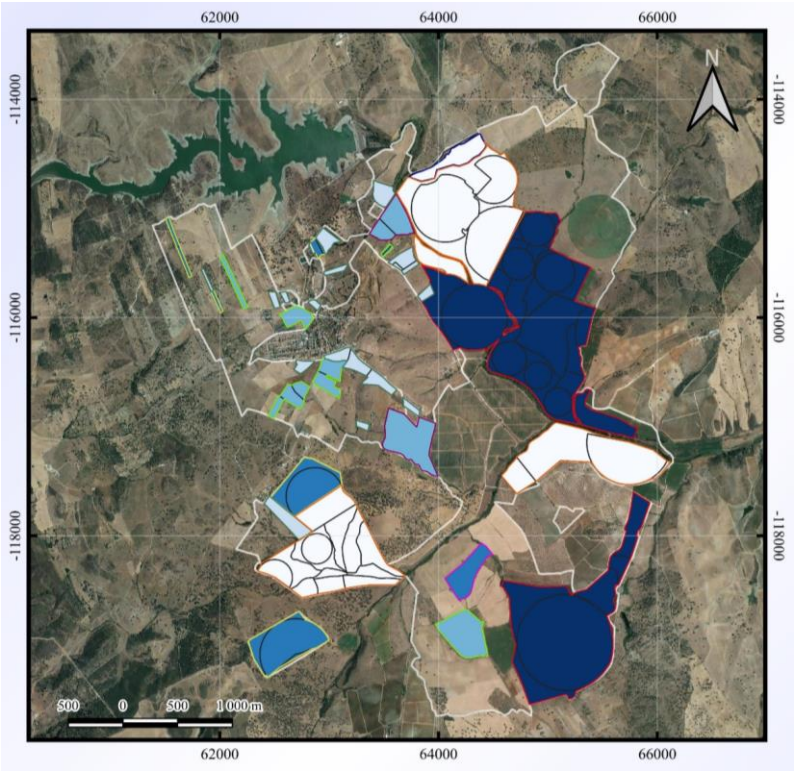
Estimated crop irrigation requirements (ISAREG model)



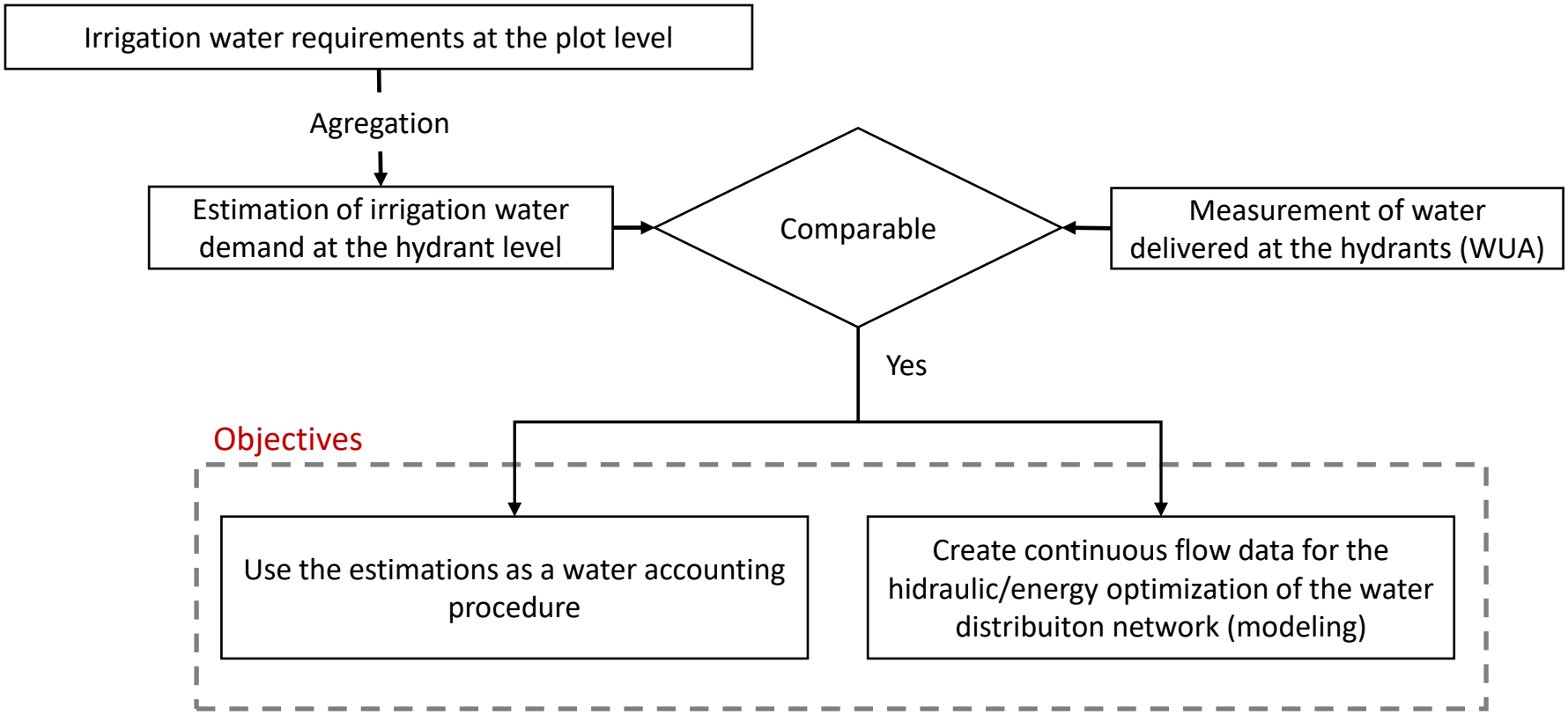


Crop irrigation requirements - Estimated vs. WUA reported values





Water accounting methodology – next steps



Conclusions

- **The use of NDVI temporal profiles** : define the phases of the phenological cycles;
- **The GEE platform**: automates the processing of EO data time series;
- Lucefecit CIS consumes 28.3% more water than the simulated annual WRS;
- Water accounting methodologies generate large volumes of data that will require automatic information processing technologies (e.g. machine learning, big data, …)

Irrigation water management methodologies based on free and open access Sentinel-2 data.

Precision irrigation

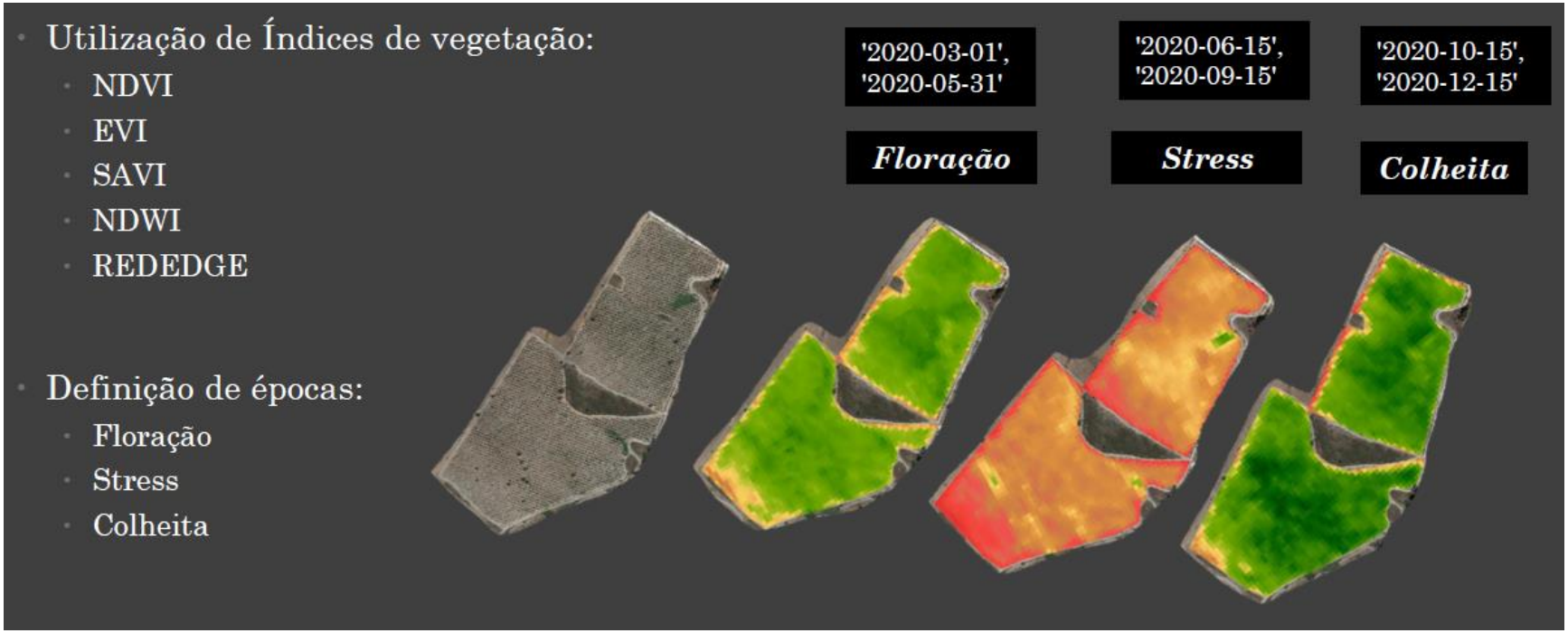
Context

Precision irrigation aims to apply irrigation depths, variable in the space and time, based on spatial distributed data. In this context it is highly relevant the Sentinel-2 images, with an high spatial resolution (10 m) and a short revisit time (5 days), which are also available for free.

Main objective

The development of an low-cost methodology for the delimitation of diferente sub-zones of crop vegetative vigour inside an olive orchard, and the estimation of the respective spatial variable irrigation depths

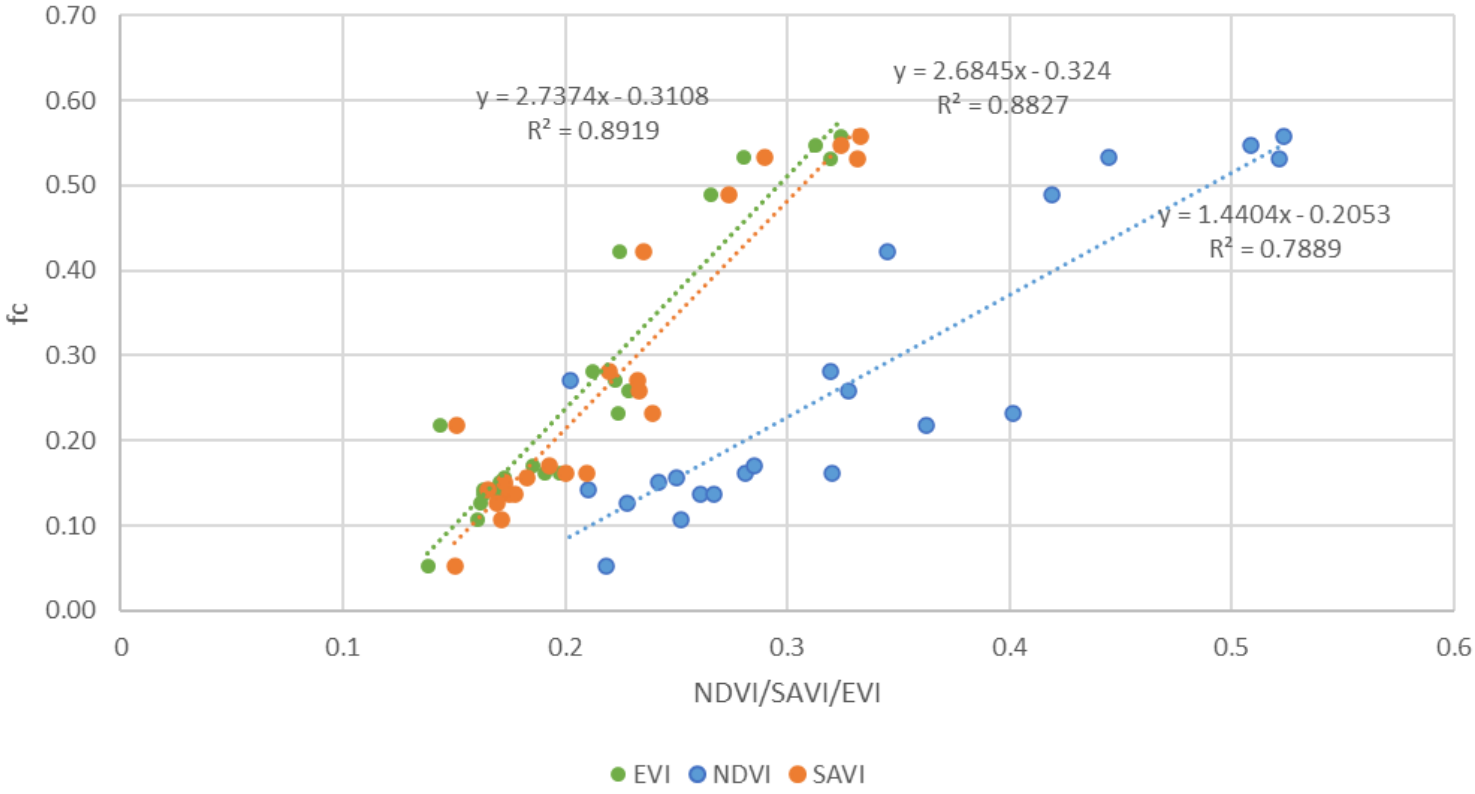
Vegetation indices for different crop phases



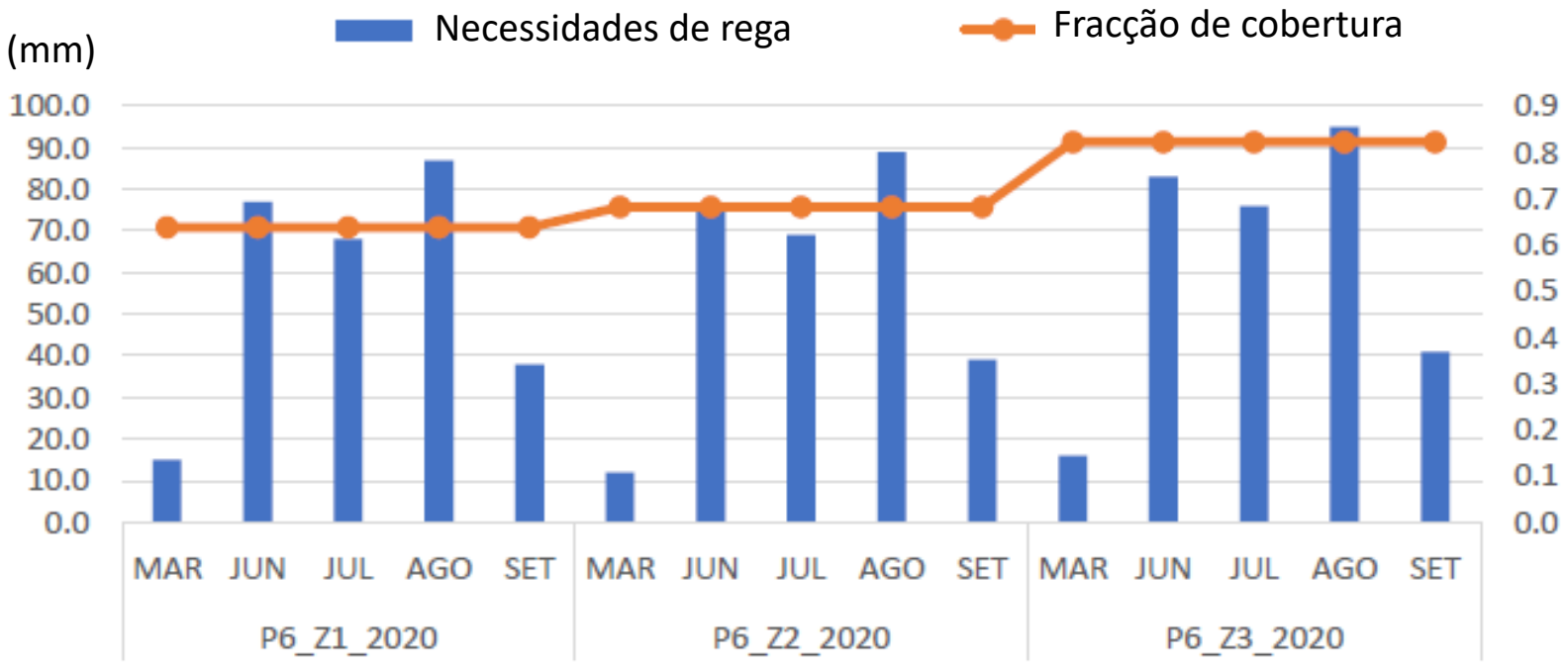
Source: Santos, S., A. Navarro, A., Rolim, J. (2022). (Poster) Rega de precisão no olival. Desenvolvimento de uma metodologia para zonamento da parcela e cálculo de dotações de rega variáveis no espaço. In: IX Congresso de Nacional de Rega e Drenagem, 18 a 20 de outubro de 2022, Beja, Portugal.

Sub-zones delimitation – Super-intensive olive orchard

Ground cover fraction and vegetation indices



Monthly crop irrigation requirements in the plot sub-zones




Thank you!