SIM PROJECT OVERVIEW

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SIM

www.sim.polimi.it

SMART IRRIGATION FROM SOIL MOISTURE FORECAST USING SATELLITE AND HYDRO – METEOROLOGICAL MODELLING

Coordinator:
Politecnico di Milano (Italy)
Team:
Delft University (The Netherlands)
University of Valencia (Spain)
University of Baleary (Spain)
Radi-Academy of Science (China)
University of Tuscia (Italy)
Epson meteo (Italy)
MMI srl (Italy)

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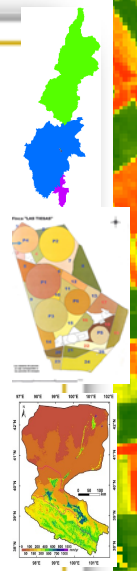
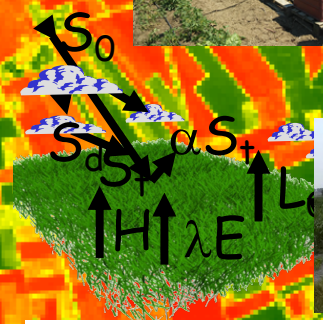
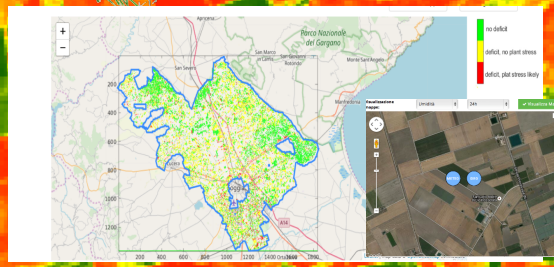
WATERWORKS 2014 COFUNDED CALL







mipaaft
ministero delle politiche agricole alimentari, forestali e del turismo

esa NASA NRSCC RANETIED

crea
Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria

copernicus
observing the earth

BAR

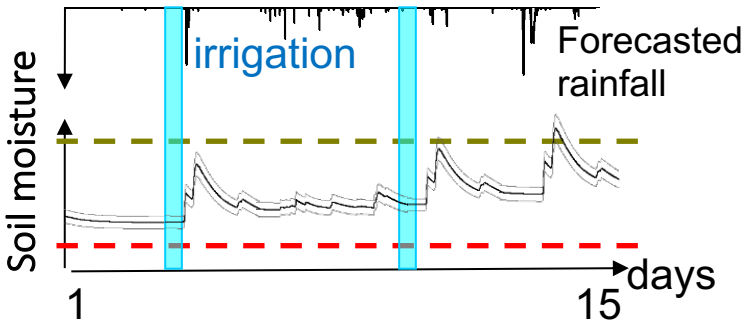
Water JPI

Roma, June 12 2019

SIM: objectives and stakeholders

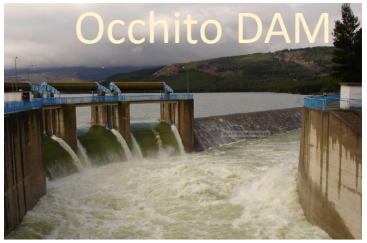
1 **monitor and forecast crop water need for parsimonious precise irrigation**

2 **setting a irrigation strategy: Increasing irrigation efficiency (ton/mc) and water productivity (€/mc)**



river basin

consortia



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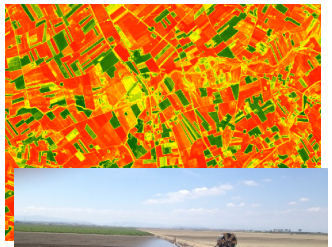
farmers



but also: …….

- **irrigation strategy at field scale: water amount and timing;**
- **economic analysis of parsimonious irrigation;**
- **satellite land surface temperature data for soil moisture hydro model update;**
- **dynamic actual evapotranspiration;**
- **satellite Fraction Cover and Leaf Area Index for cultivated area identification and parametrization;**
- **Impacts of meteorological forecast ;**
- **impacts on existing irrigation disribution network.**

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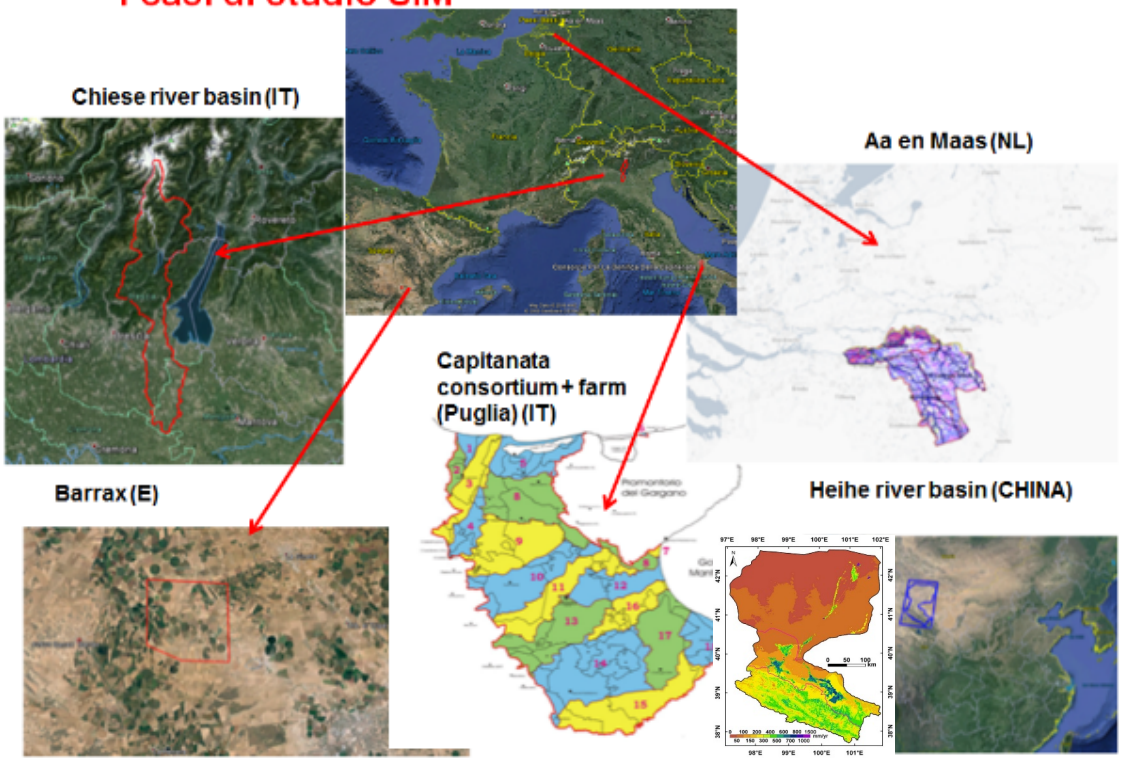
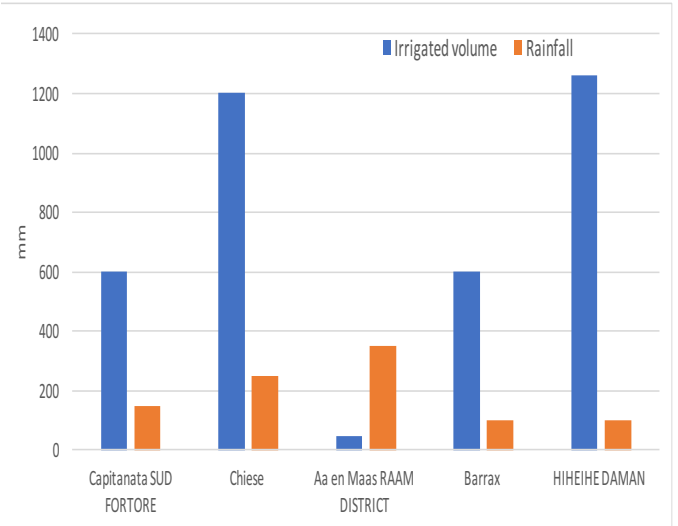
SIM : WHERE AND WHY ?

I casi di studio SIM



DIFFERENT CLIMATATE DIFFERENT PRACTICES

Irrigation supply and **rainfall** in the crop season (mm)



Irrigatium Consortia	Irrigated surface	Irrigation technique	irrigation timing
Chiese	20000 ha	flooding irrigation	fix scheduled 7,5 days
Capitanata SUD Fortore district	50000 ha	drip (70%) & spring (30%)	on demand
AA en Maas RAAM distritct	12600 ha	sprinkler	on demand
Barrax ITAP	1500ha	central pivot sprinkler	on demand
Hehie Daman district	20000 ha	flooding	fix schedule

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SIM AND OTHER IRRIGATION MONITORING & MANAGEMENT SYSTEMS

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Dashboards	Satellite data Drones	Weather forecats	ET estimation	Real time data	Soil moisture monitoring	Saving assessement
Figaro: www.figaro-irrigation.net	_	X	Kc	X	X	fresh water + energy savings
SWAMP: swamp-project.org	Drones	X	_	X	X	Water saving
Apollo: http://apollo-h2020.eu/	Satellite + Drones	X	_	X	X	Environmental + water+economic benefits
IrriSAT: www.irrisat.com	Satellite	X	Kc	X	_	water + energy saving
Moses: http://moses-project.eu/moses_website/	Satellite	X	Kc	X	_	Water + energy + cost + drought reduction
Irrinet/irriframe www.irriframe.it	_	_	Kc	X	_	Water saving
Blue leaf: www.bluleaf.it	X	X	Kc	X	X	Water + energy + Environmental impact reduction
FATIMA http://fatima-h2020.eu/	X	X	Kc	X	X	Water+ energy + economic saving
NetBeat™ - NETAFIM www.netafim.com/en/digital-farming/netbeat	X	X	Kc	X	X	Commercial purpose
SIM – www.sim.polimi.it	X	X	Water energy budget	X	X	Water, economic savings

The SIM methodology: from field to consortium area
SIM.polimi.it

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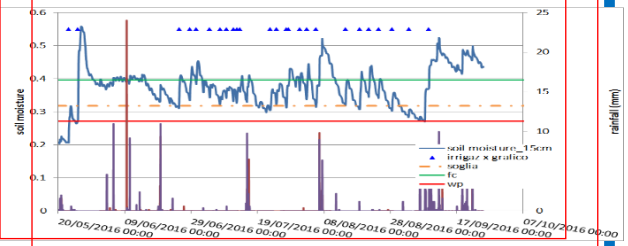
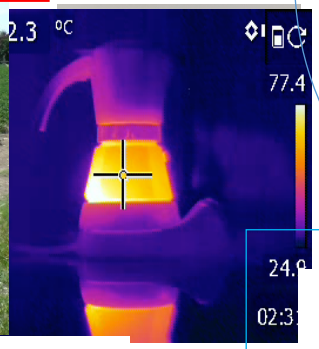
HYDROLOGICAL MODELING: MASS & ENERGY BALANCE

GROUND MONITORING

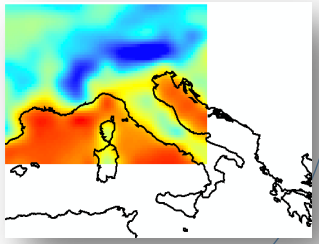


$$P_{tot}=R+ET_{eff}+D+(\theta_{t+1}-\theta_t)*Z$$

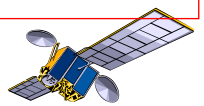
$$Rn-G-H-LE=\frac{dS}{dt}$$



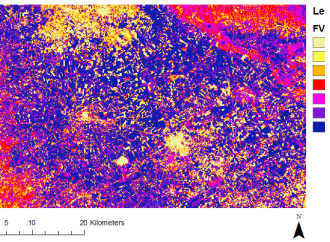
Meteorological forecast UNIBAL + EPSON

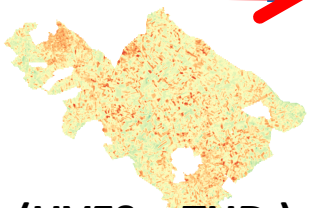


SATELLITE MONITORING



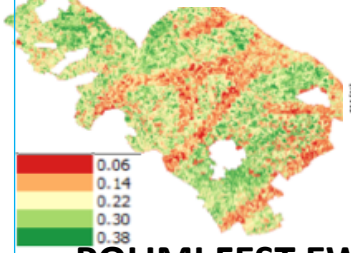
(LANDSAT – SENTINEL) Vegetation and LST

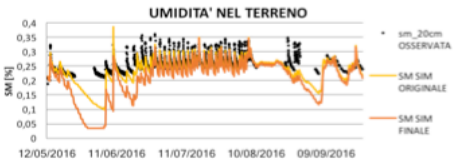




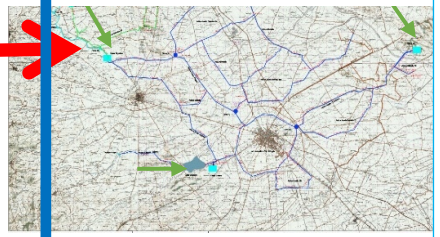
(UVES + TUD)

soil moisture and irrigation water need : mapping and pixel wise



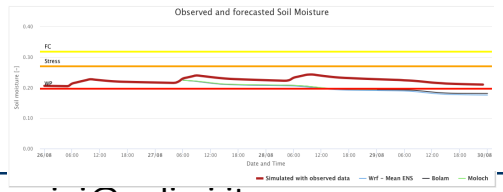


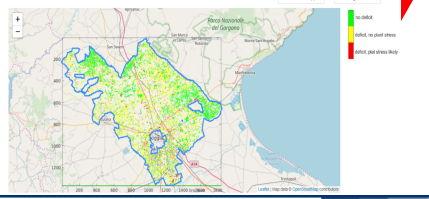
irrigation aqueduct model MMI



POLIMI FEST EWB, ETP RADI CAS

POLIMI Irrigation water needs forecast and operative tool





Economic profitability (UNITUS)

Scenario		
1 = Water savings	3%	(% of 2015 Effective AWU)
2 = CY increased	2%	(% of 2015 CY at Average 2015 CP)
3 = Depreciation savings	2%	(% of technical duration of irrigation system)
4 = Energy cost savings	4%	(% of lifting and pressure costs)
5 = Labor cost savings	5%	(% of labor for maintenance irrigation sytem
CAP	0,15	(average consortium price for m^3/ha)

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Satellite temperature data and Hydrological FEST-EWB model

FROM CONSOTIUM TO FIELD

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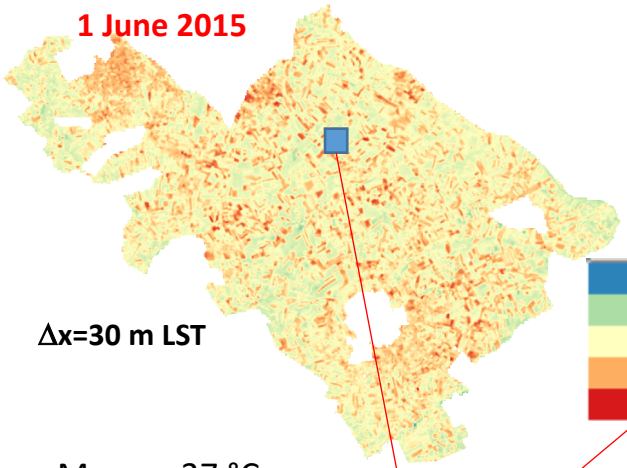
SATELLITE ⟷ HYDROLOGICAL MASS ENERGY MODEL FEST-EWB

LANDSAT_8 Surface Temperature

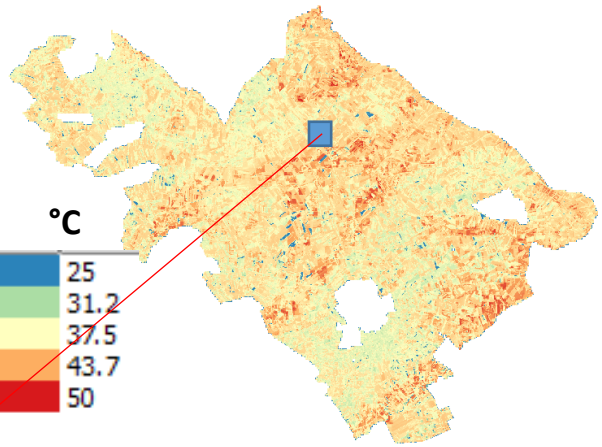
1 June 2015



Δx=30 m LST

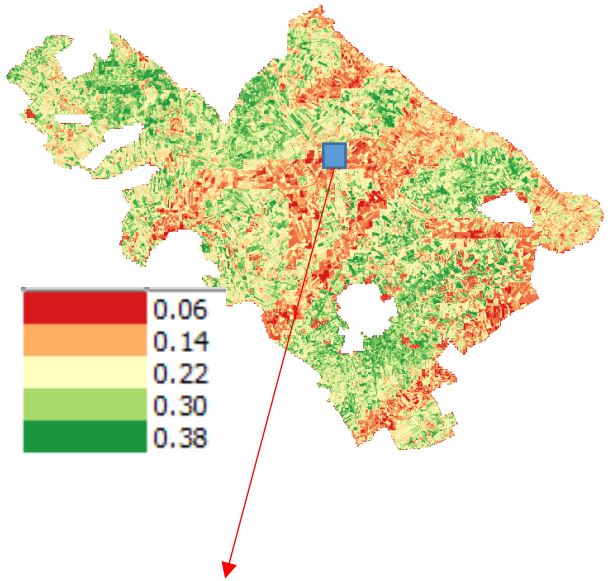
Mean = 37 °C

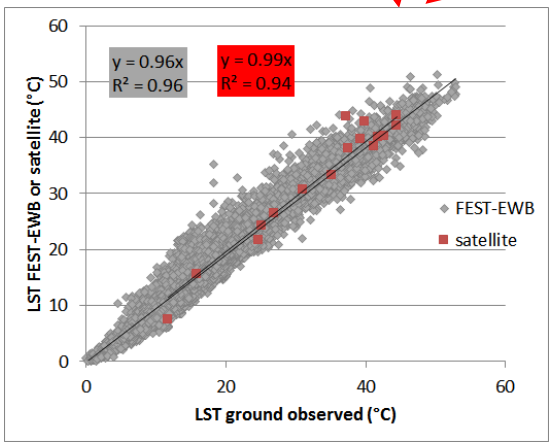
LST

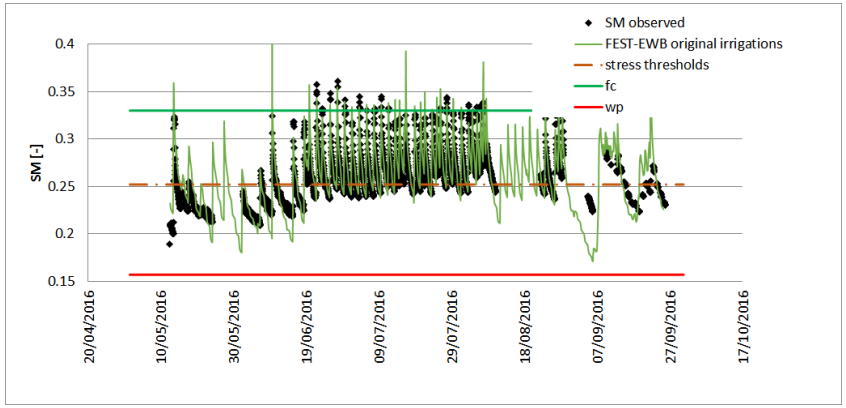


Mean= 36.5 °C

Soil moisture







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Ground measurements: Soil Moisture, Evaporation, discharge measures

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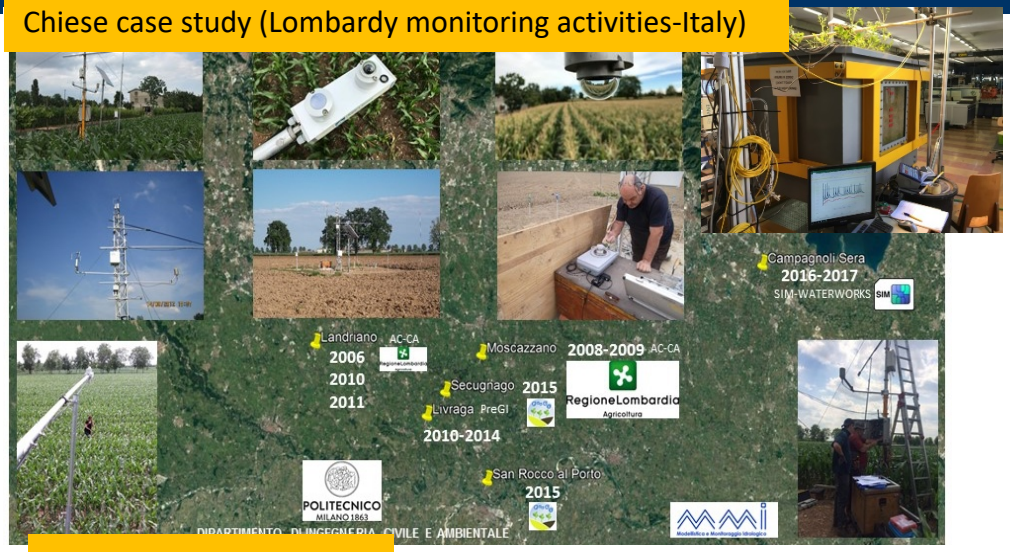
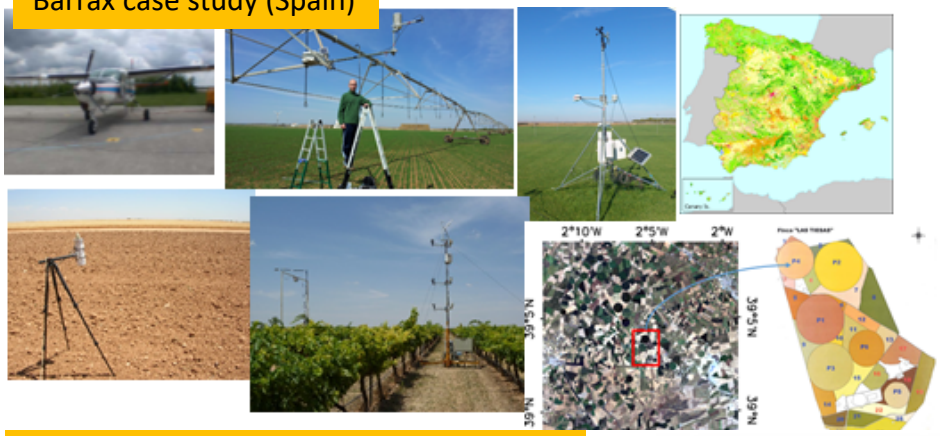
Chiese case study (Lombardy monitoring activities-Italy)



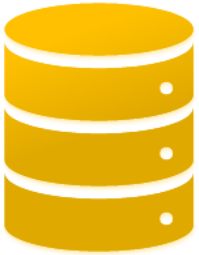
Capitanata case study (Puglia-Italy)

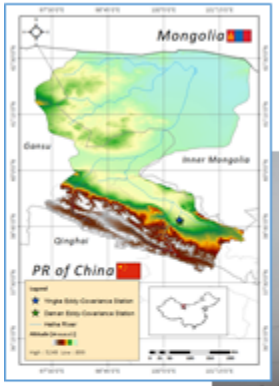
Eddy covariance from 2013 (asparagus, tomatoes)

Barrax case study (Spain)



On-line Database





Aa en Maas case study (The Netherlands)

Heihe case study (China)

SIM IRRIGATION STRATEGY: REANALYSIS RESULTS on soil moisture

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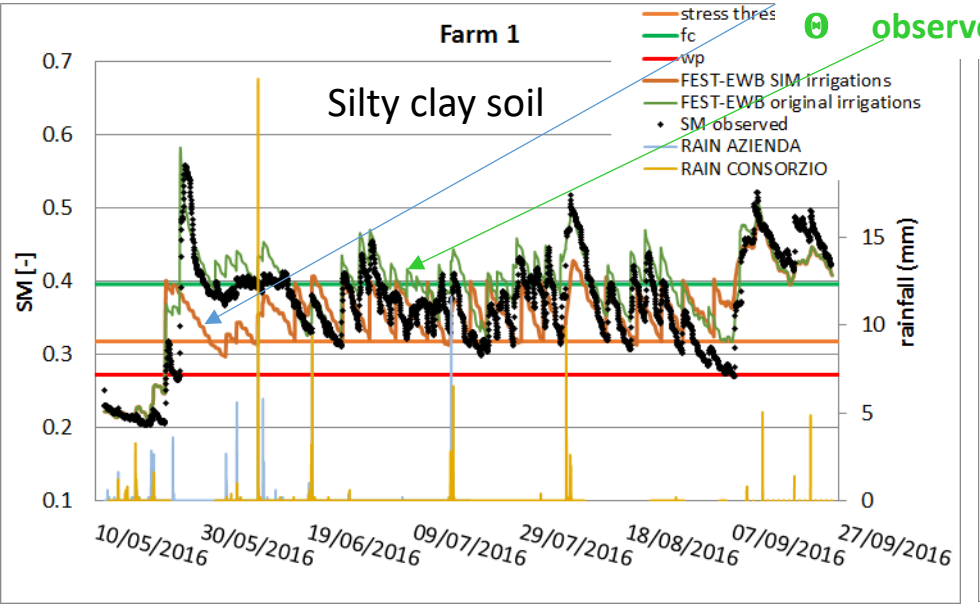
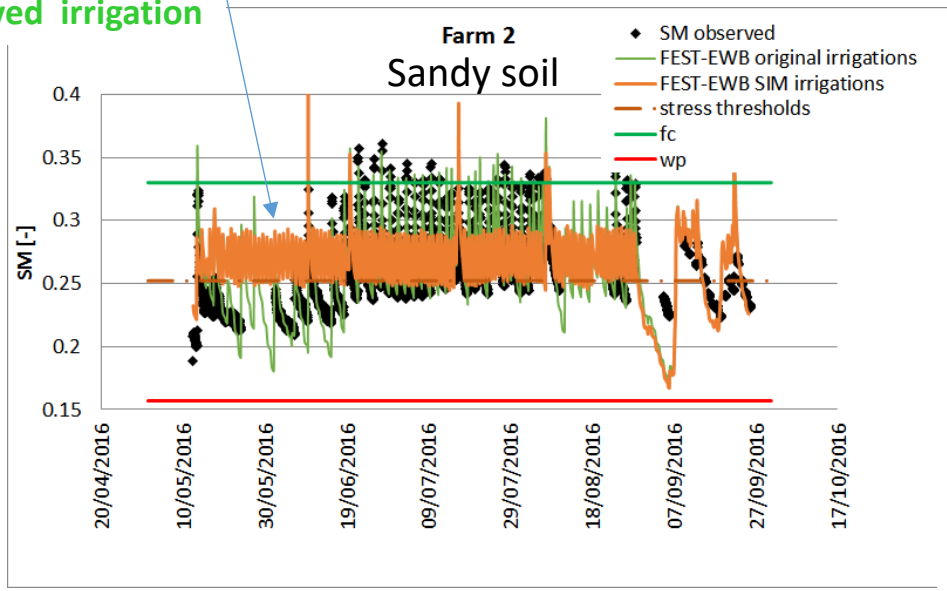
Capitanata Consortium fields: tomatoes

on demand pressurized Irrigation

θ SIM IRRIGATIONS

θ observed irrigation





		Irrigation (mm)	Number of irrigations	Rainfall cum (mm)
Farm 1 (2016)	**Observed**	**547.9**	**27**	**145**
	SIM	322.3	15	
Farm 2 (2016)	**Observed**	**646.6**	**43**	**150**
	SIM	590	90	
Farm 3 (2017)	**Observed**	**1000**	43	28
	SIM	850	25	

the SIM strategy allows to reduce the passage over the FC threshold reducing the percolation flux with a saving of irrigation volume

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SIM IRRIGATION STRATEGY: where saving water AND IMPROVE WATER EFFICIENCY ?

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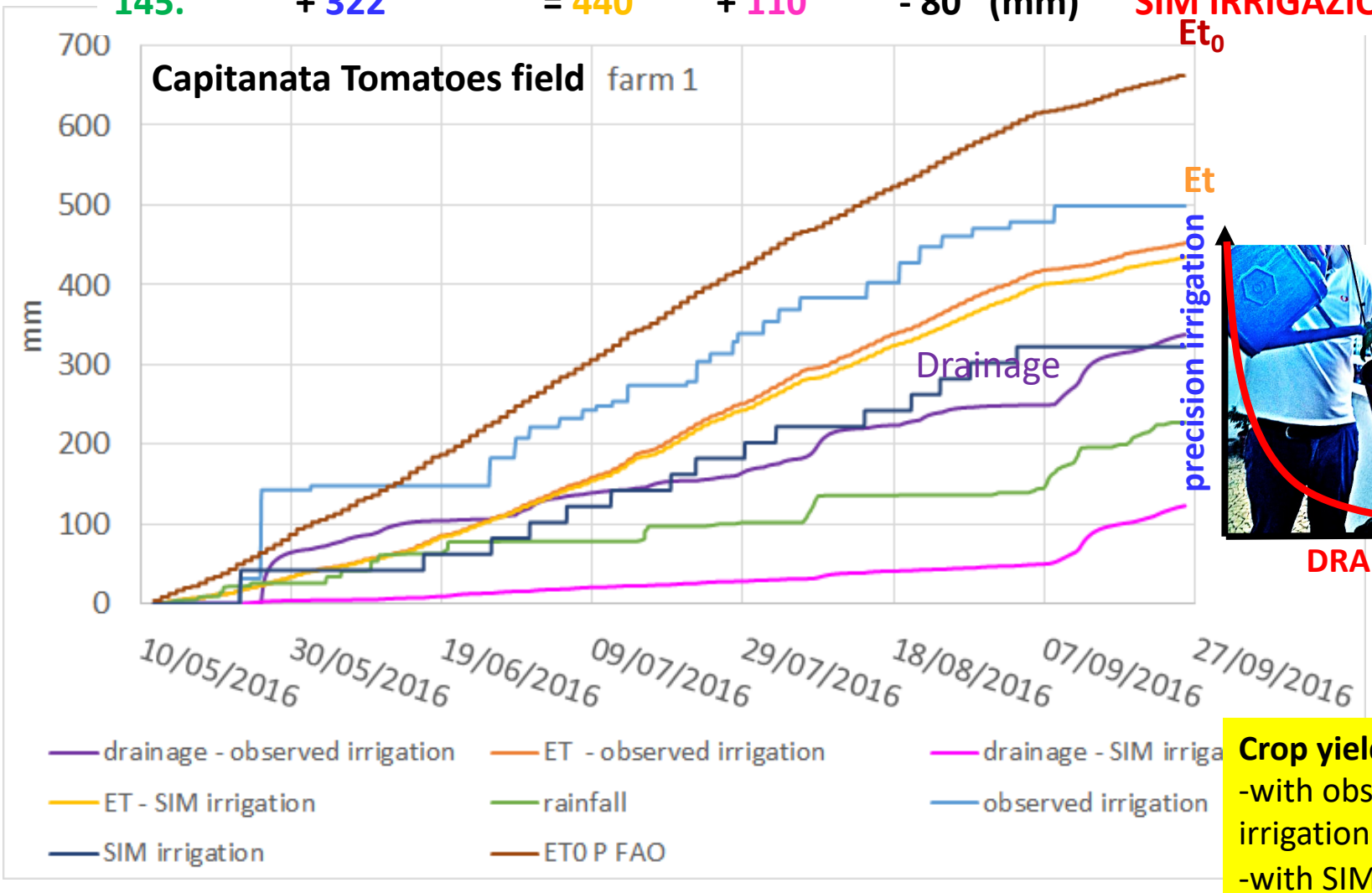
Rainfall	+ Irrigation =	ETP	+ Drainage	+ DW
145	+ 547	= 450	+ 320	– 70. (mm)
145.	+ 322	= 440	+ 110	- 80 (mm)

SIM IRRIGAZIONE



Crop yield:
-with observed irrigation 120 ton/ha
-with SIM strategies 116,3 ton/ha

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SIM IRRIGATION STRATEGY: REANALYSIS RESULTS on soil moisture

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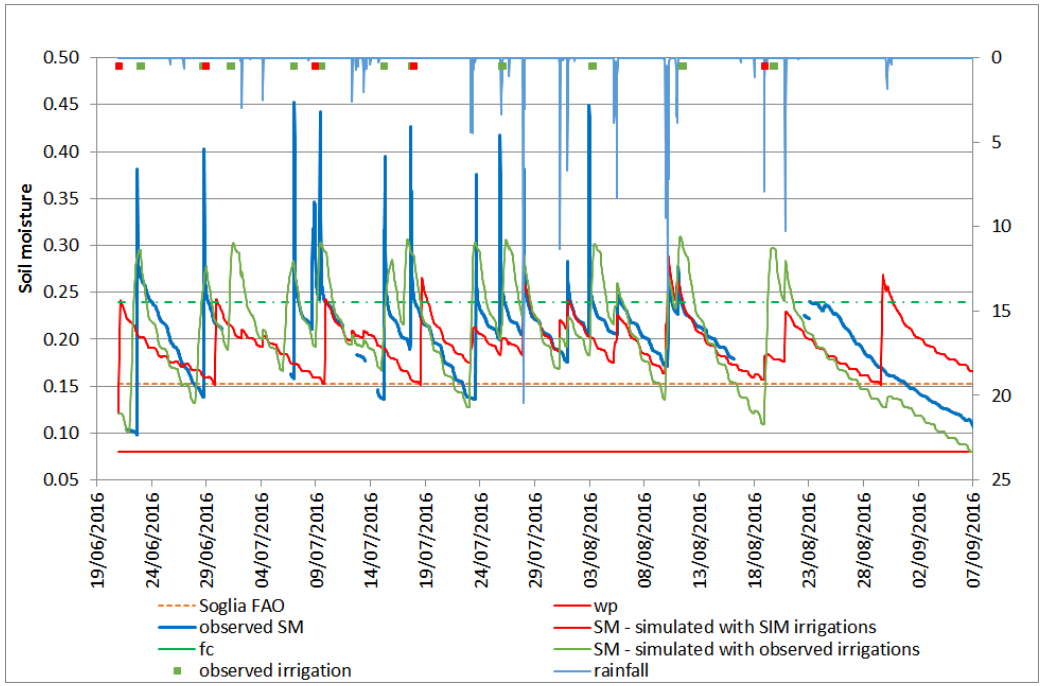
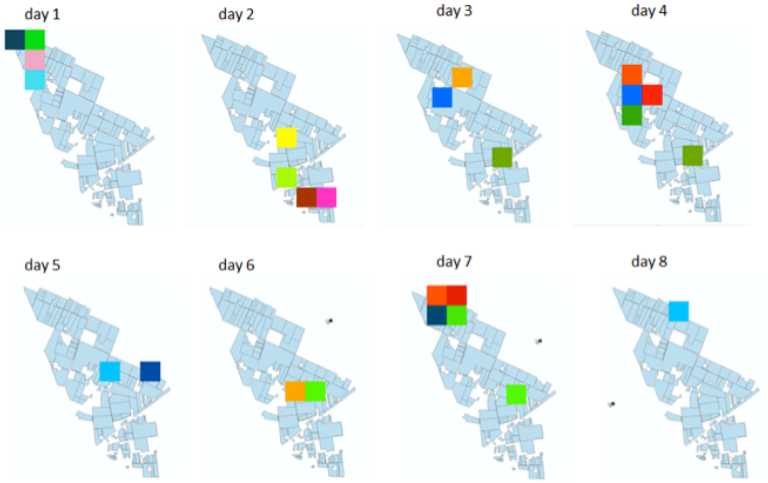
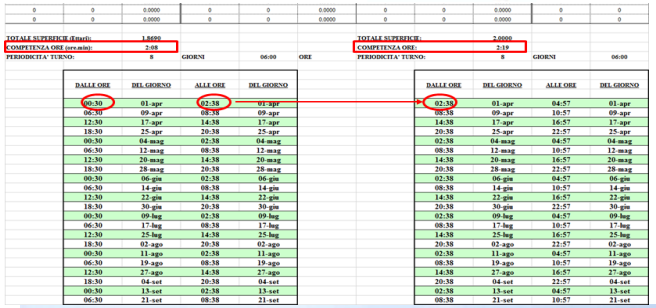
Chiese irrigation consortium Fields ,Maize fields



		Irrigation (mm)	Number of irrigations	Rainfall cum (mm)
2016	**Observed**	**1426**	**11**	**269**
	SIM	**301**	**5**	
2017	**Observed**	**1480**	**17**	**223**
	SIM	**488**	**10**	
2018	**Observed**	**1750**	**13**	**515**
	SIM	**200**	**5**	

Scheduled flooding irrigation





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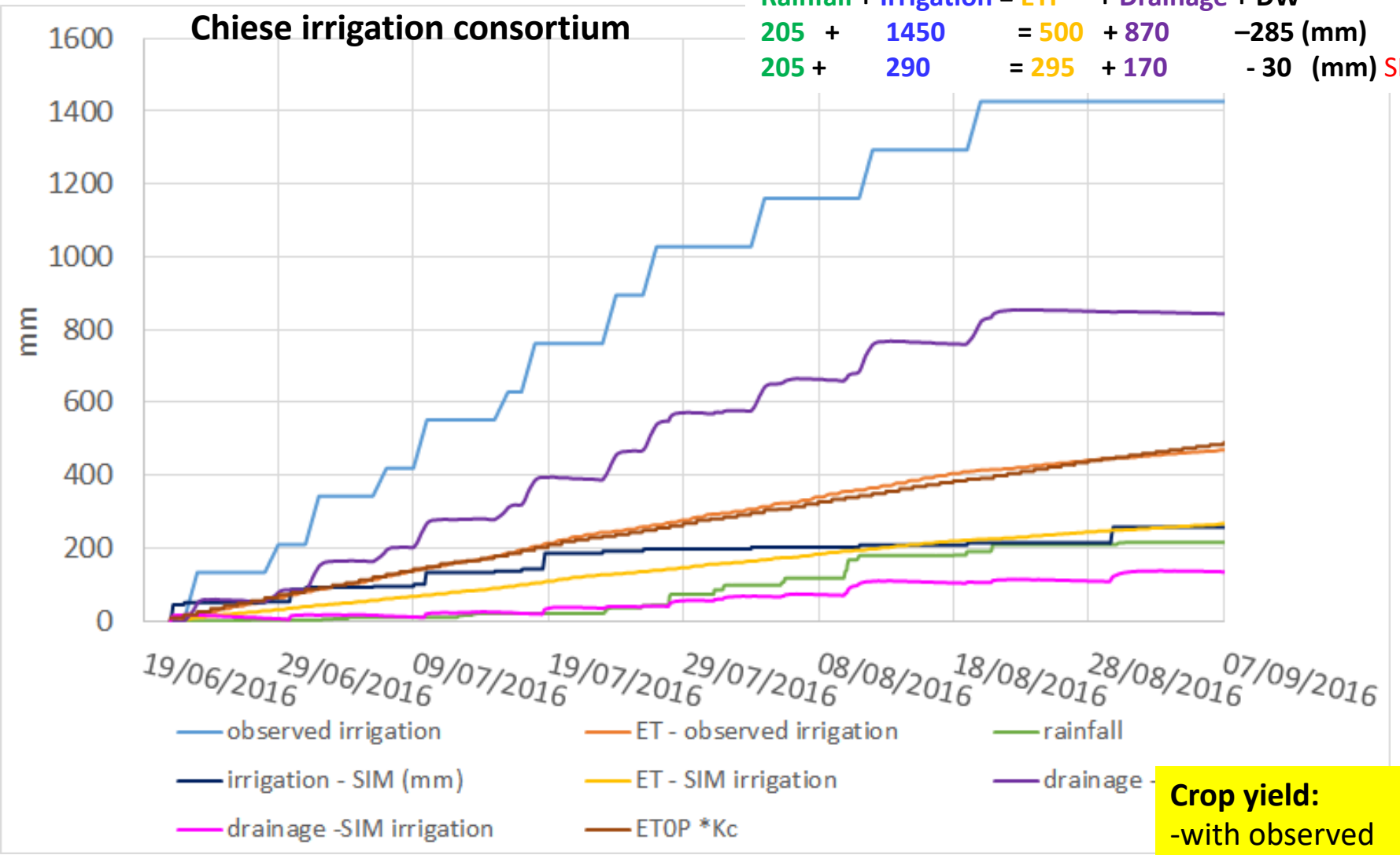
SIM IRRIGATION STRATEGY : where saving water?

Rainfall + Irrigation = ETP + Drainage + DW

205 + 1450 = 500 + 870 –285 (mm)

205 + 290 = 295 + 170 - 30 (mm) SIM



Crop yield:
-with observed irrigation 9,1 ton/ha
-with SIM strategies 8,9 ton/ha

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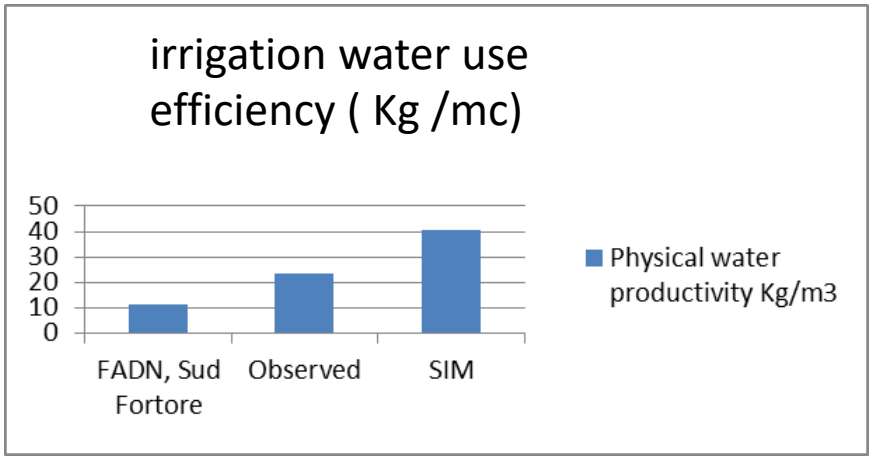
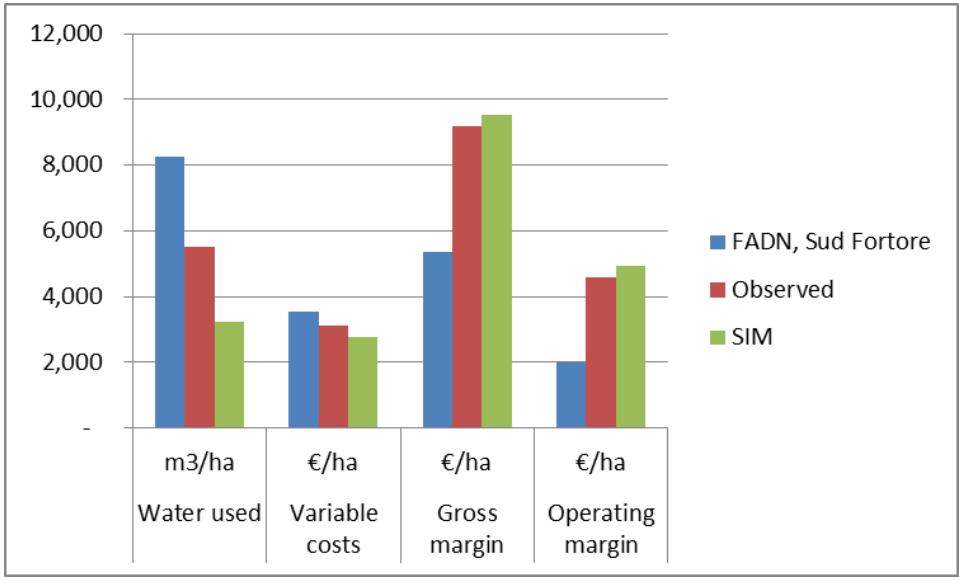
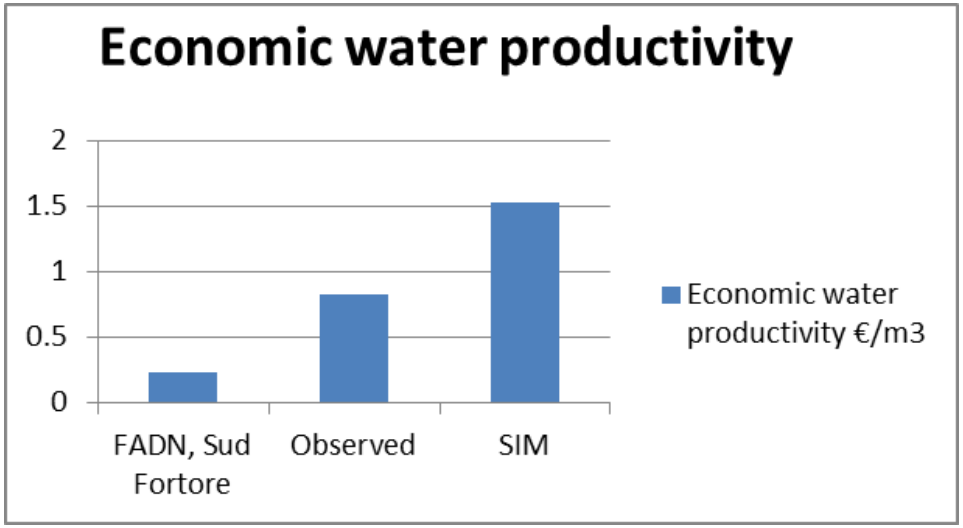
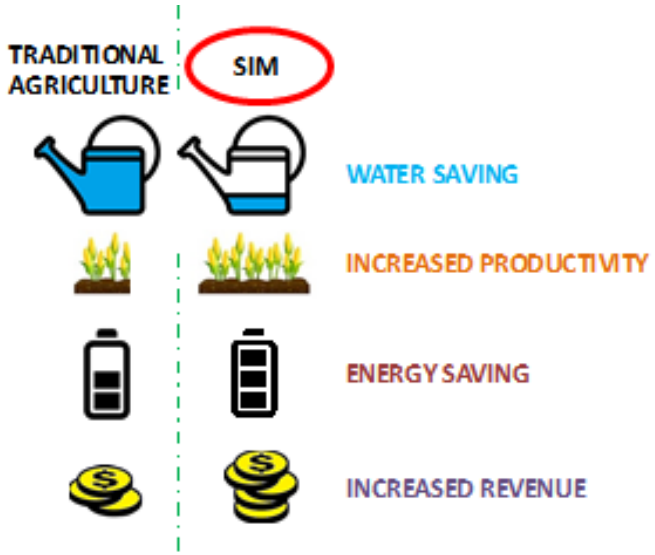
SIM IRRIGATION STRATEGY: economic indicators





Economic water productivity = Operating margins costs/Water used





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SIM IMPACT ON PRESSURIZED DISTRIBUTION NETWORK:
THE CAPITANATA SUD FORTORE EXAMPLE

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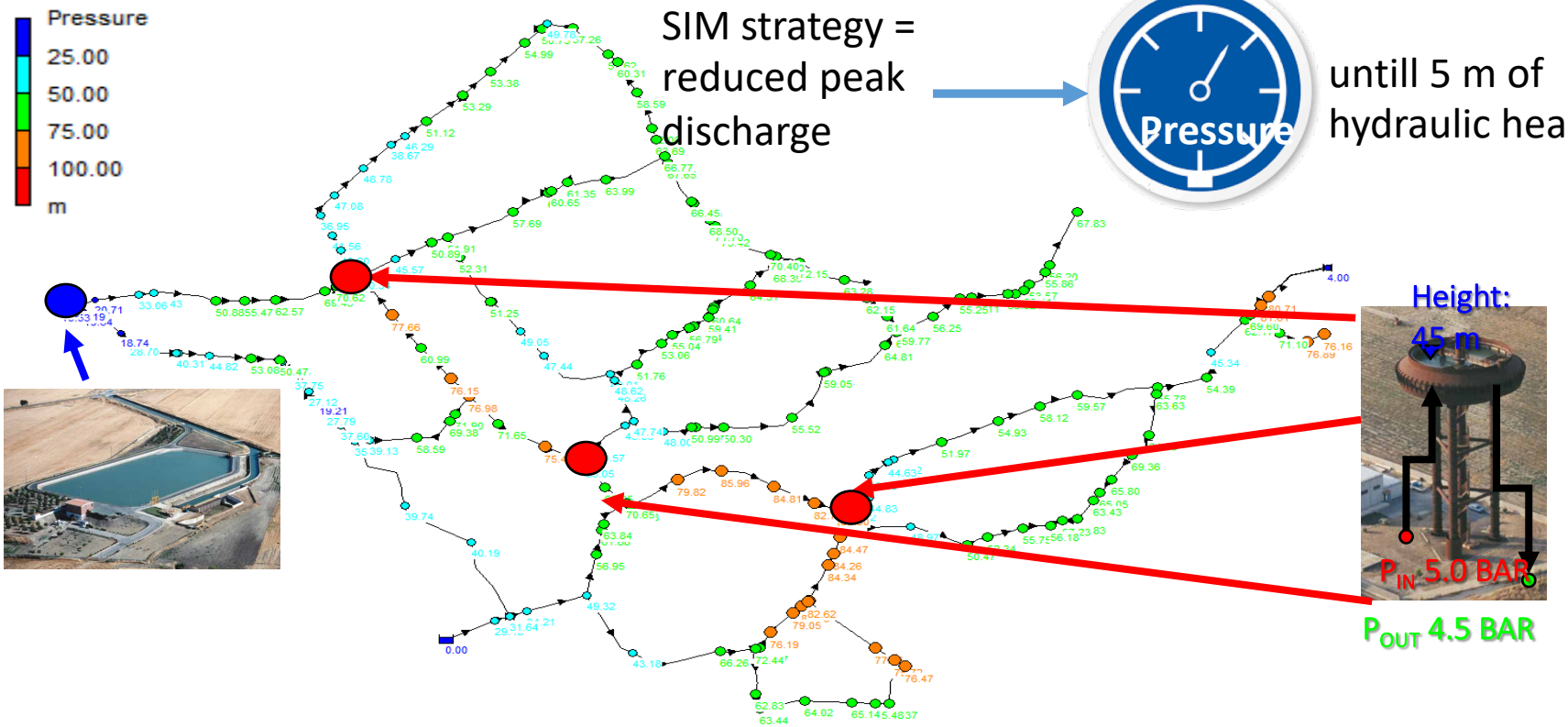
- USERS DEMAND 10 ÷500 L/S IN 124 NODES
- NODES ARE LINKED TO A SECOND MORE COMPLEX NETWORK MANAGED BY THE CONSORTIUM



PRESSURES FROM 8 to 4 BAR

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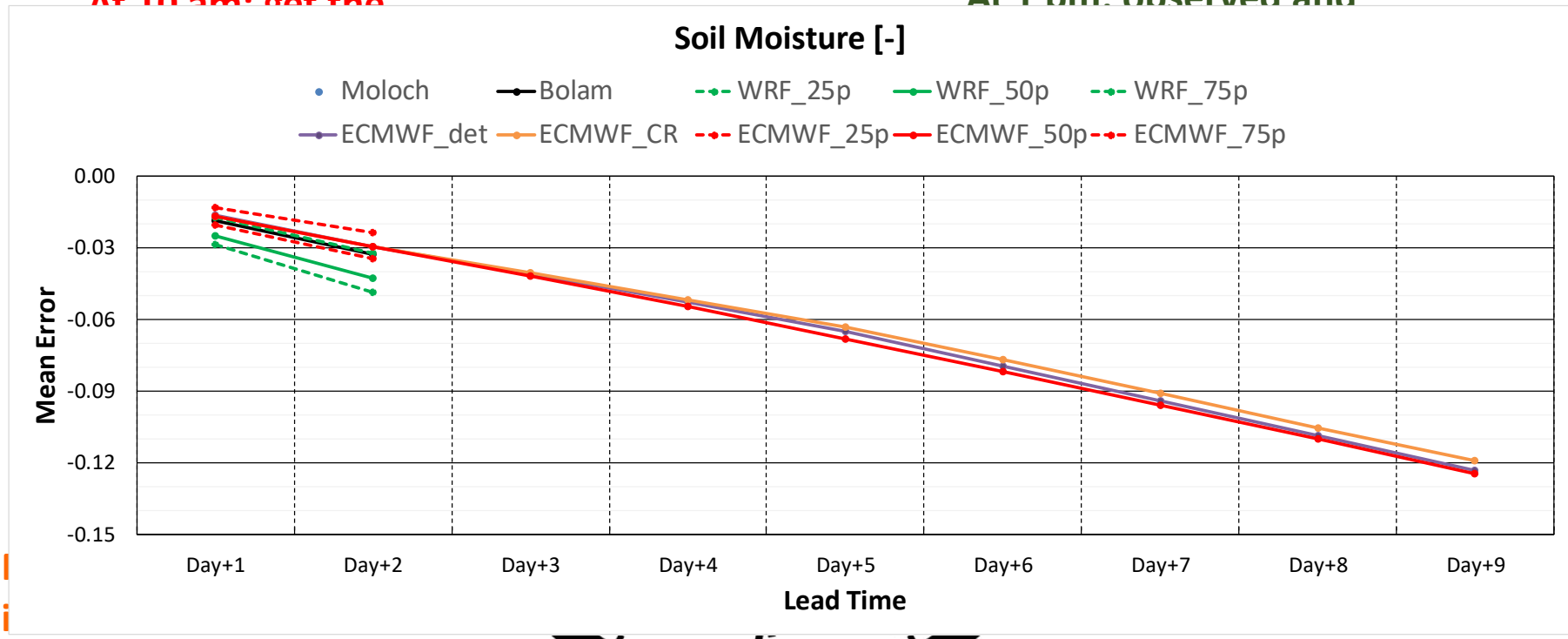
At 10 am: get the

At 1 pm: observed and



model

At 5 pm: WRF-MOPI forecasted data are uploaded on the SIM dashboard

CPU information:

1 Processor Intel Xeon (6 Cores, 12 threads)
32 GB ECC RAM
Hard Disk: Primary 256 GB SDD
Secondary: 9.1 TB Array of 5 Hard Disk in Raid-5 Configuration
NAS: 14 TB Array of 5 Hard Disk in Raid-5 Configuration

Stakeholder interactionS

Zhangye (China) during a meeting between the **Heihe water basin authority**, and the chinese partner RADI-CAS and the italian partner POLIMI. (19-23 may 2016)

The SIM project has been invited for presentation at the «The consortium and its territory» meeting organized by **Capitanata Irrigation Consortium** (Foggia – Italy),
many other meetings (2015-2017)

Aa en Maas water authority

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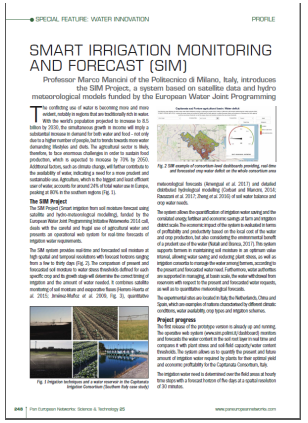
SIM Project diffusion

www.sim.polimi.it

POLITECNICO DI MILANO

GROW OBSERVATORY



A number of scientific conferences

-European Geoscience Union (Austria)
-Digital Earth Summit – Africa
-DBAR (Digitial Belt and Road)- China
-ESA Living planet symposium (Italy)
-convegno di Idraulica/Idrologia (Italy)
-Recent Advances in Quantitative Remote Sensing (Spain)

Papers on scientific journals
PhD and master thesis

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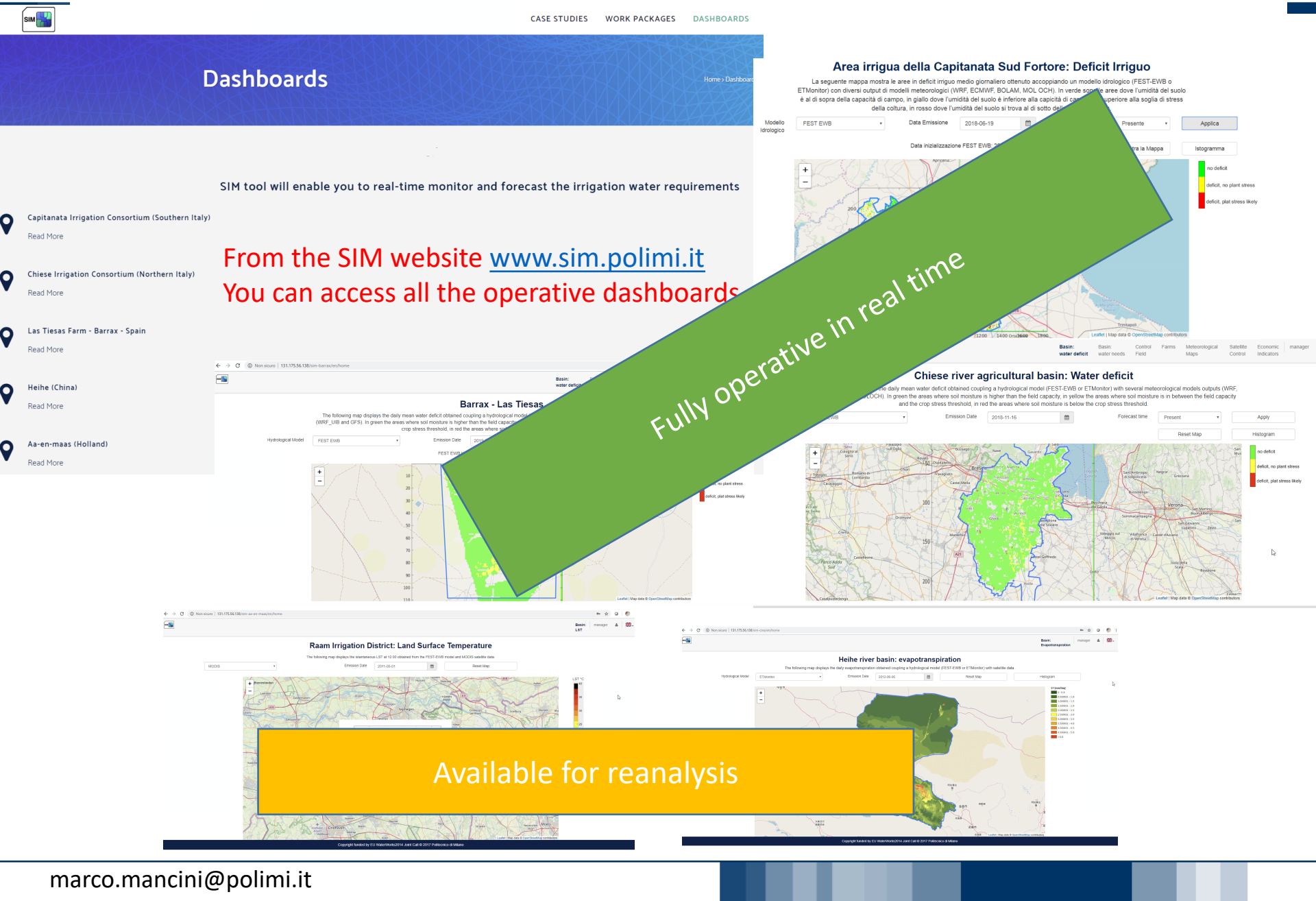
Operative tool for real time irrigation water needs forecast

The SIM dashboard WATER INFORMATION SYSTEM



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The SIM Group!

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