An integrative information aqueduct to close the gaps between global satellite observation of water cycle and local sustainable management of water resources (iAqueduct)

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Water JPI Water Works 2017

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Funded by the Horizon 2020 Framework Programme of the European Union

iAqueduct

HARMONIOUS uas for environmental monitoring

WORKSHOP HARMONIOUS, Coimbra, 6 November 2019 iAqueduct

Water JPI

Water Works 2017

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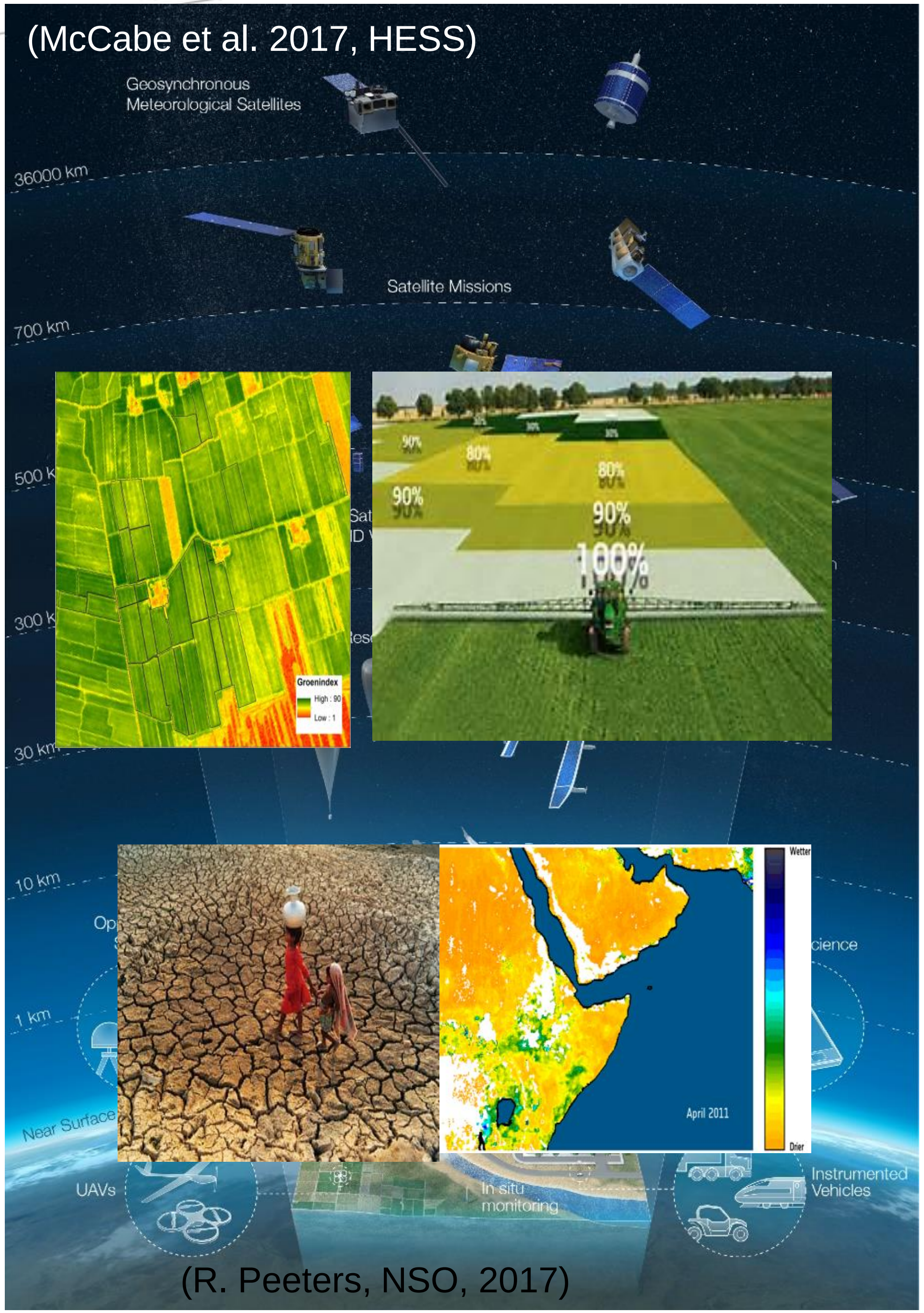
Motivation

Current agricultural services

- Weather forecasts
- Crop monitoring
- Disease prevention and monitoring
- Yield production and yield gap
- Irrigation advices
- Water productivity
- Agricultural subsidy control



(McCabe et al. 2017, HESS)

(R. Peeters, NSO, 2017)

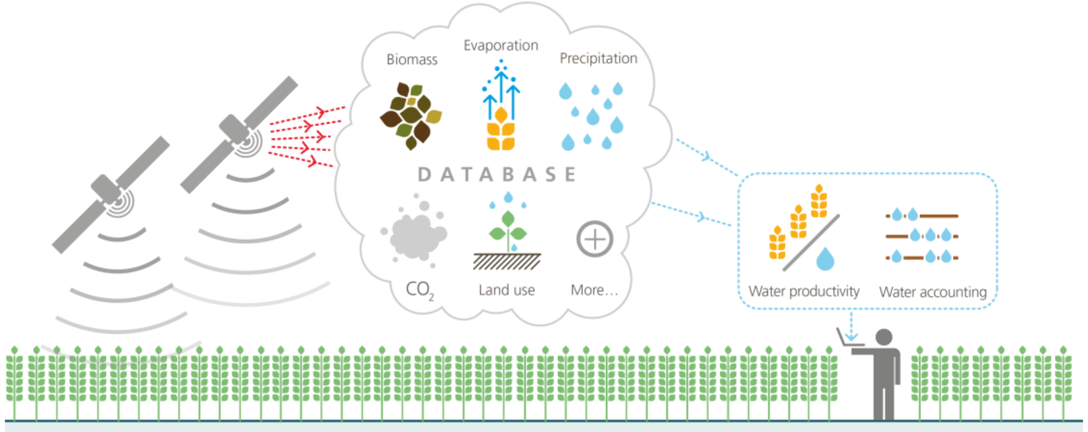
Food and Agriculture Organization of the United Nations

Using Remote Sensing in support of solutions to reduce agricultural water productivity gaps

Motivation

WaPOR is the FAO portal to monitor Water Productivity through Open access of Remotely sensed derived data.

Remote Sensing can help monitor water productivity in an objective and cost effective way.



Database structure.

Level 1: continental (250 m ground resolution);

Level 2: 21 countries and five river basin (100 m);

Level 3: 8 areas in Lebanon, Egypt, Ethiopia, Mali, Kenya, Mozambique, Sudan (30 m).

Seamless monitoring from April 2009 to date, at 10 days or daily (for precipitation and ET0) interval.

Variables: Water productivity, land productivity, actual and reference evapotranspiration, land cover and use, biomass, precipitation, carbon dioxide uptake, yields, harvest index and crop calendar (Level 2 and 3 only).

MOTIVATION

- For local agricultural service, it is always needed high resolution spatiotemporal data;
- Furthermore, to understand climate impacts on agricultural/natural ecosystems, we should combine different sources of remote sensing data with process-based models.

Photo: Akkerwijzer.nl

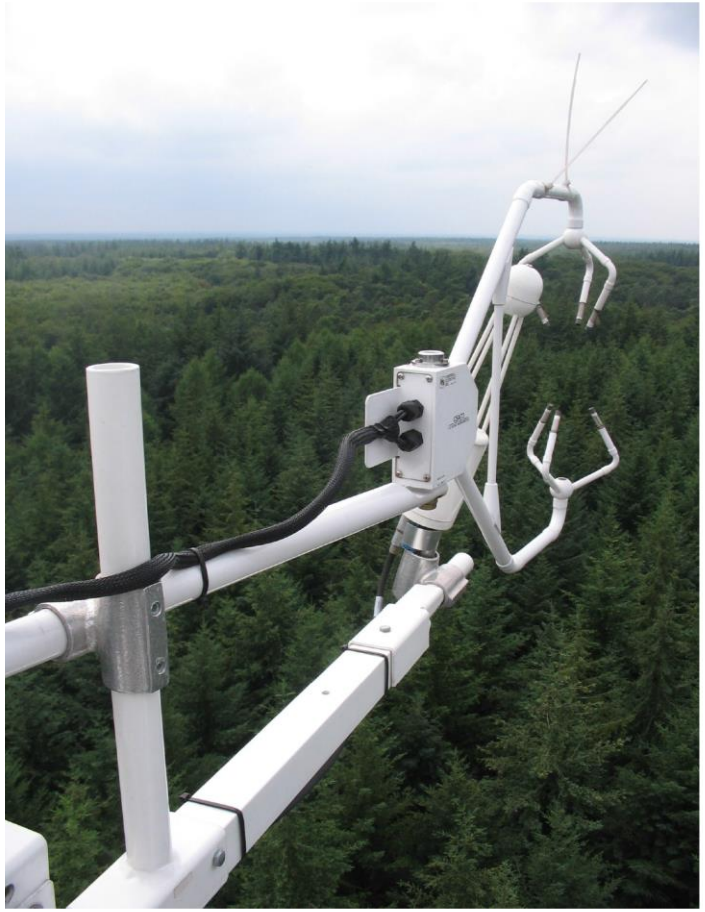
MOTIVATION

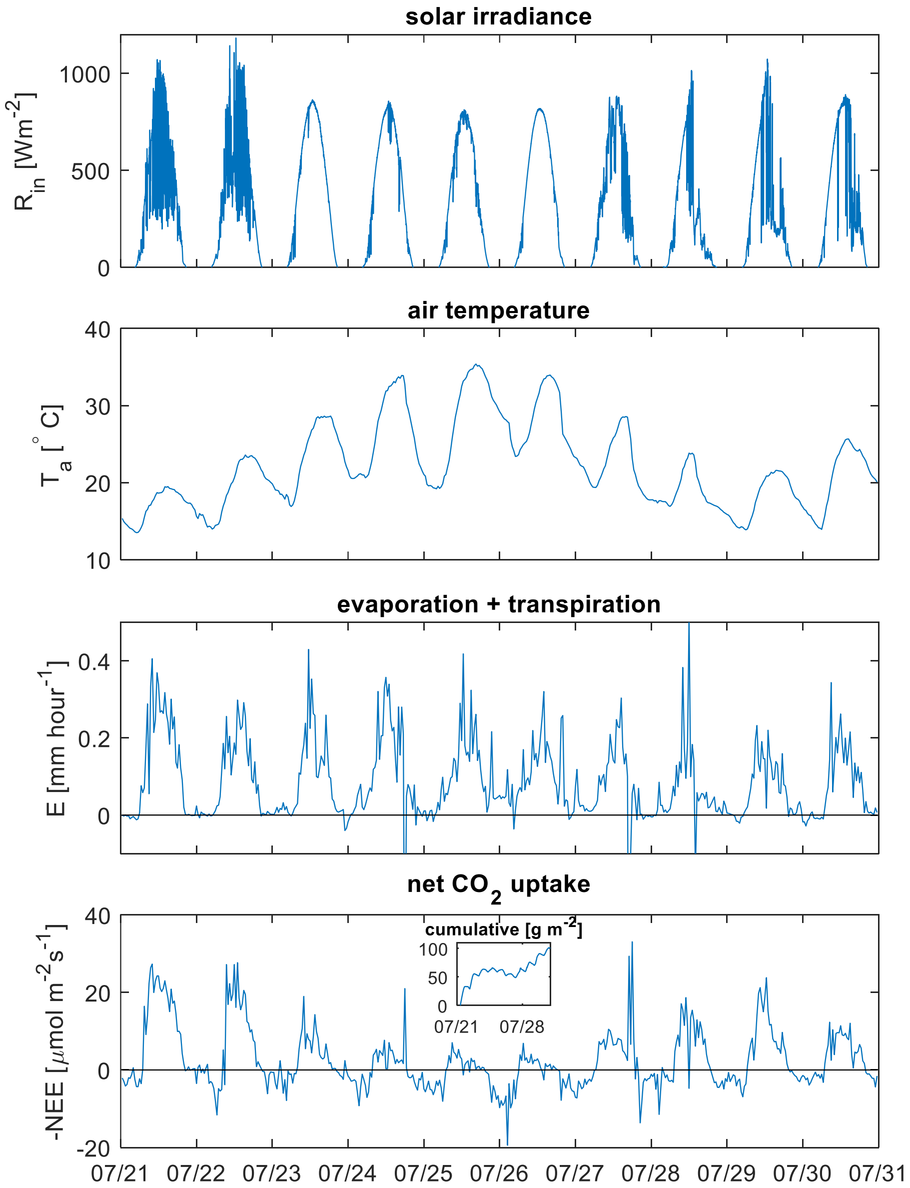
What happened to the Dutch forest during the exceptionally hot days of 24-26 July 2019, as measured at our station in Speulderbos, NL.

Transpiration rates remain high, but the daytime CO2 uptake diminished, and did not compensate for the (increased) night-time respiration.

The forest turned from a sink into a source of CO2 for a couple of days.

Forest, The Netherlands





(C. van Der Tol 2019)

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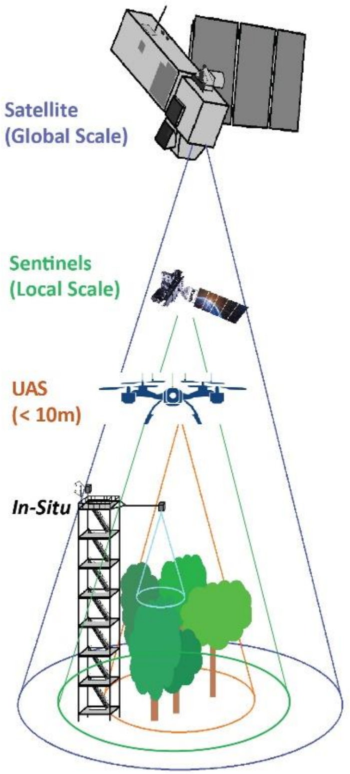
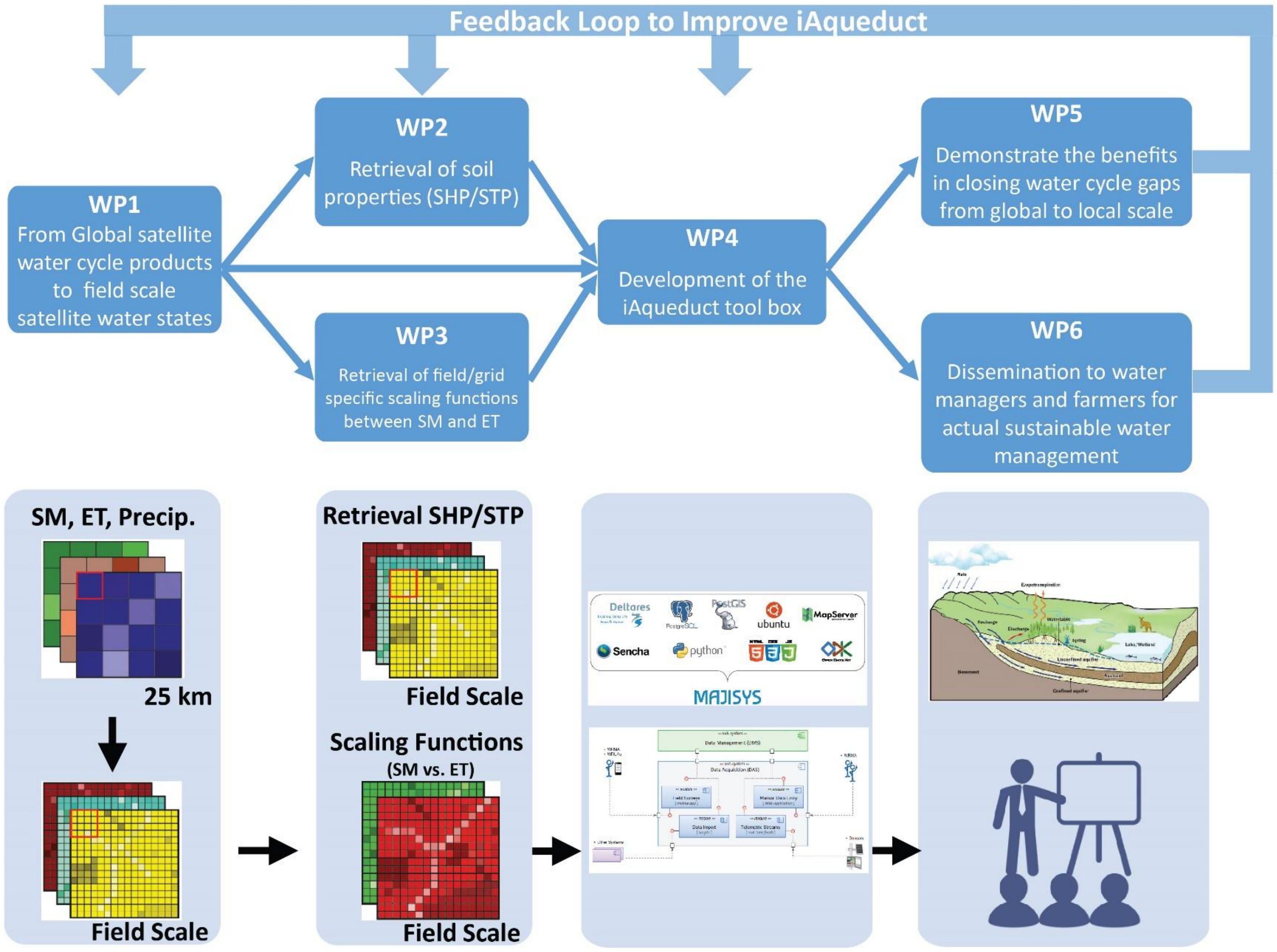
Main Objective

iAqueduct will integrate the various components ***from the global water cycle observation to local soil and water states*** in an open-source water information system and test and demonstrate their utility on pan-European scale at a set of carefully selected research sites for sustainable management of water resources.

iAqueduct Concept

Site1. Twente, NL	Temperate, Dry Winter, Hot Summer
Site2. Zala, HU	Cold, Humid, Warm Summer
Site3. Alento, IT	Temperate, Dry Hot Summer
Site4. Corleto, IT	Temperate, Dry Warm Summer
Site5. Barranco del Carraixet, ES	Arid, Steppe, Cold
Site6. Haogen , IL	Arid, Dry Hot Summer





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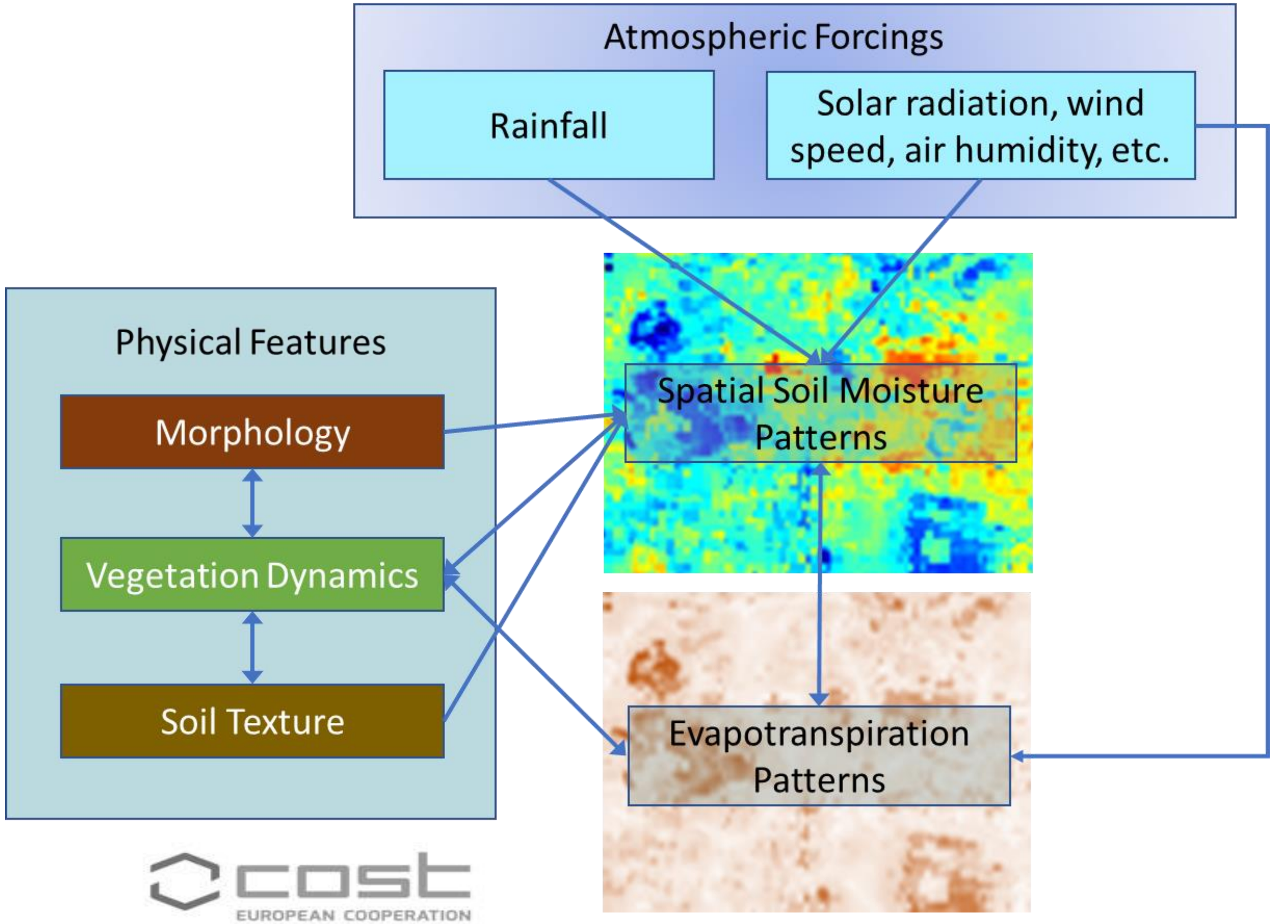
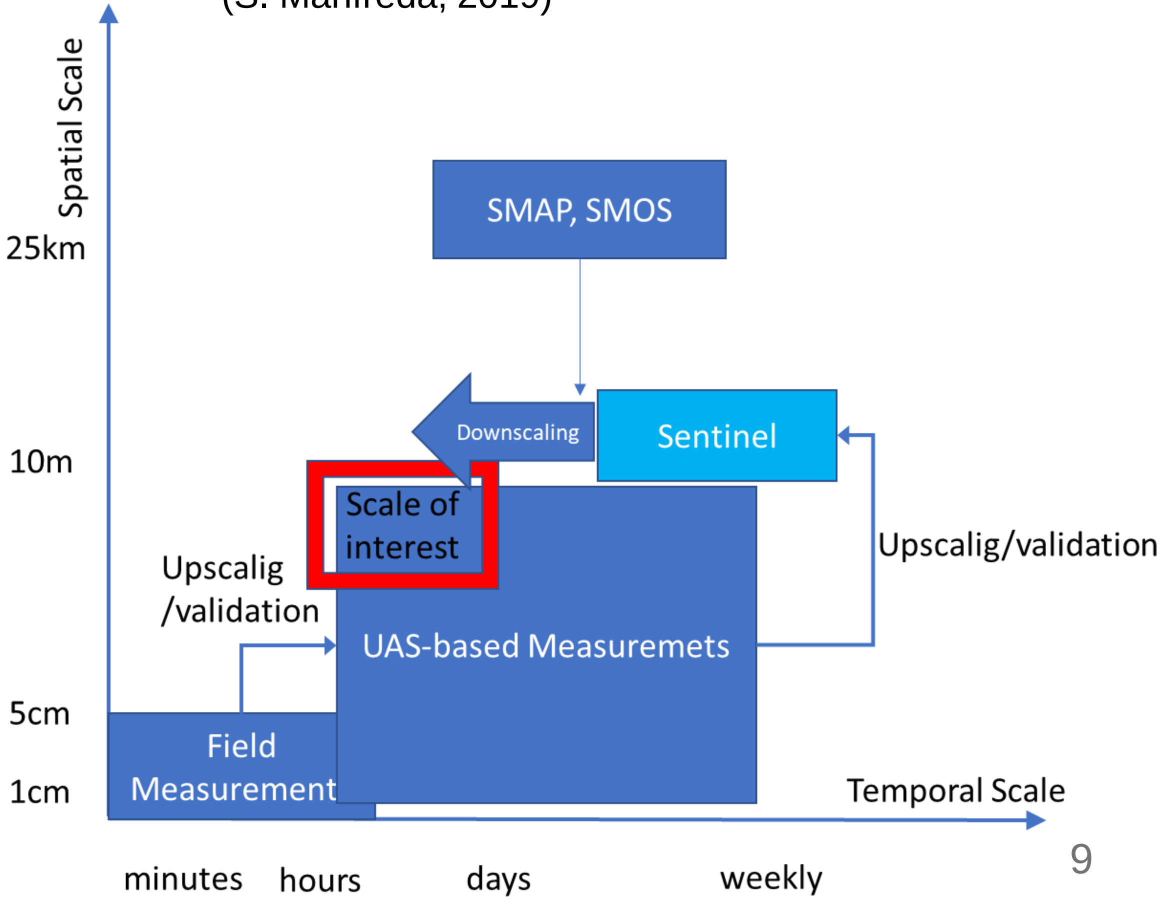
Global satellite water cycle products to field scale water states



(S. Manfreda, 2019)



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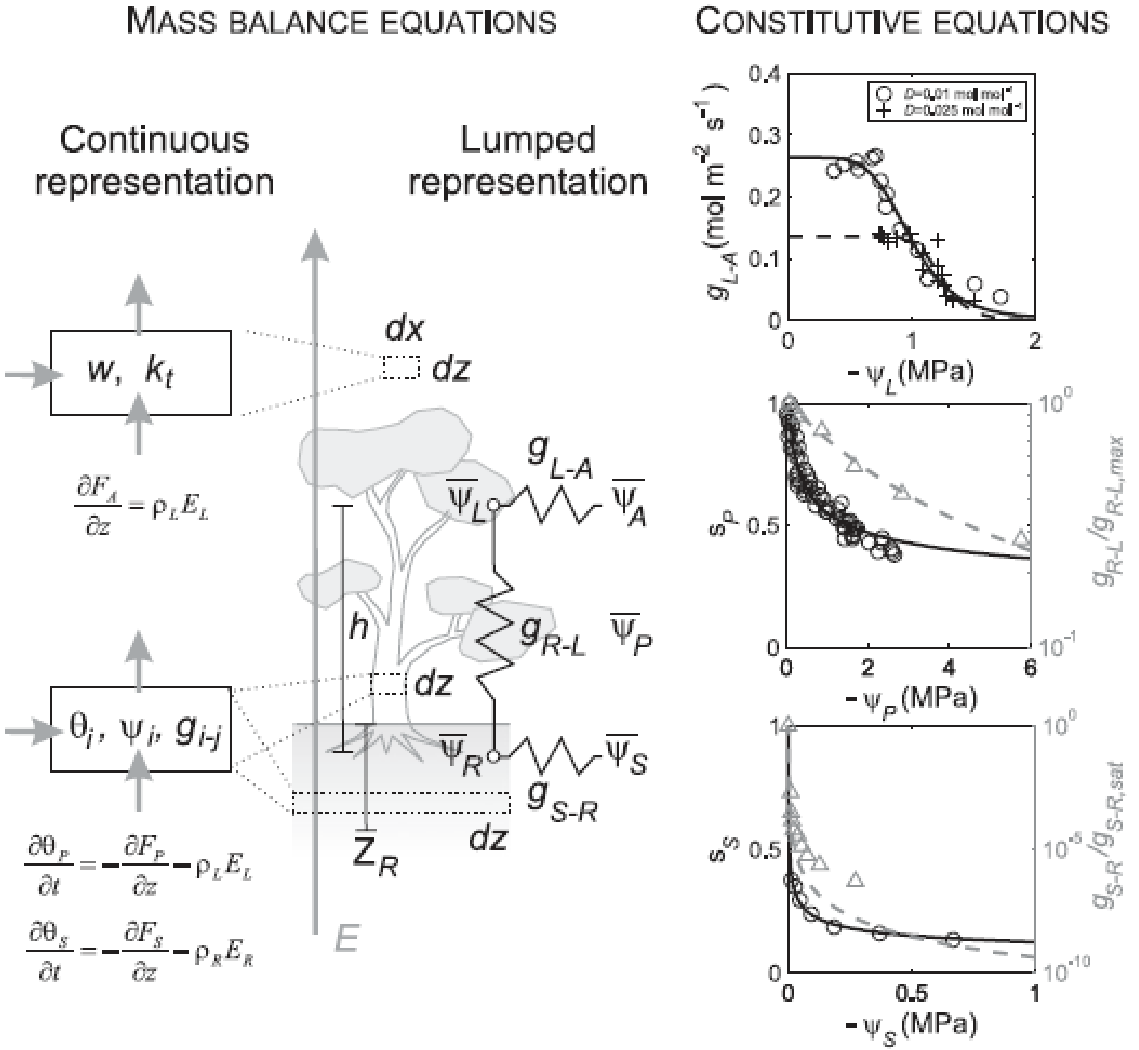
Soil-Plant-Atmosphere Model

-Focus on water balances and fluxes

-Energy in some (stomatal) models

-Can be lumped (big leaf + soil bucket models) or resolved layers wise (two big leaves or canopy layers + soil layers)

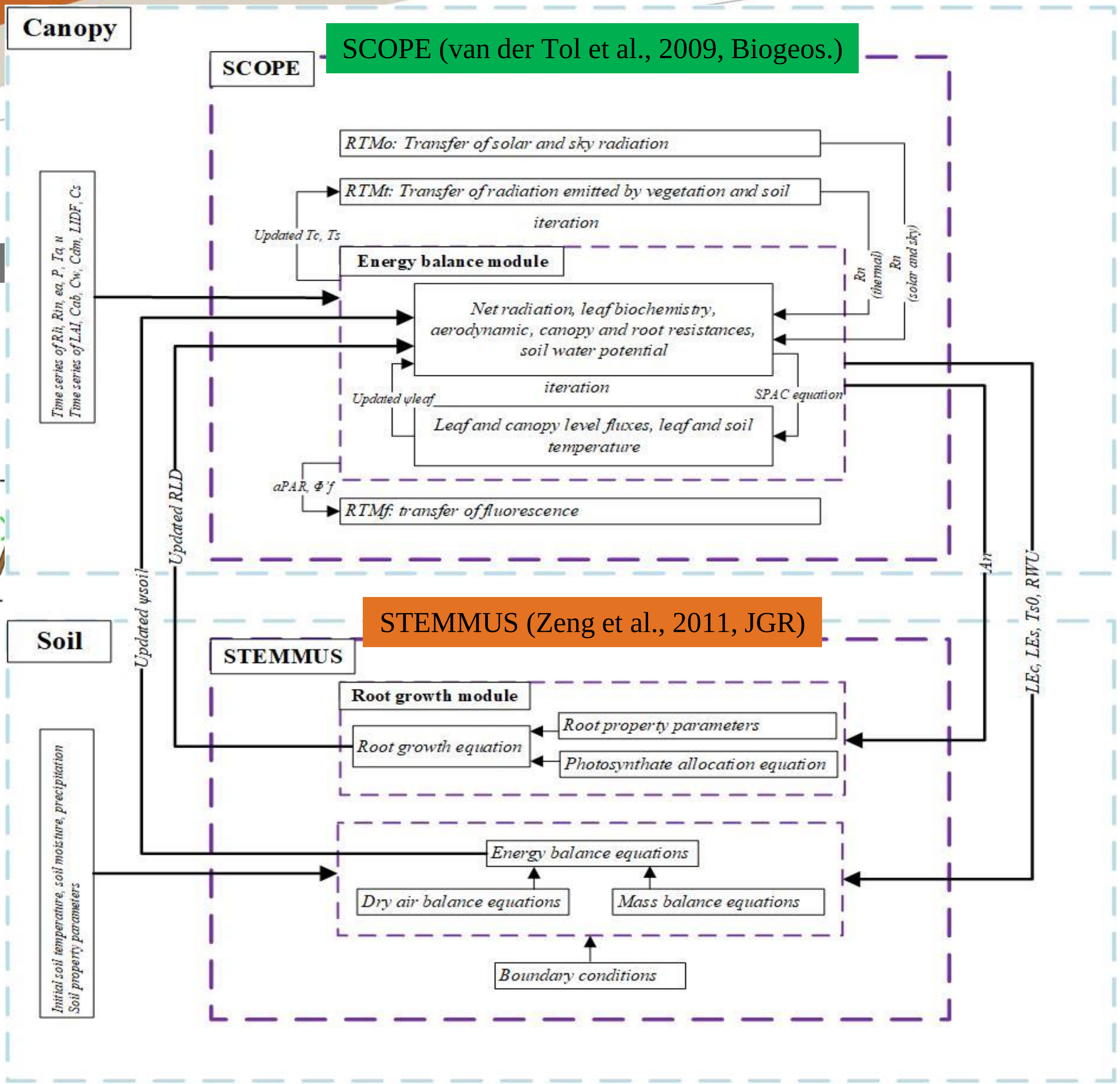


(Manzoni, Vico, Porporato, Katul, 2013 AWR)

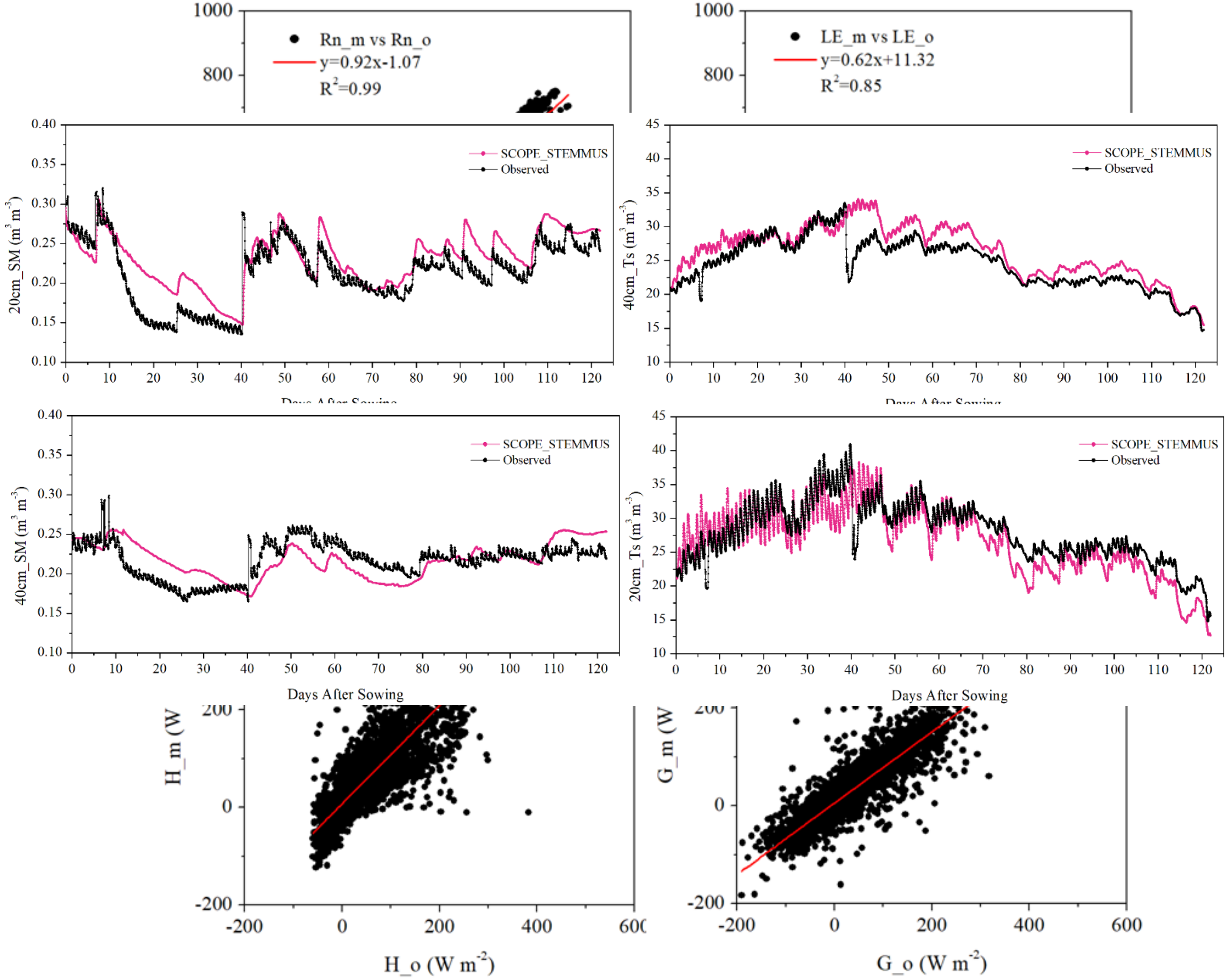
Soil-Plant-Atmosphere I

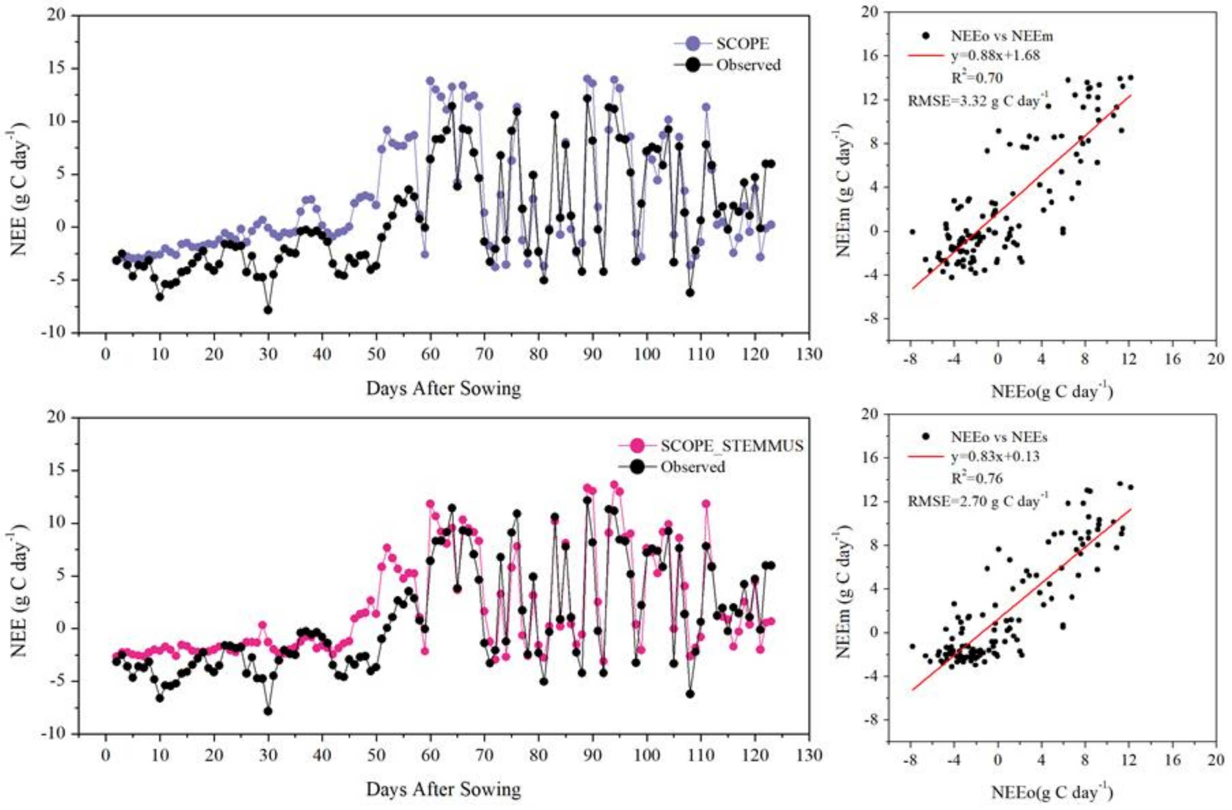
STEMMUS: a soil heat and moisture transfer model, considering vapor flow and airflow.

SCOPE: Integrated model of soil-canopy spectral radiances, photosynthesis, fluorescence, temperature and energy balance, at leaf level.

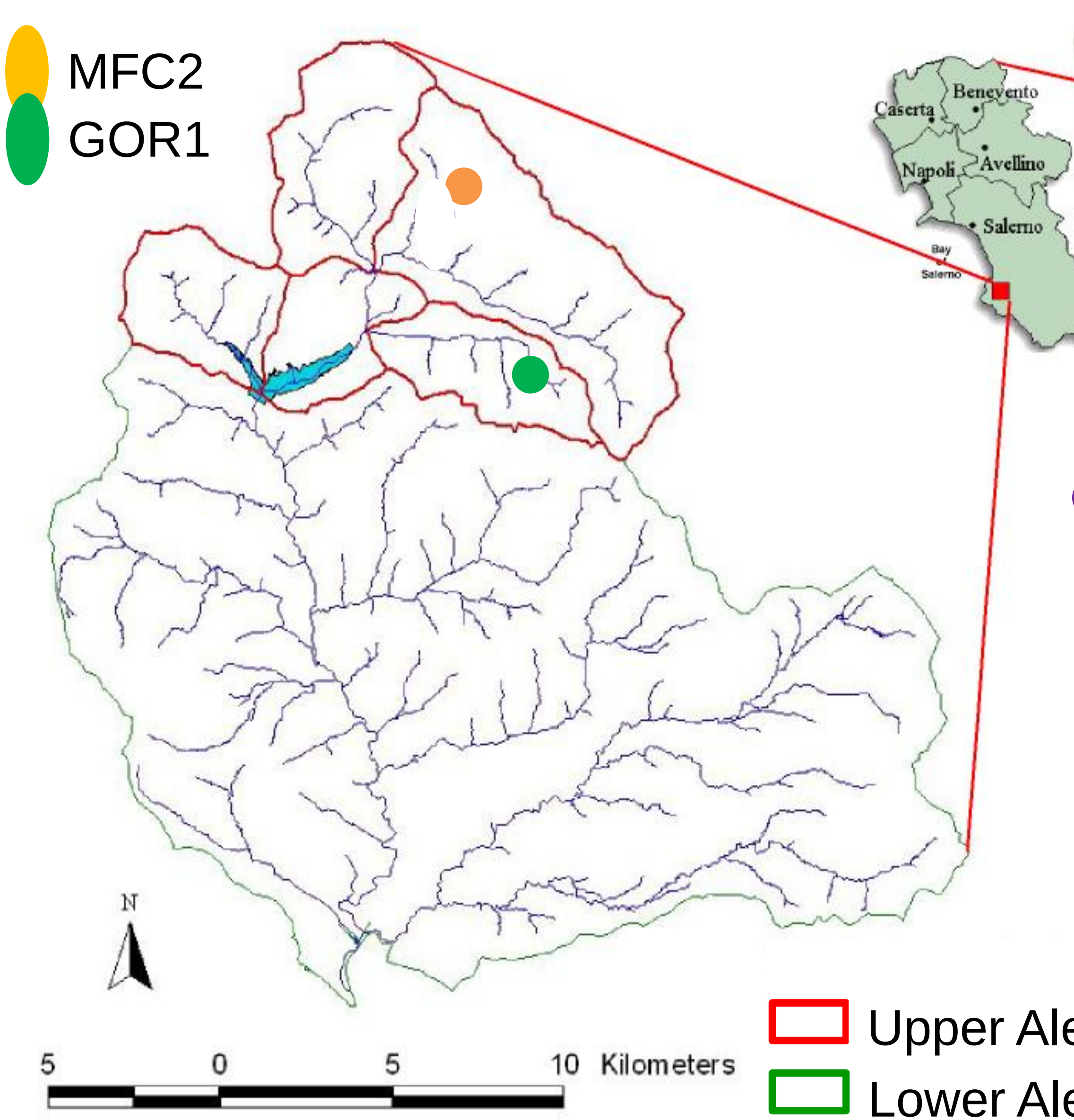


Soil-Plant-Atmosphere Model (for an ecosystem alike Alento)





Core Study Site (N. Romano)



Weather station

SoilNet wireless sensor network

Cosmic Ray Sensor Probe (Hydroinnova)

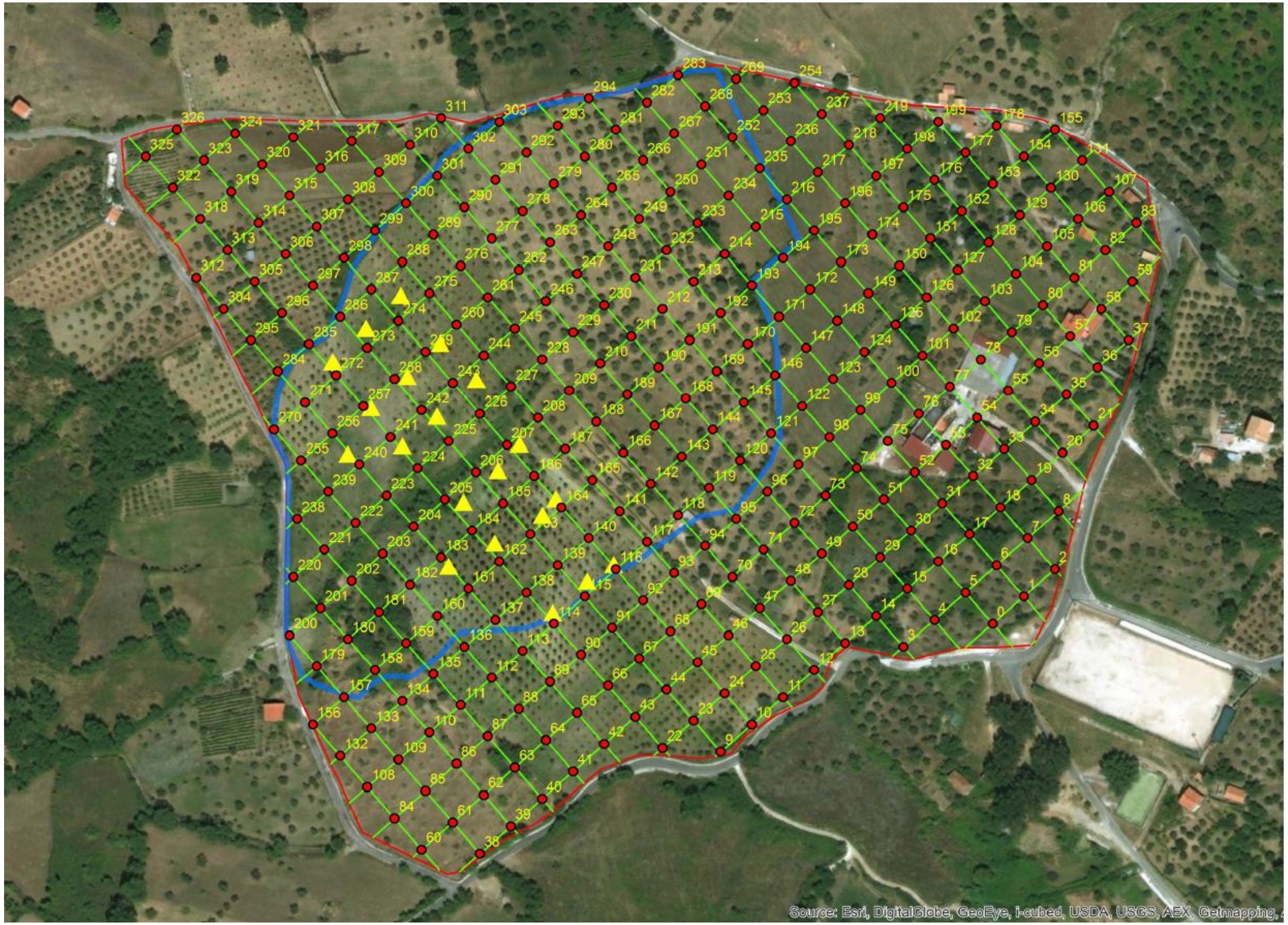
Upper Alento River Catchment (101 km^2)

Lower Alento River Catchment (308 km^2)

Water reservoir

Alento Catchment

To provide soil physico-chemical and hydraulic parameters for running models of different complexity, and in-situ soil moisture and temperature for validation. (Nunzio Romano, 2019)



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Soil Spectroscopy (Eyal Ben Dor, 2018-2019)

iAqueduct

CEC	HIGF	OM	Sand	Silt	Clay	TOTAL TEXTURE
17.65	2.11	6.22	5.42	5.42	34.72	45.55
42.23	3.27	3.64	11.64	11.64	58.89	82.18
49.82	3.39	3.81	12.60	12.60	59.38	84.59
48.27	2.98	3.03	10.15	10.15	67.03	87.34
45.33	2.39	4.00	10.10	10.10	60.30	80.49
51.77	0.92	3.41	6.50	6.50	80.77	93.77
33.39	3.38	3.20	12.55	12.55	54.15	79.26
45.40	2.61	2.93	13.28	13.28	69.58	96.14
41.28	3.50	4.38	12.40	12.40	44.87	69.68
56.56	1.84	3.54	10.75	10.75	75.47	96.97
44.83	2.48	4.30	11.36	11.36	56.28	79.01
60.49	4.20	4.27	19.17	19.17	53.95	92.28
52.54	3.78	4.10	16.24	16.24	55.13	87.61
57.50	3.99	3.78	18.91	18.91	56.45	94.27
43.74	1.68	3.99	7.31	7.31	70.05	84.66
50.27	4.14	3.53	13.78	13.78	58.31	85.87
44.06	2.67	4.49	11.84	11.84	52.28	75.95
55.38	3.59	4.34	15.95	15.95	56.10	87.99
61.60	4.23	4.06	19.35	19.35	58.36	97.07
60.11	4.15	4.67	18.77	18.77	49.76	87.31

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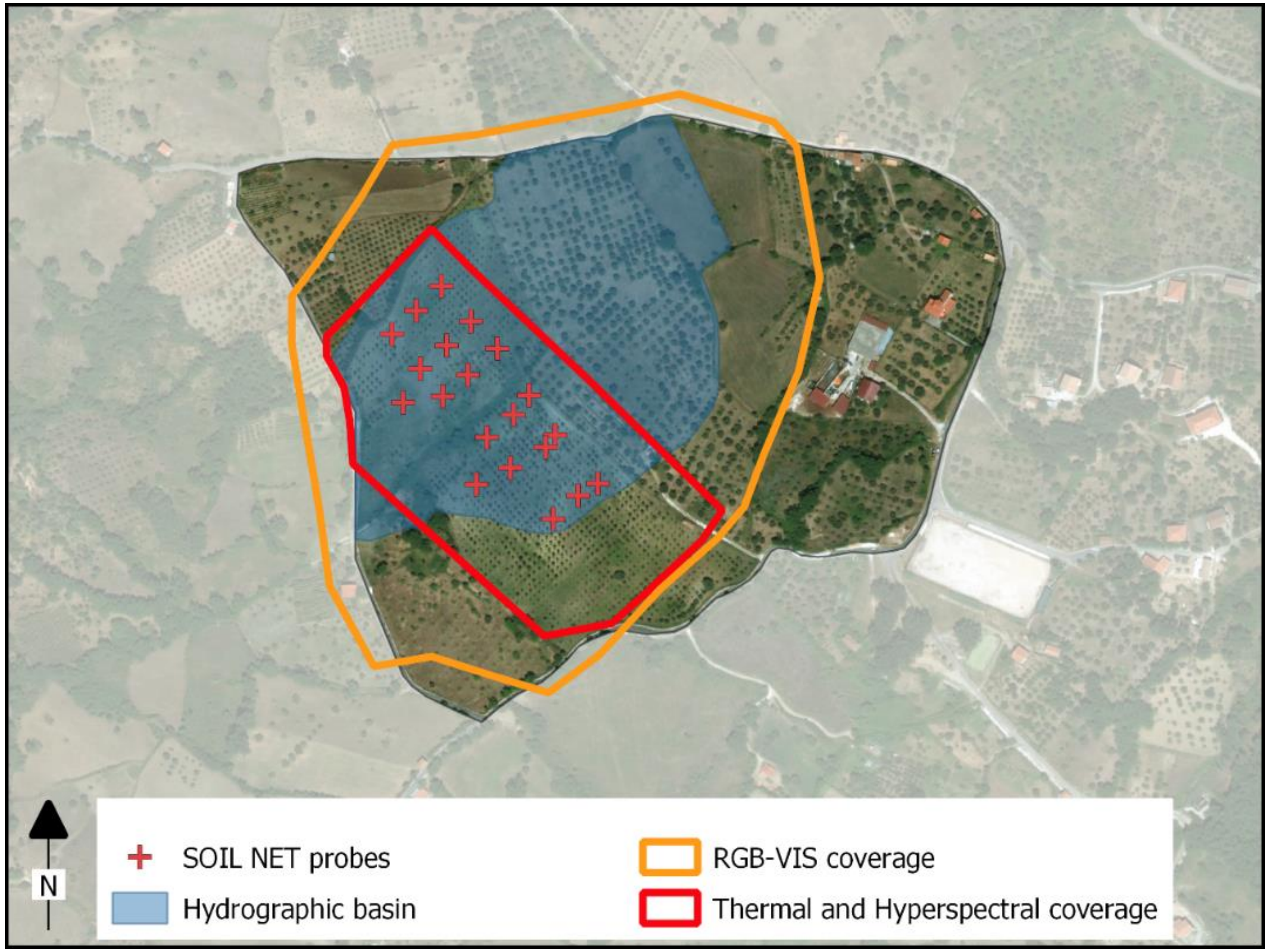
3D soil hydrological parameters (Brigitta Szabó)

Map of the area for which images with UAS platform have been acquired, and location of 20 soil moisture monitoring probes (SOIL NET probes) at the MFC2 sub-catchment of the Upper Alento River Catchment.



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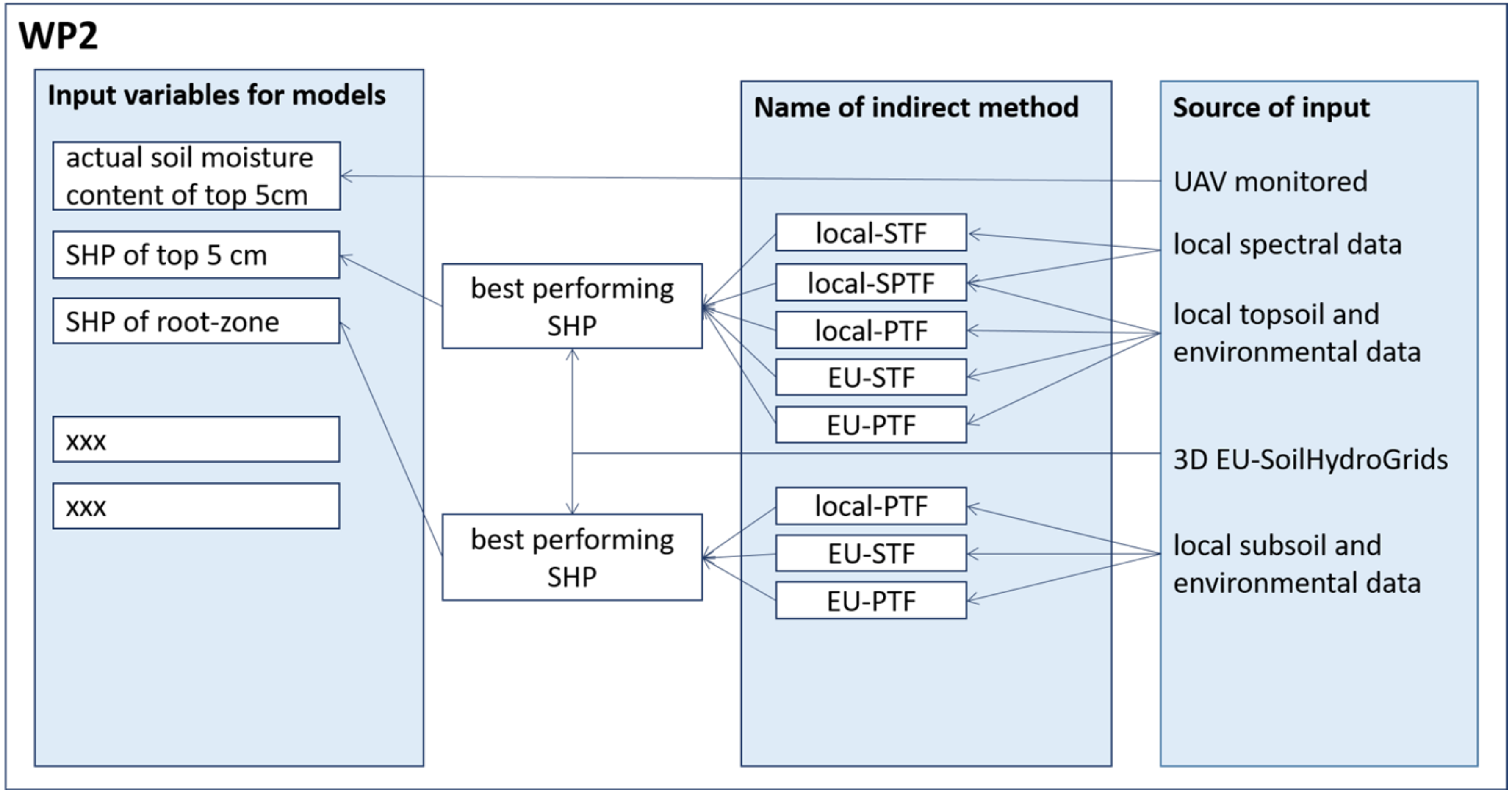


Inventory of models to be used in iAqueduct

Inventories for Soil-Vegetation-Atmosphere Models To-Be-Applied in iAqueduct

Models	Soil Model	Vegetation Model	Soil-Vegetation-Atmosphere Interfaces	Model Input Parameters
TETIS				
Biome-BGC				
SPAC				
SCOPE				
SEBS				
STEMMUS				
HydroGeoSphere				

(Félix Francés García, 2019)

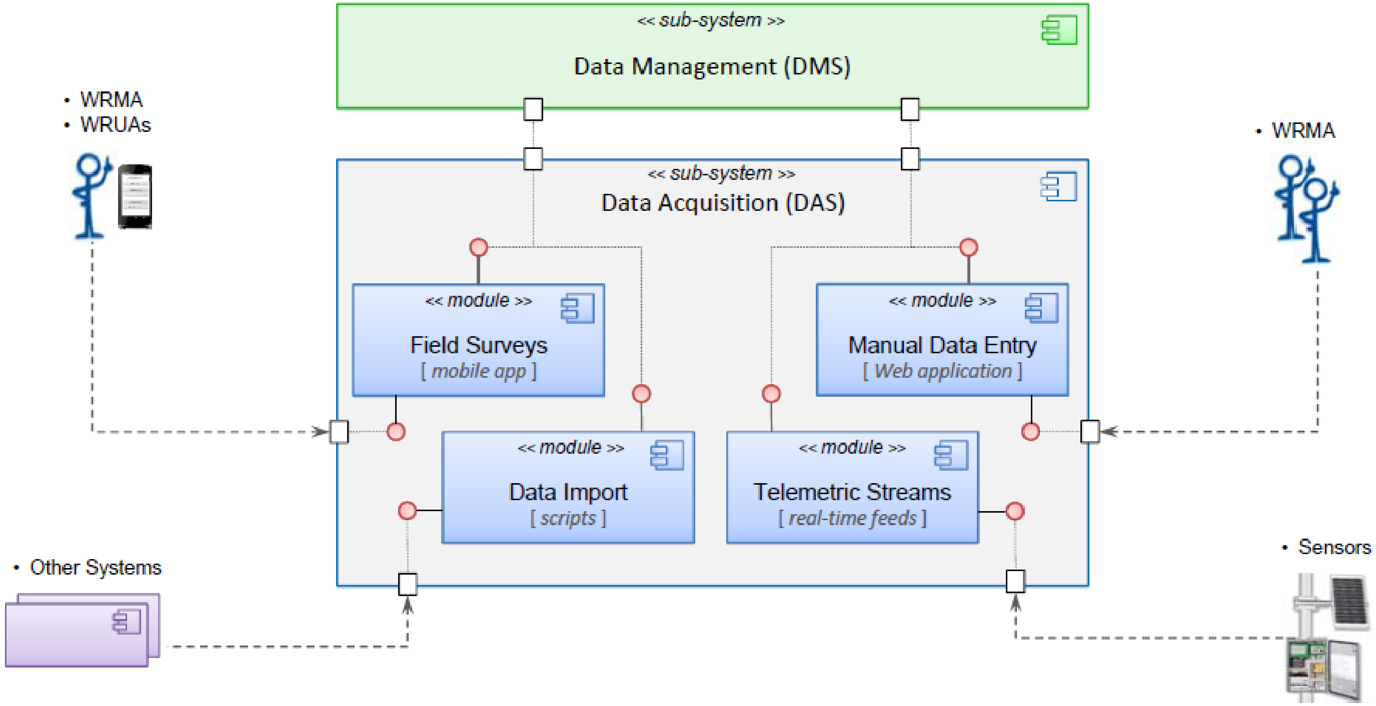
(Giulia Vico, 2019)

(Bob Su, Yijian Zeng, 2019)

(Nunzio Romano, Paolo Nasta, 2019)

iAqueduct toolbox

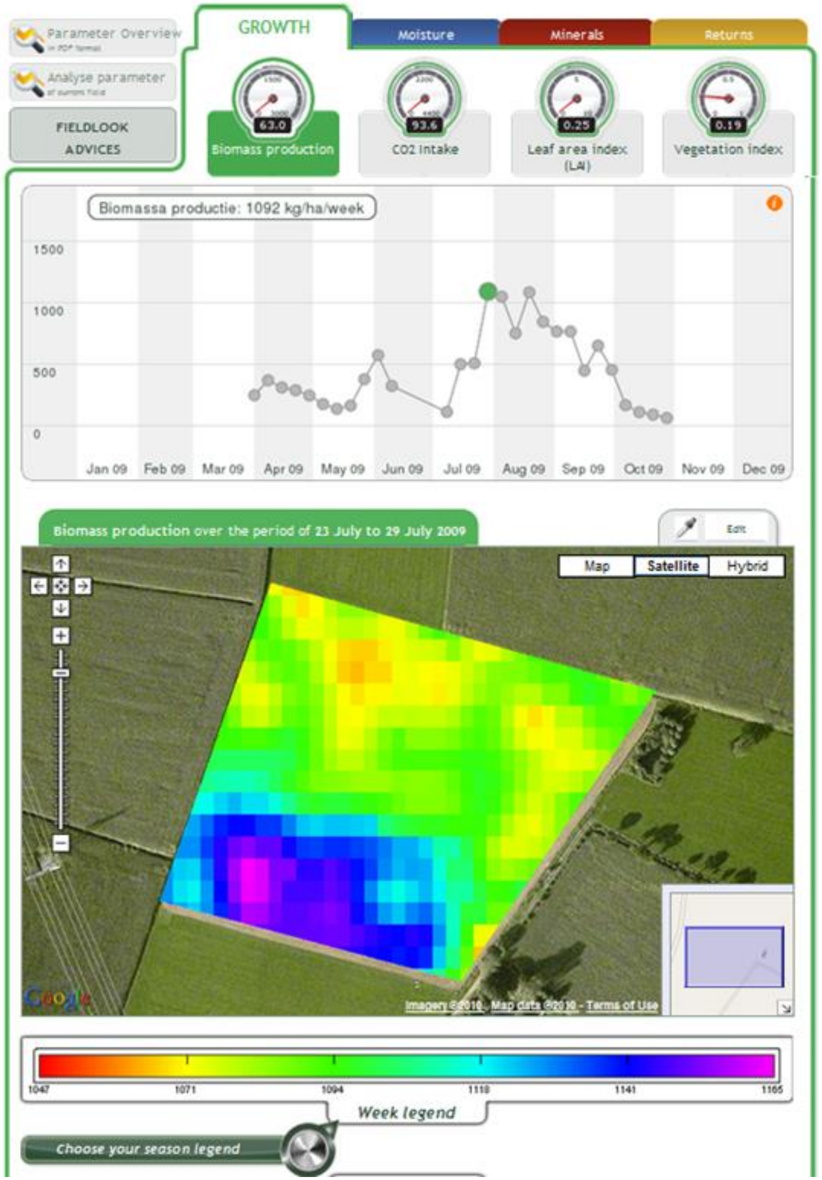
MAJISYS



iAqueduct

- **Growth**
  - biomass production (kg/ha)
  - CO_2 intake (kg/ha)
  - leaf area index LAI (m2 leaf/m2 ground)
  - vegetation index NDVI

- **Moisture**
  - evaporation shortage (mm/week)
  - current evaporation (mm/week)
  - surplus rain (mm/2 weeks)
  - reference evaporation



CONCLUSION

- Most of current global satellite data (and relevant downscaled products, e.g., FAO-WaPOR dekadal data) still cannot fully match the requirement for practical agricultural services;
- This is even so, especially under the backdrop of more frequent extreme events due to climate warming;
- It is needed to combine all possible sources of remote sensing data, together with process-based models for understanding climate impacts on agricultural/natural ecosystem functioning, and toward the sustainable management of water resources.