A novel methodology for mapping irrigation types from very high resolution remotely sensed data

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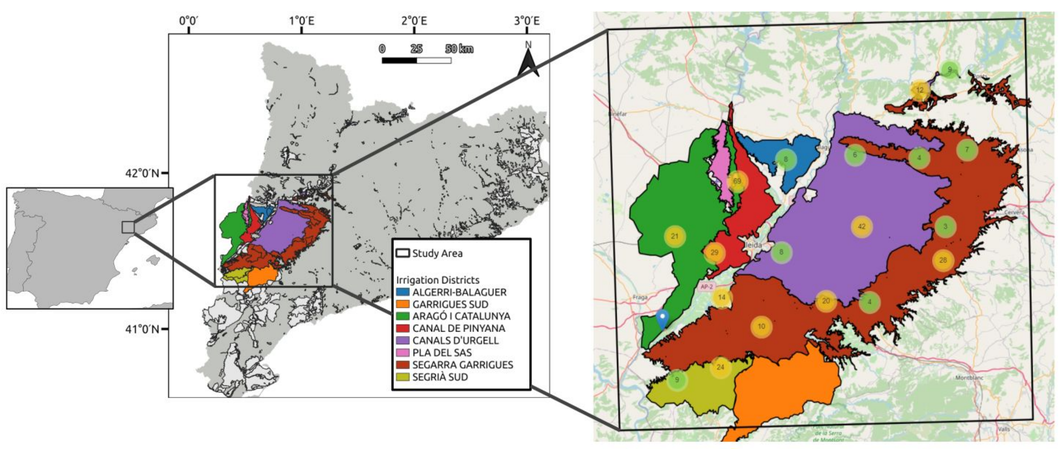
Introduction

While different studies were already performed on just detecting irrigated areas, there is still no research on classifying different irrigation systems (i.e. flood, sprinkler or drip irrigation) based on remotely sensed data. This information is needed to improve the modelling and understanding of the human impact on the water cycle, but it also useful at the administrative level in order to monitor changes and optimize irrigation practices. In this context, we propose a novel approach for classifying different irrigation systems. Time series of Actual Evapotranspiration (ET_a) and Soil Moisture (SM) at 20 m spatial resolution were used as inputs of three supervised AI models. Ground truth data from over 300 fields inside a total area of around 80 km x 85 km was collected. The three following AI models specialized for time-series were used: Random Forest, Rocket and ResNET.

Study Area

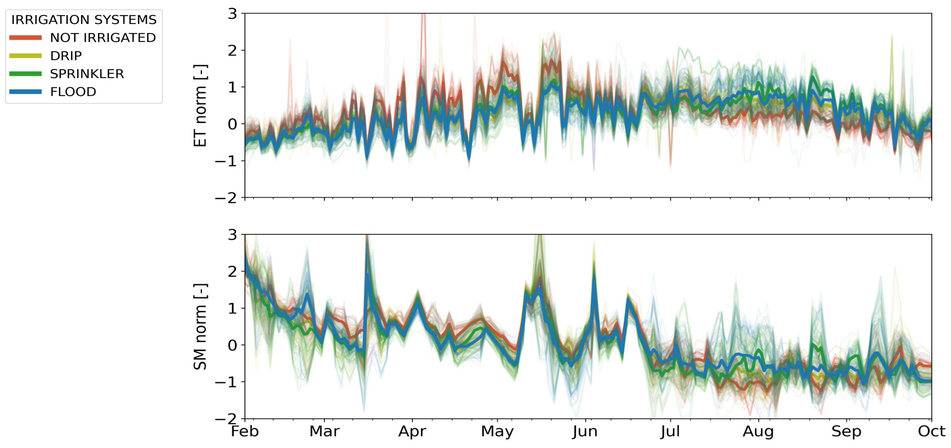


Dataset

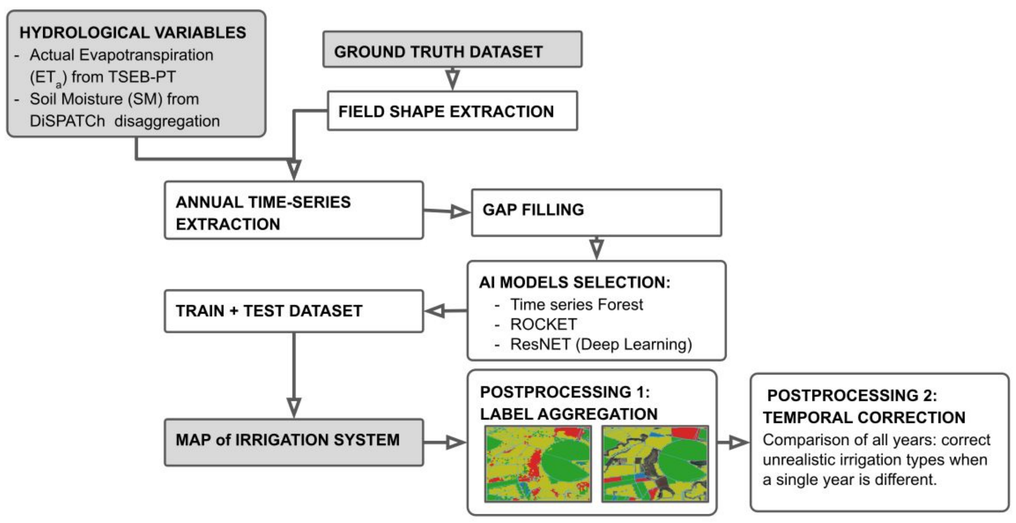
Ground Truth dataset:
> 300 fields / 3 years considered / >100k time-series

Main Hydrological Variables (from satellite data):

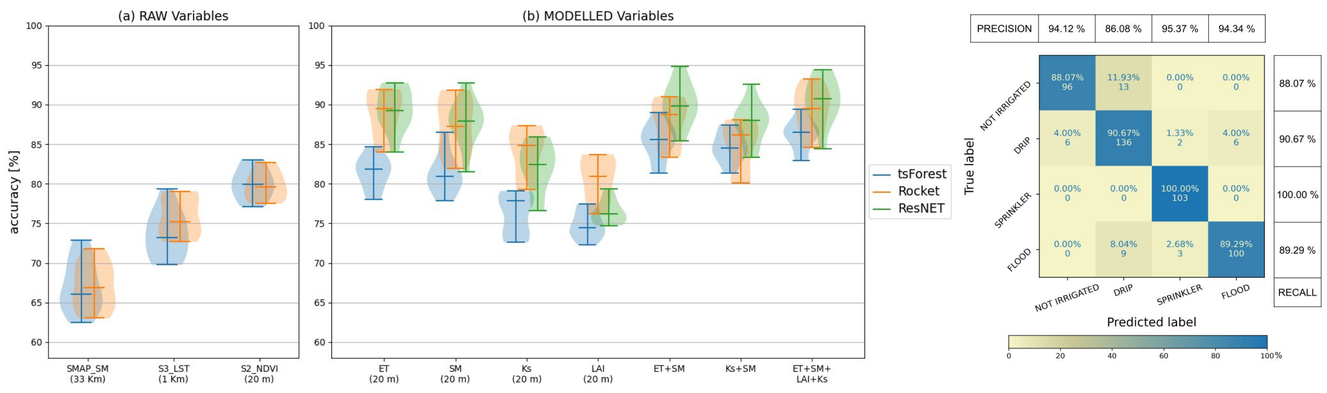
- Disaggregated Soil Moisture (SM) from DisPATCh at 20 m (SMAP + LST from S2-S3)
- Actual Evapotranspiration (ET_a) from TSEB-PT at 20 m (Sen4ET)



Methods



Results

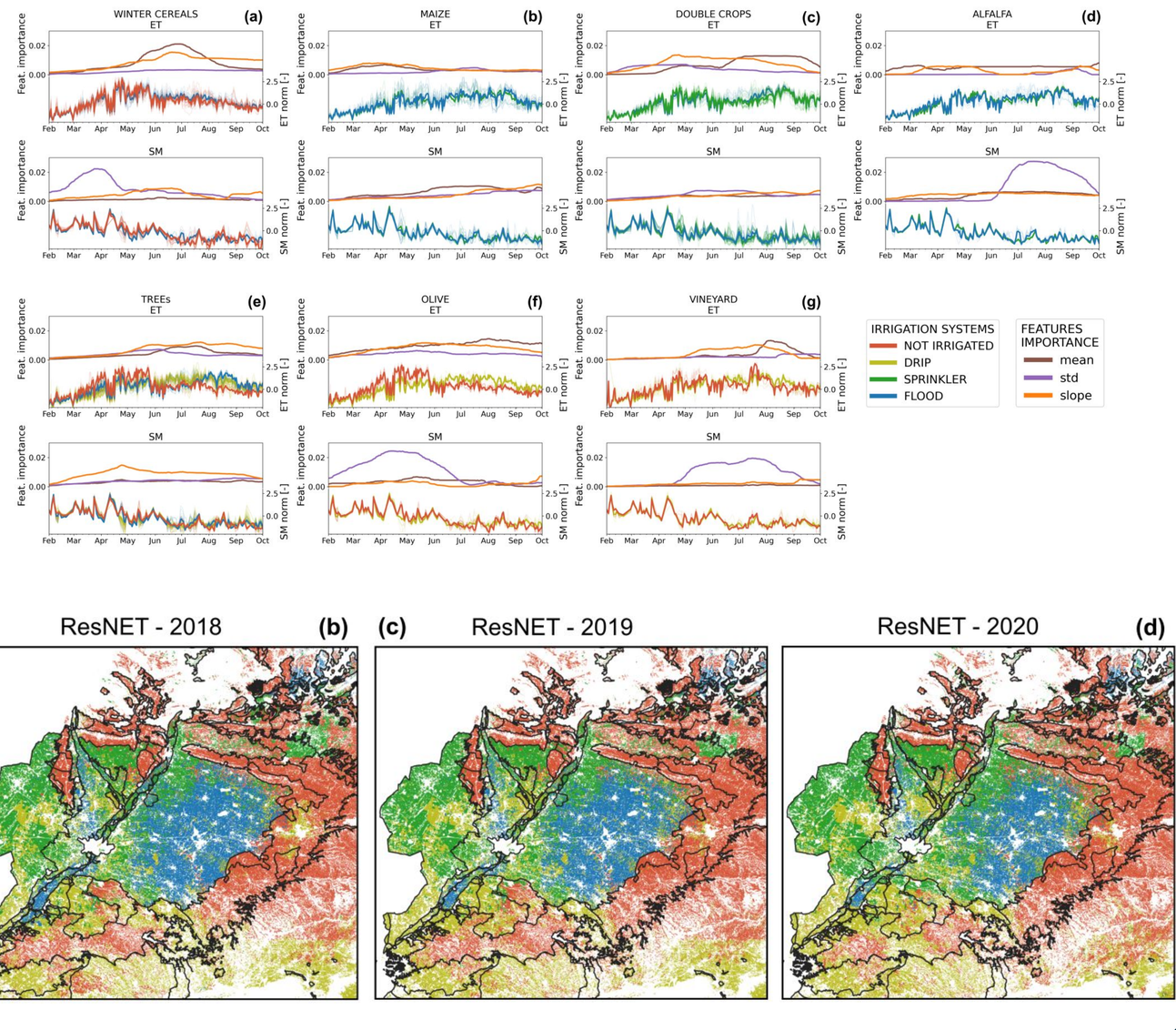


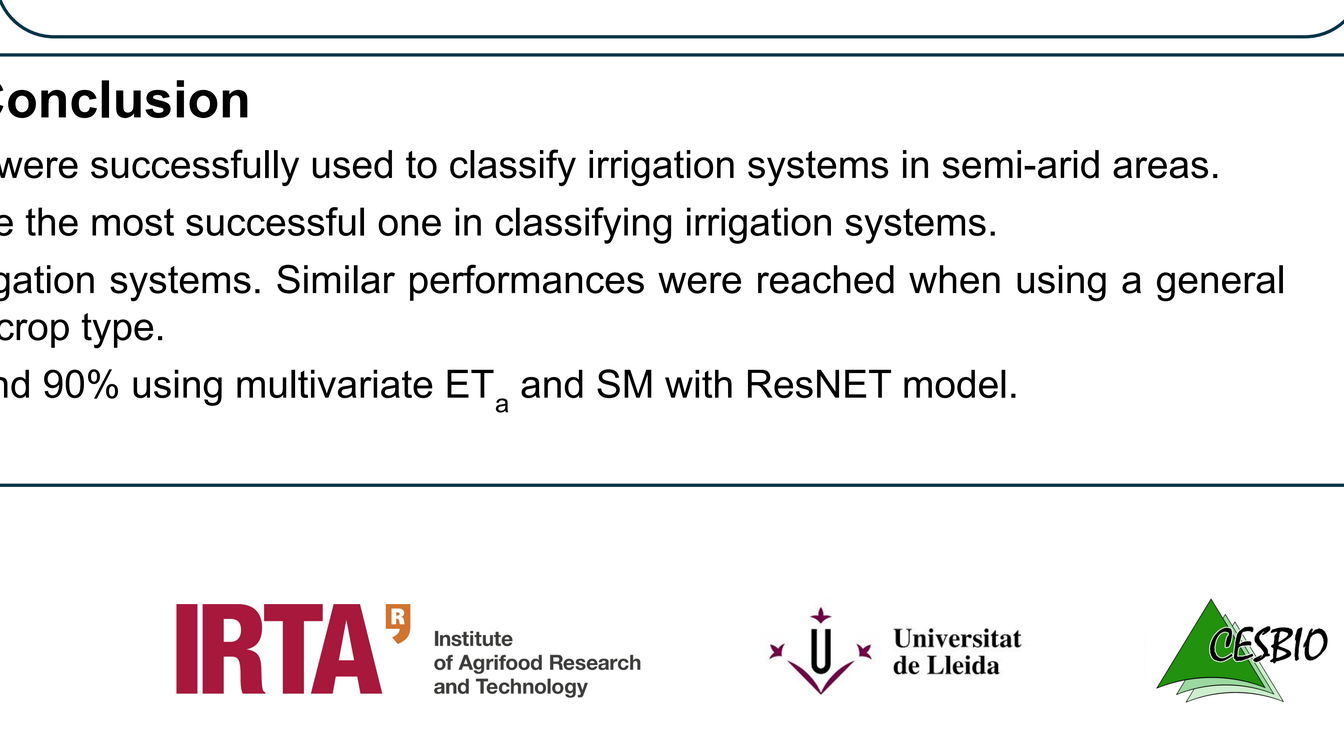
Single model / multi-model comparison

Variables	Crop types							RESULTS	
	Winter Cereals	Maize	Double Crops	Alfalfa	Fruit & Nut Trees	Olives	Vineyards	Aggregated Models	General Model
ET_a-TSEB	**94.00%**	76.36%	90.00%	**58.33%**	92.59%	**100.00%**	85.56%	89.94% ± 2.23	86.11% ± 3.20
ET_a-TSEB cropped	93.20%	77.27%	88.18%	48.33%	92.96%	**100.00%**	84.44%	89.07% ± 1.70	-
SM Dispatch	90.80%	79.09%	86.36%	**58.33%**	90.74%	99.23%	86.67%	88.02% ± 2.33	83.77% ± 1.85
SM Dispatch cropped	89.60%	**82.73%**	85.23%	**58.33%**	90.37%	96.92%	82.22%	87.22% ± 1.81	-
ET_a+*SM*	93.20%	**82.73%**	**92.95%**	**58.33%**	**93.70%**	**100.00%**	**88.89%**	**91.60% ± 2.11**	**89.44% ± 2.97**
ET_a+*SM* cropped	93.20%	81.82%	92.27%	53.33%	94.26%	**100.00%**	86.67%	91.23% ± 1.63	-

Final metrics extracted after post-processing

METRICS (%)	MODELS		
	tsForest	ROCKET	ResNET
Accuracy	85.29 ± 2.41	87.56 ± 2.95	**90.10** ± 2.70
Precision	85.43 ± 2.53	88.80 ± 3.12	**90.33** ± 2.78
Recall	84.76 ± 2.51	86.81 ± 3.17	**90.02** ± 2.76
Kappa	80.20 ± 3.25	83.19 ± 4.00	**86.70** ± 3.62





Conclusion

- Temporal time-series of fundamental hydrological variables were successfully used to classify irrigation systems in semi-arid areas.
- ResNET, the only **deep learning model** tested, proved to be the most successful one in classifying irrigation systems.
- **Crop types** did not interfere with the task of classifying irrigation systems. Similar performances were reached when using a general model for all crop types and multiple models specialized by crop type.
- Classification **accuracy** for irrigation systems reached around 90% using multivariate ET_a and SM with ResNET model.