

**ESA-MOST Dragon Cooperation**

中国科技部-欧洲空间局“龙计划”合作

# 2017 DRAGON 4 SYMPOSIUM

2017年“龙计划”四期学术研讨会

Hydrology products and river basins monitoring: Forcing, calibration, validation and data assimilation in basin scale hydrological models using satellite data products

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26-30 June 2017 | Copenhagen, Denmark

2017年6月26-30日, 丹麦 哥本哈根

## Project Objectives

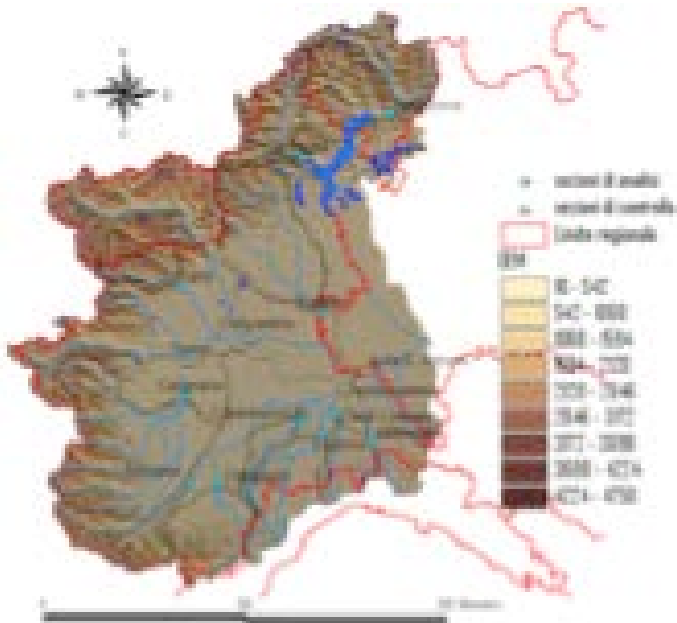
Improve the estimate of **water balance under natural and human pressure** on the Heihe basin in China and in the Po river basin in Italy, by using **MOST, ESA and NASA** satellite data coupled with **three distributed hydrological models** (FEST-EWB & SHAW-DBHM, HeiFLOW

WP1: Satellite data of surface properties for hydrological models

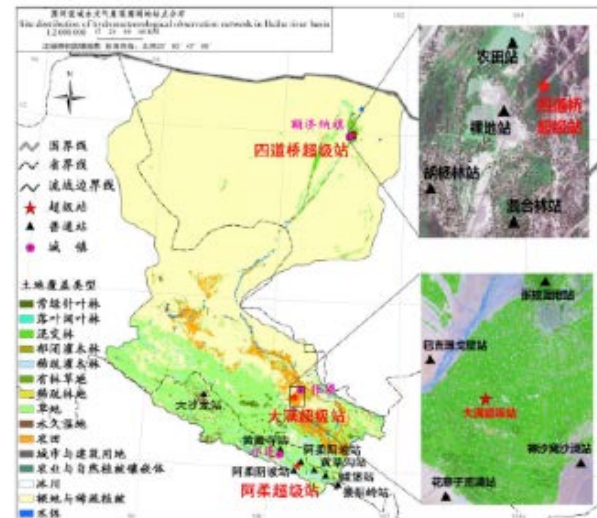
WP2: Data base of hydro meteorological data

WP3: Hydrological model calibration validation assimilating ground and satellite data

WP4: Operative hydrological data products time series: Gridded SM, ET, SWE,  
time series: local discharges and flow duration curve



Upper Po river basin 40'000 sqkm



黑河流域水文气象观测网


Heihe river basin 120'000 sqkm



### SIM

[www.sim.polimi.it](http://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 Balearic (Spain)  
Radi-Academy of Science (China)  
University of Tuscia (Italy)  
Epson meteo (Italy)  
MMI srl (Italy)

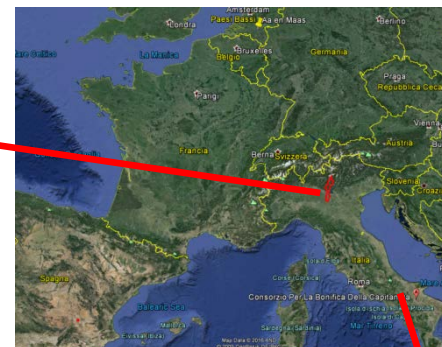
[marco.mancini@polimi.it](mailto:marco.mancini@polimi.it)

Water Works

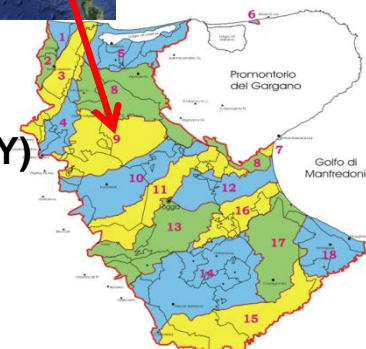
WATERWORKS 2014 COFUNDED CALL



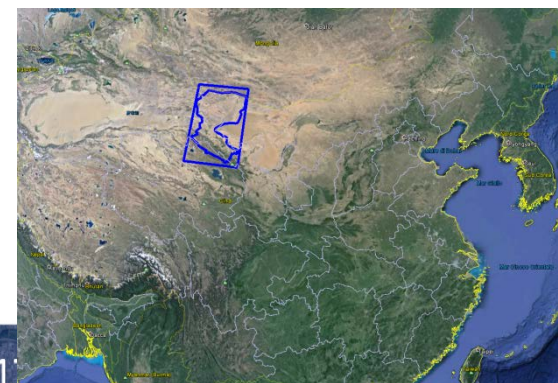
**Chiese river basin (ITALY)**



**Capitanata consortium (Puglia) (ITALY)**



**Heihe river basin (CHINA)**



2017年6月26-30日，丹麦 哥本哈根

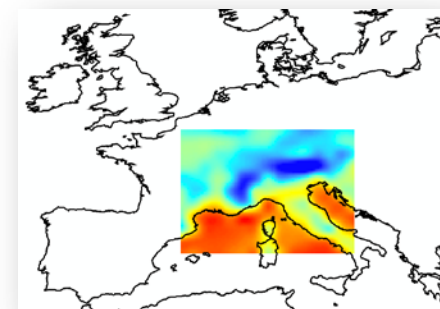
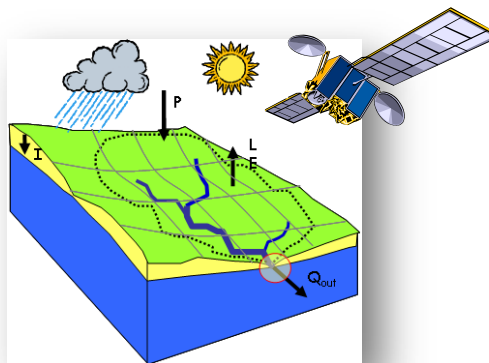
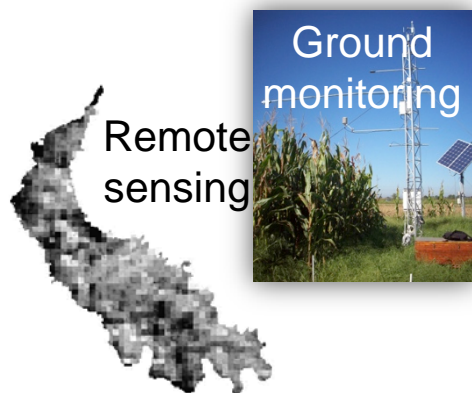
### Scientific motivation:

- 1) Increasing fluxes control points to improve the mass balance accuracy for large basin area;
- 2) Improving the understanding of the relationship between LST and SM;
- 3) Improving the synergic use of hydrologic modelling and Remote Sensing data for estimating water resources.

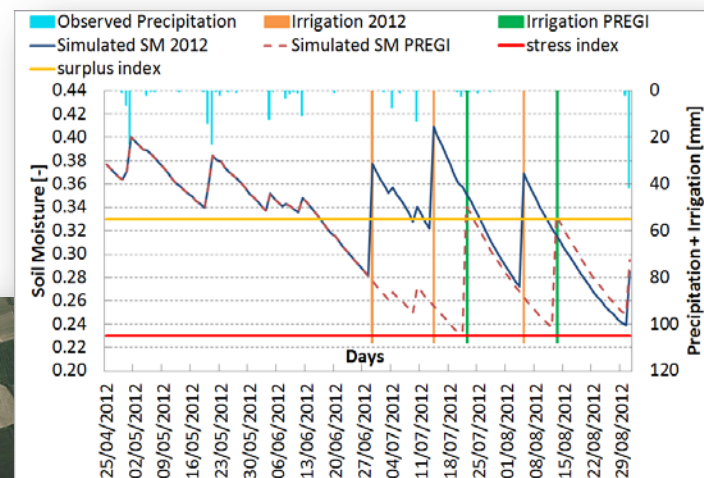
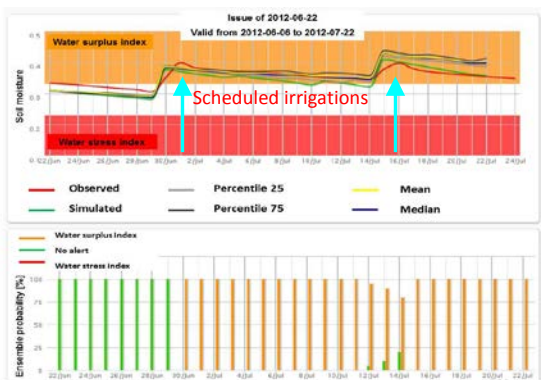
## Initial State

## Hydrological Modeling and Satellite data

## Meteorological Forecast



## MONITORING AND FORECAST SOIL MOISTURE DYNAMIC

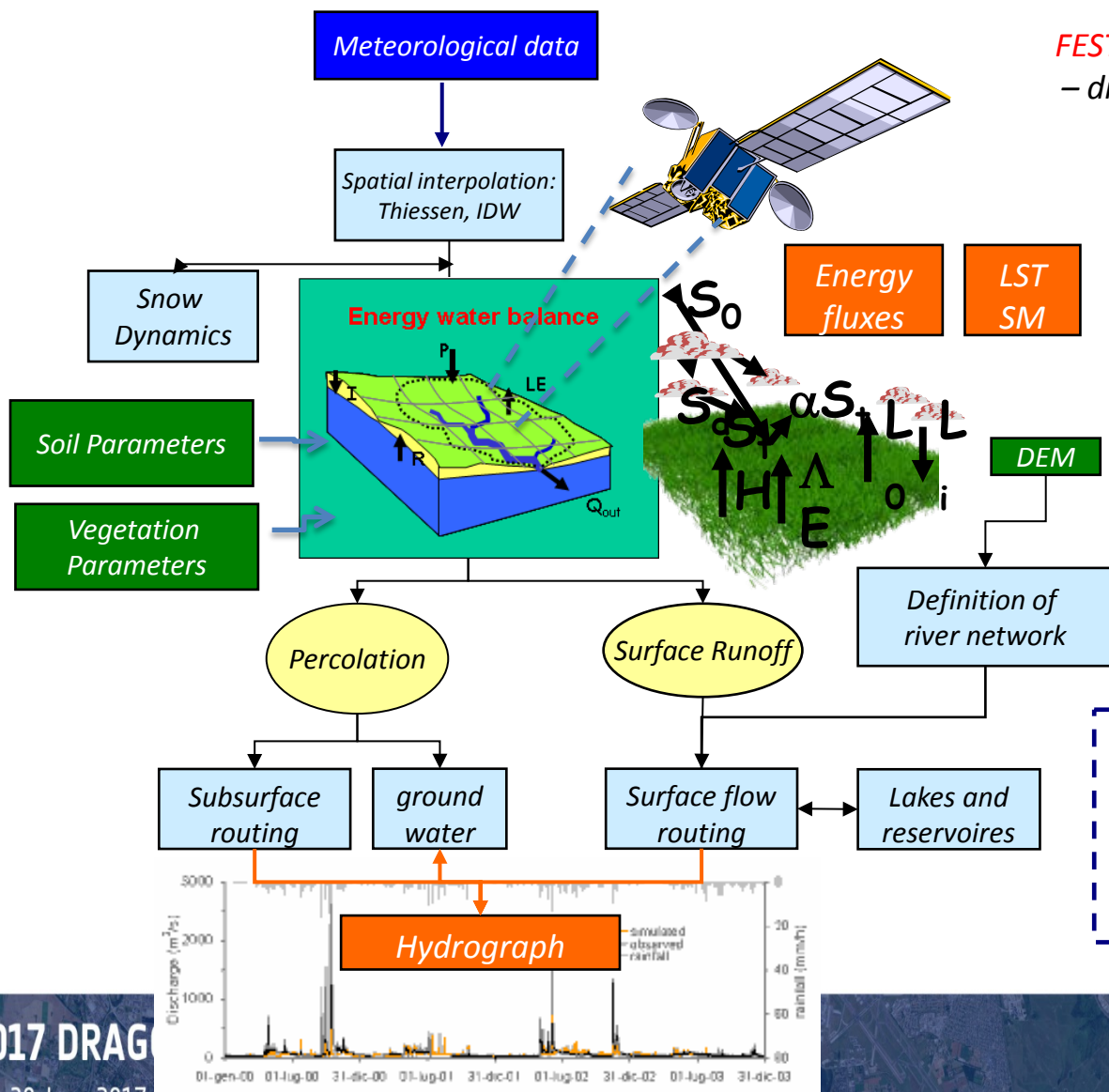






# SATELLITE DATA FOR RIVER BASIN: Distributed Hydrological & Hydraulic MODEL with continuous in time soil moisture accounting ( FEST-EWB - by POLIMI MODEL )

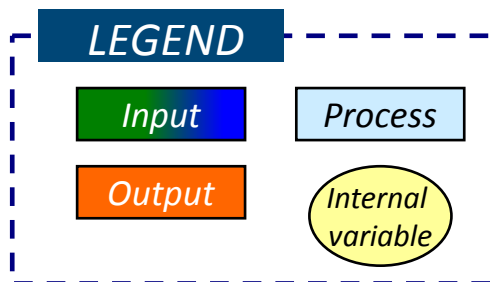
esa



**FEST-EWB:** Flash – flood Event – based Spatially  
– distributed rainfall – runoff Transformation –  
including Energy - Water Balance

[Mancini phd 90; Montaldo et al., 2007;  
Rabuffetti et al., 2008; Corbari et al., 2009;  
Ravazzani et al., 2011; Corbari et al., 2011]

**Corbari & Mancini, 2014 (JHM)**  
**Corbari et al., 2014, (HSJ)**



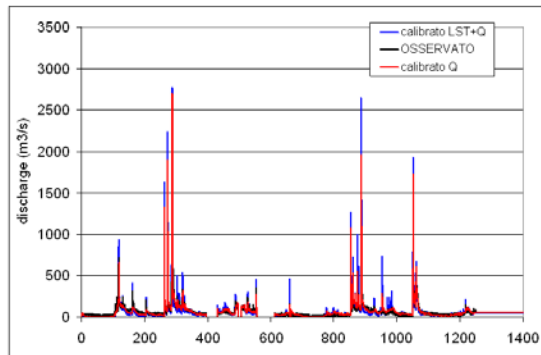
2017 DRAG

26–30 June 2017 | Copenhagen, Denmark

2017年“龙计划”四期学术研讨会

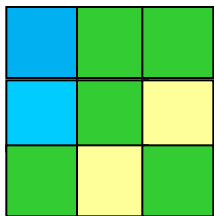
2017年6月26-30日, 丹麦 哥本哈根

Traditional calibration on local measurements (observed discharge, local soil moisture or evapotranspiration)

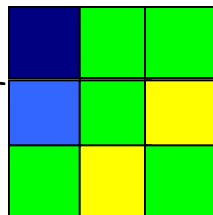


$$\frac{1}{t} \int_0^t \Delta Q(t) dt = \text{MIN} (Q_{\text{obs}}(t) - Q_{\text{sim}}(t))$$

Not calibrated



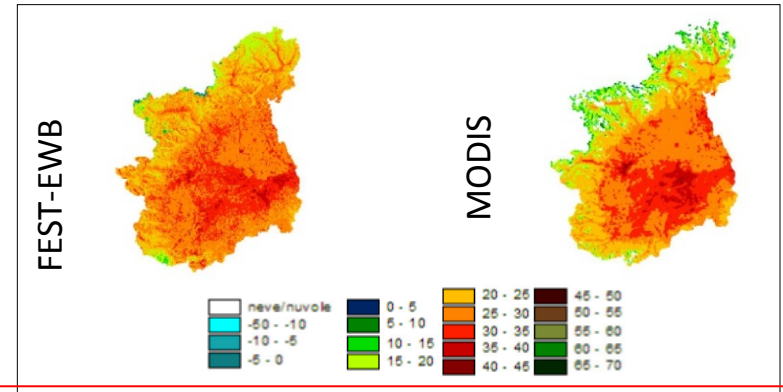
calibrated



Each pixel is multiplied by a **common factor** which depends on discharge differences

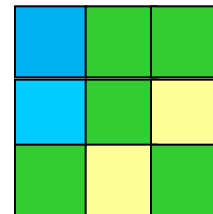
**Soil parameters:** same spatial distribution

PIXEL to PIXEL calibration on satellite LST

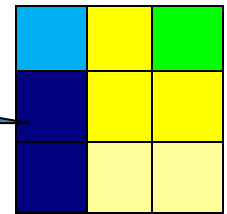


$$\frac{1}{t} \int_0^t \Delta T(t) dt = \text{MIN} (RET(.,t) - LST(.,t))$$

Not calibrated



calibrated



Each pixel is multiplied by a **local factor** which depends on the temperature matrix differences

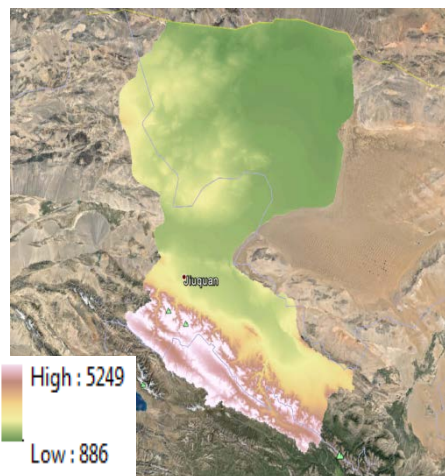
**Soil parameters:** Increased spatial variability  
Corbari & Mancini, 2014 (JHM)  
Corbari et al., 2014, (HSJ)

## Casw Study 1 : Heihe river basin (CHINA)

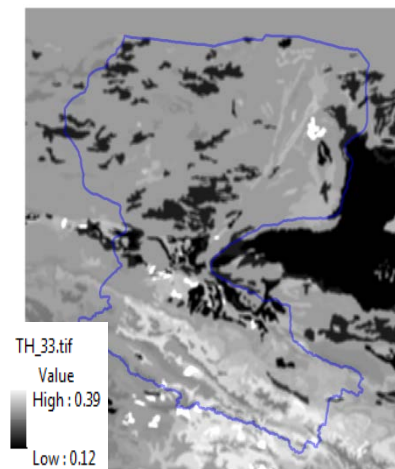
- 1- Topographic data collection
- 2- soil data collection (soil type, definition of soil hydrological parameters)
- 3- land use/cover (ESA globcover)
- 4-vegetation AND ALBEDO data collection (SATELLITE data from MODIS/ENVISAT)

METEOROLOGICAL and Hydrological data in progress.....

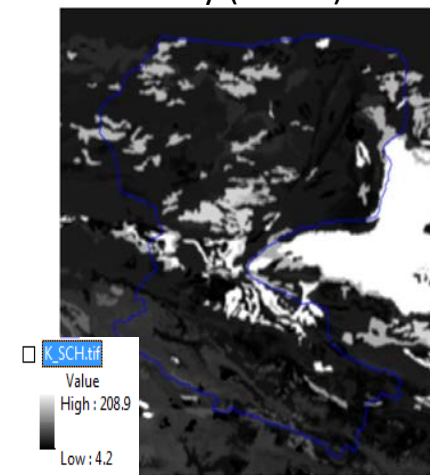
DEM (m a.s.l.)



Field capacity



Saturated hydraulic conductivity (cm d<sup>-1</sup>)



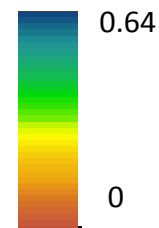
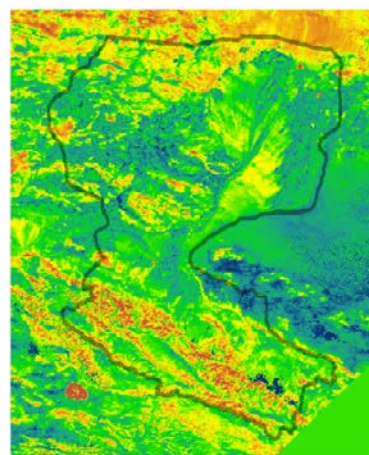
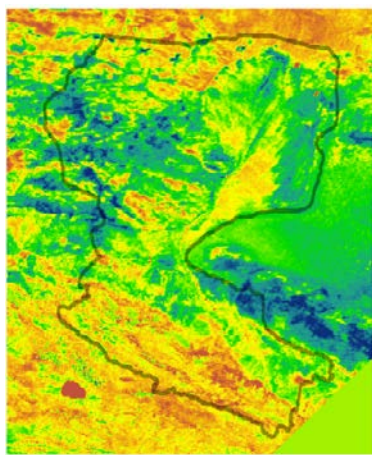
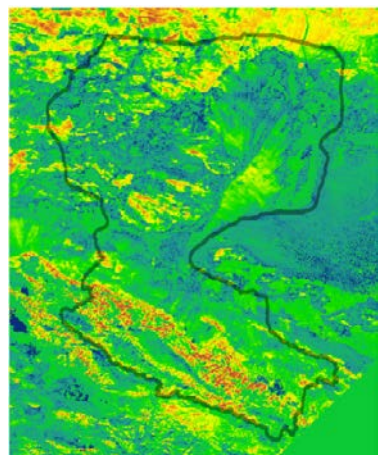


The GLASS **albedo** product from 2000 to 2010 is derived from MODIS data, with a spatial resolution of 1km

2012001

2012185

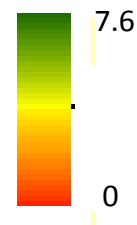
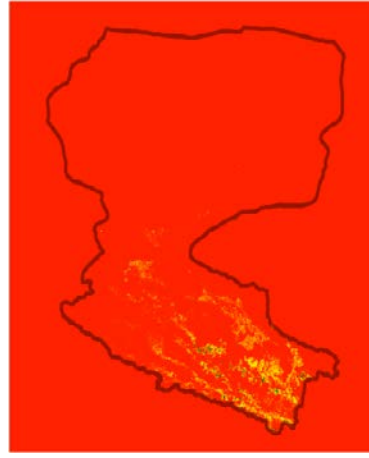
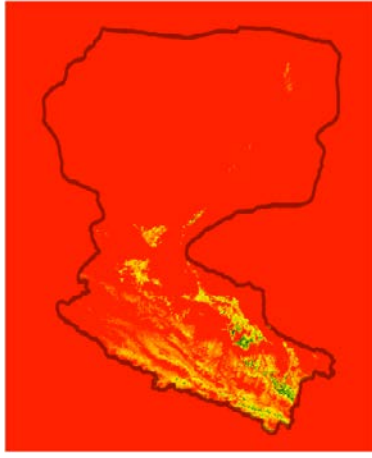
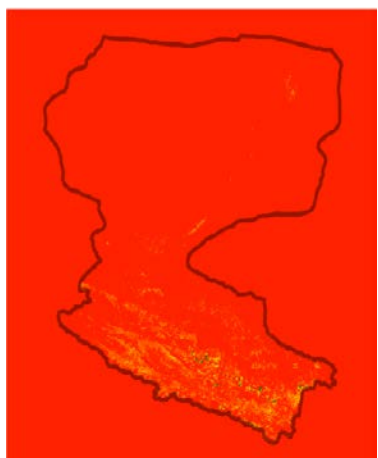
2012312



Shunlin Liang, Qiang Liu. Global Land Surface Products: Albedo Product Data Collection(1985-2010), Beijing Normal University, 2012

The **LAI** from MODIS data, with a spatial resolution of 1km

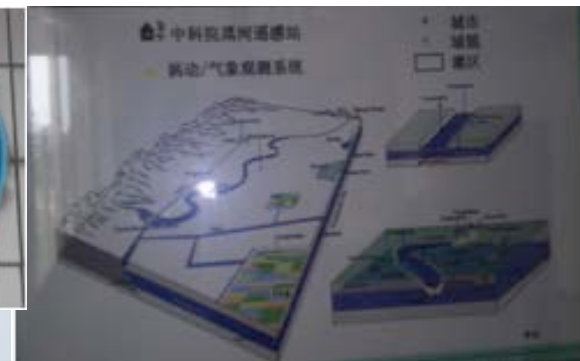
Courtesy Li Jia RADi CAS group







End-users meeting



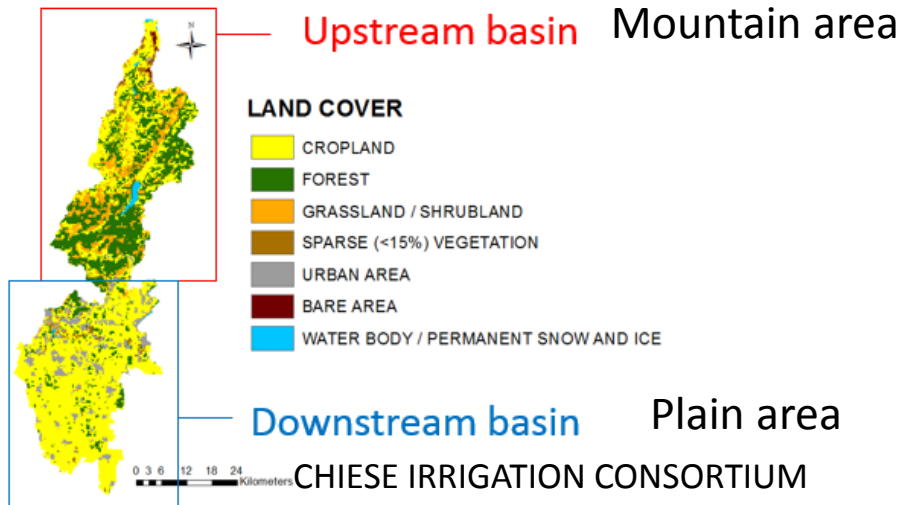


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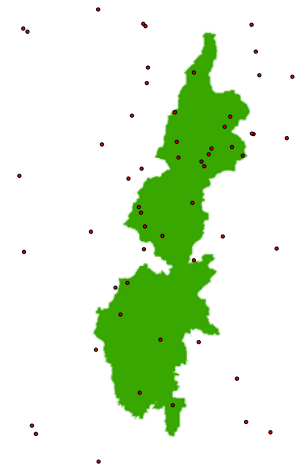
## ESA GLOBCOVER



## Meteorological data

56 ground station for air temperature and precipitation

32 ground station for radiation and wind speed



Arpa Lombardia/Trentino



**Eddy covariance station  
In a maize field**

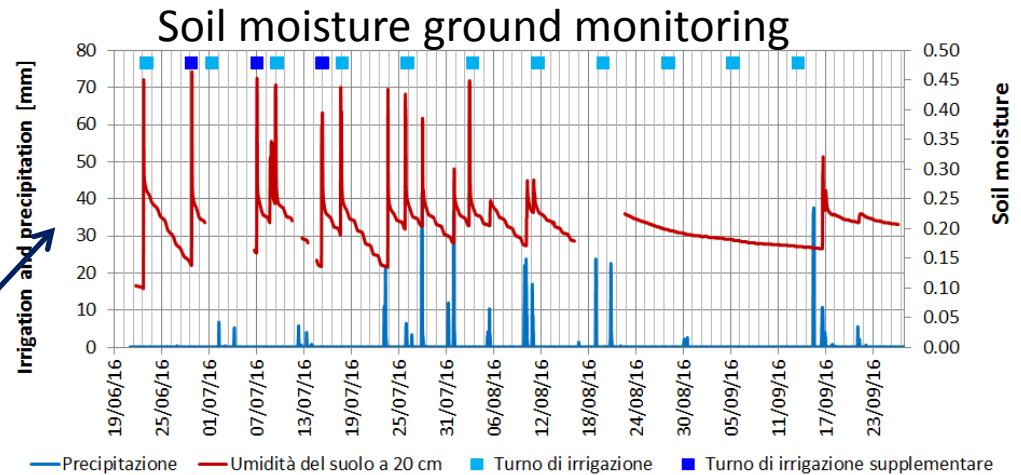
## Discharge data

- Bacino di Ponte dei Tedeschi ~ 470 km<sup>2</sup>
- Bacino di Gavardo ~ 967 km<sup>2</sup>
- Bacino di Mezzane ~ 1110 km<sup>2</sup>
- Bacino di Asola ~ 1267 km<sup>2</sup>

- Diverted discharge from the Chiese river for irrigation= 21 m<sup>3</sup>/s
- Dense irrigation channels network
- Scheduled irrigation: every 6 days and half

 Irrigated area

Montichiari District





## LAI MOD15A2

January

May

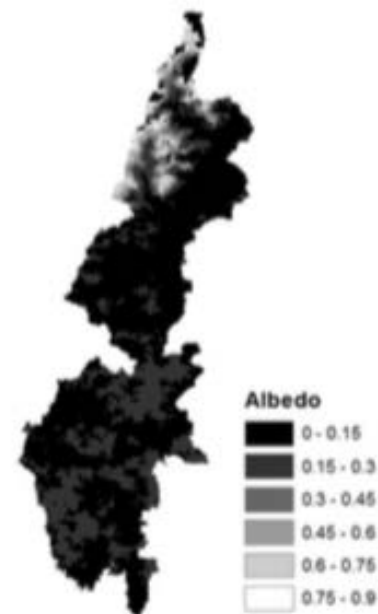
August

November 2005



## ALBEDO MOD43A

January 2005



1 image every month (2005-2016), DX = 250 m  
For LAI, NDVI, vegetation fraction and albedo

FEST-EWB not  
calibrated

FEST-EWB  
calibrated

MODIS

2005-2011

Difference between

MODIS and  
RET not  
calibrated

MODIS and  
RET calibrated

24.5 (°C)

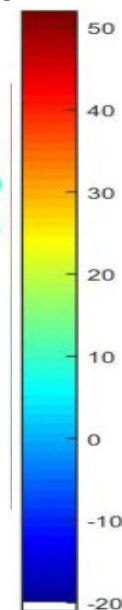
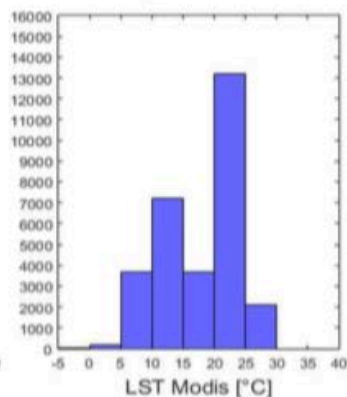
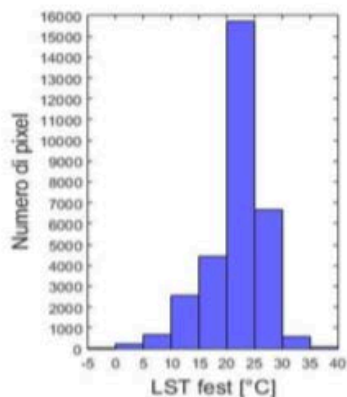
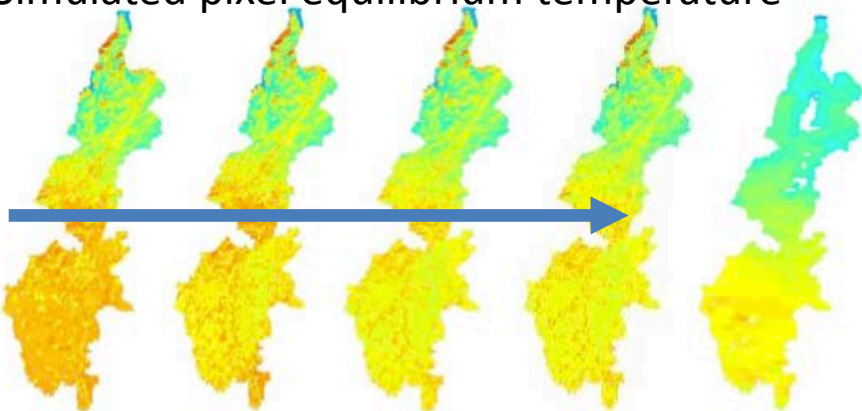
13

1.5

Mean 6 °C

Mean 3 °C

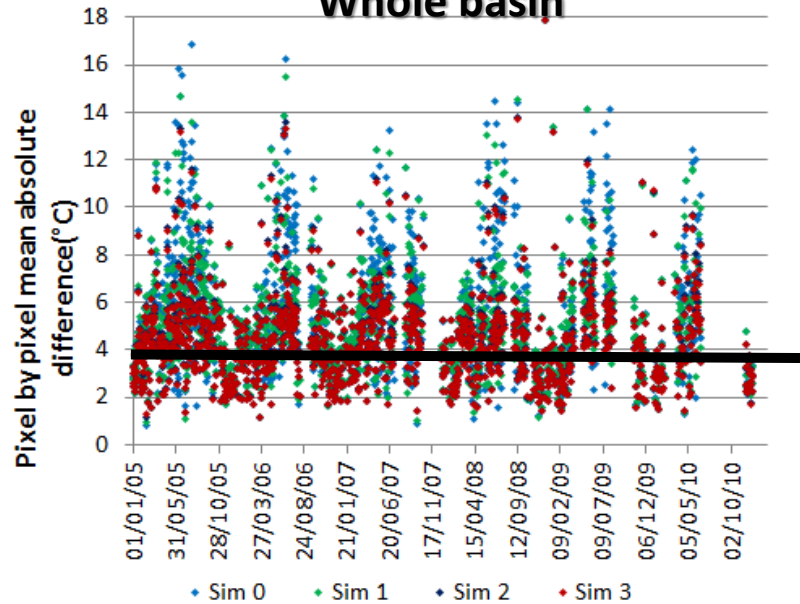
Simulated pixel equilibrium temperature



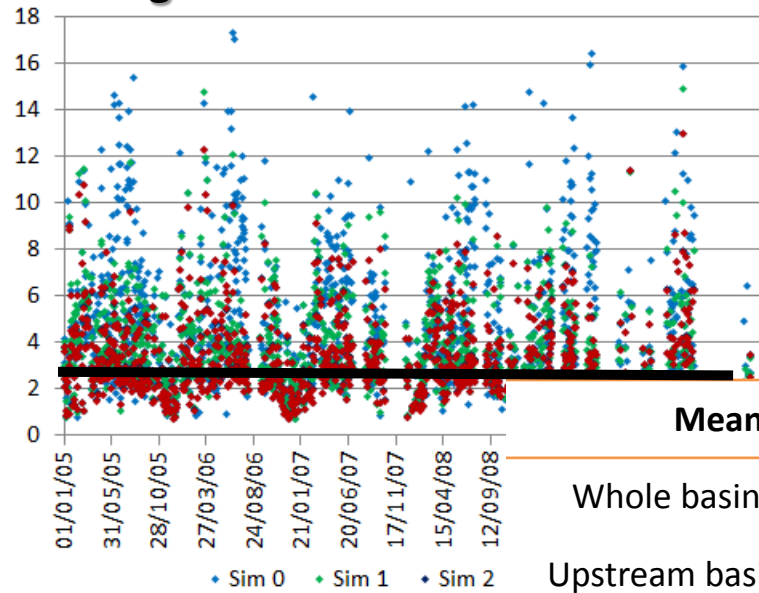


LST Dx= 1000m ( WP3)

**Whole basin**



**Irrigation district**

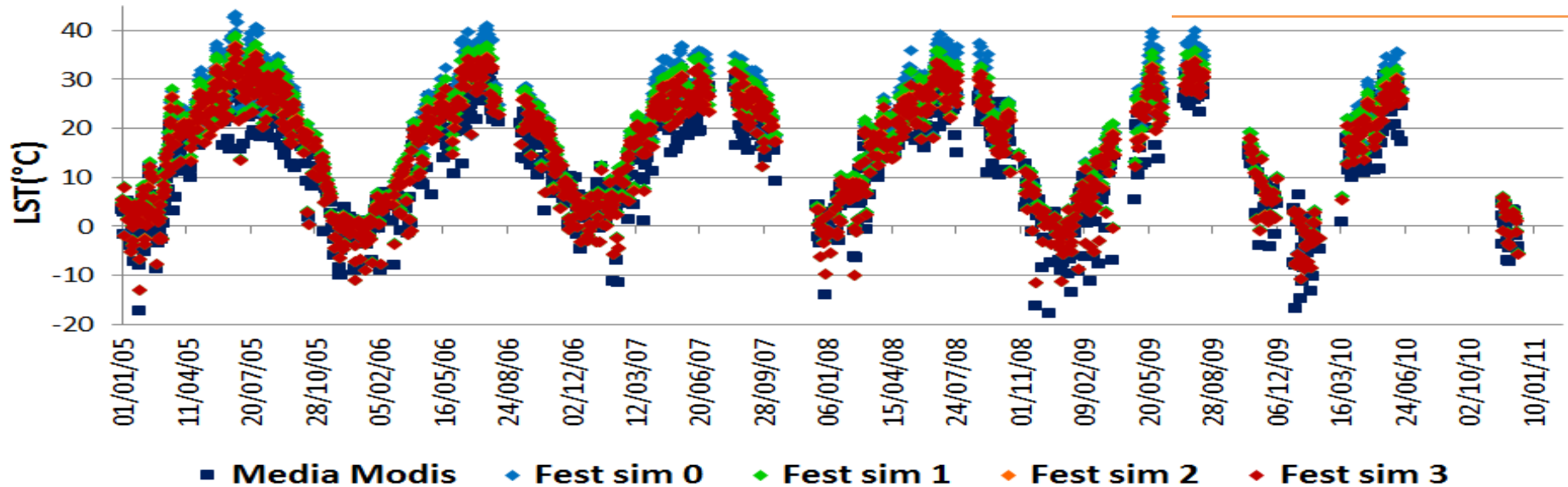


**Mean errors**

Whole basin 3.43 °C

Upstream basin 4.66 °C

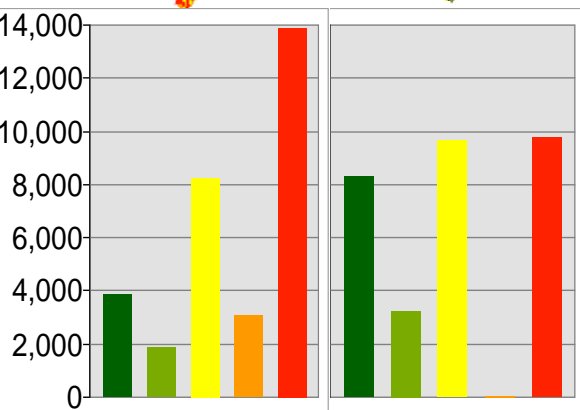
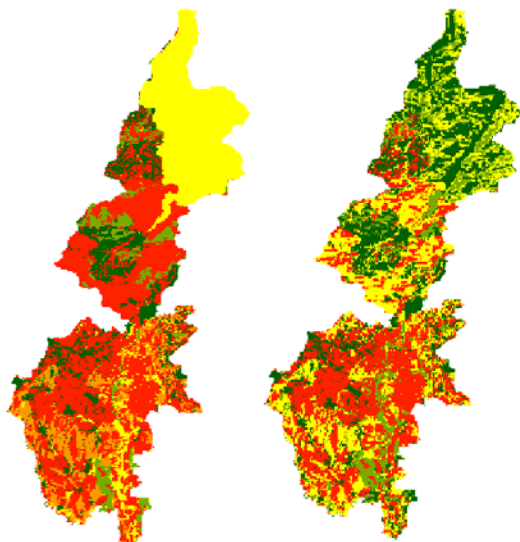
Irrigation district 2.40 °C



**Ksat saturated hydraulic conductivity(m/s)**

Not calibrated

calibrated

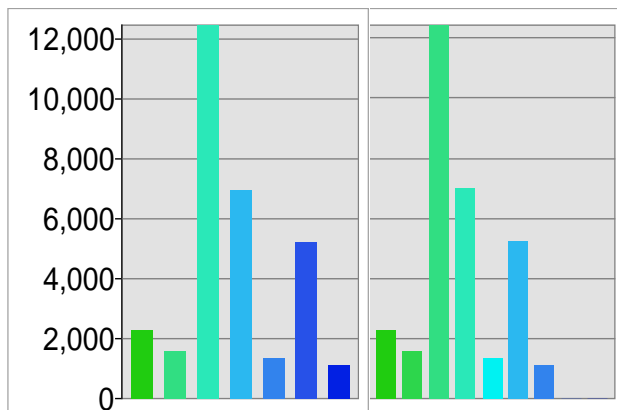
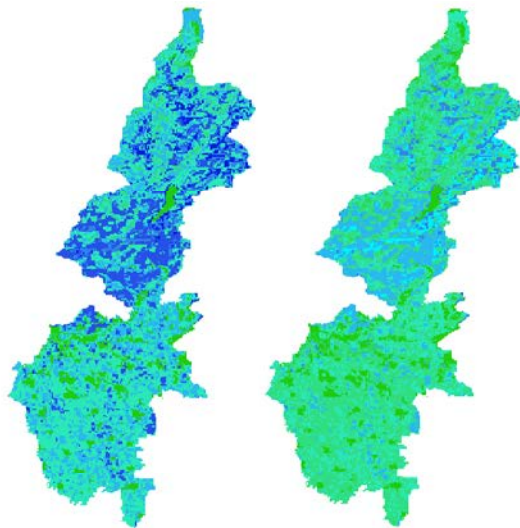


m/s

**Rsmn Stomata Resistent**

Not calibrated

calibrated

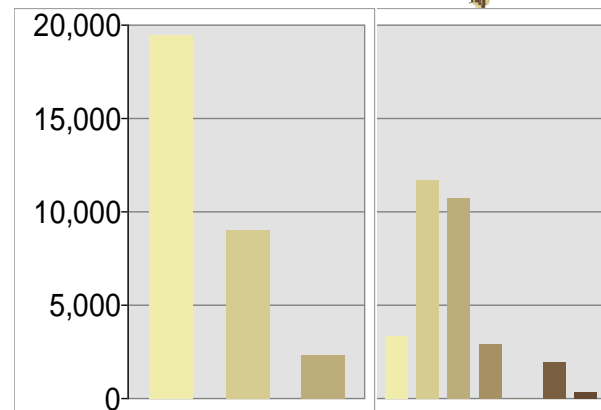
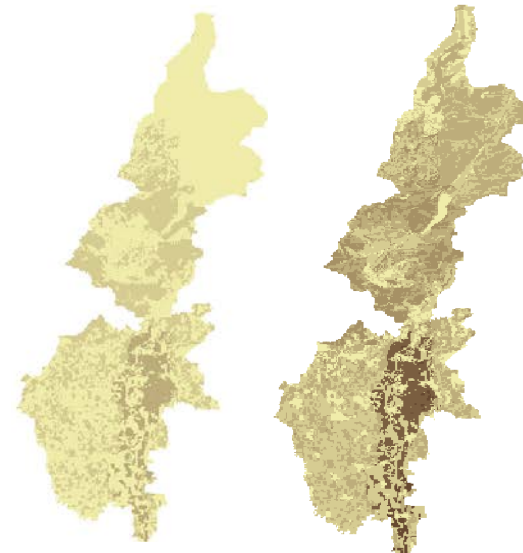


s/m

**Soil depth (m)**

Not calibrated

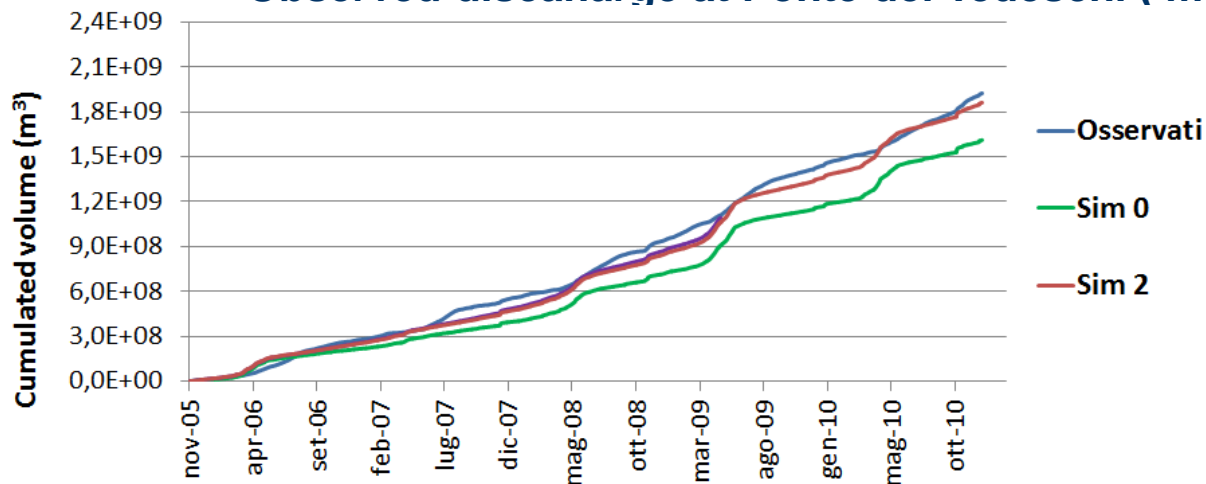
calibrated



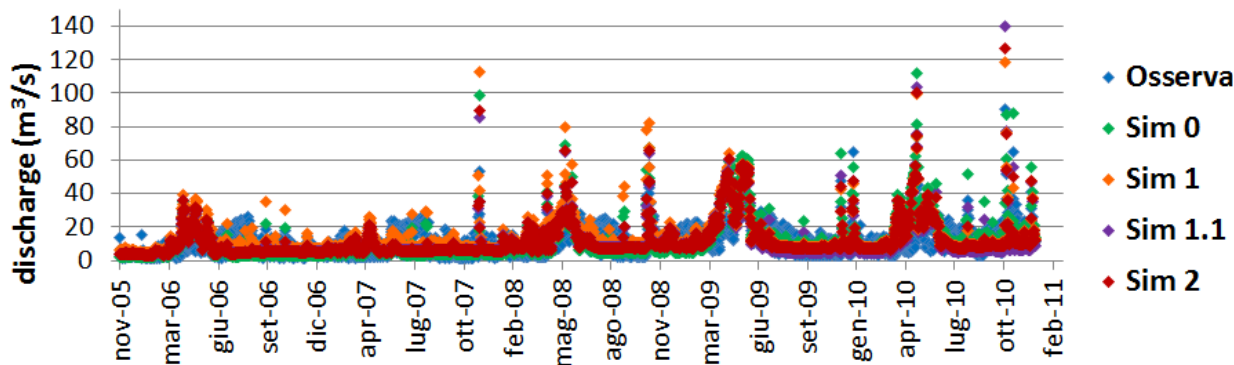
m



## Observed discharge at Ponte dei Tedeschi ( mountain basin area)

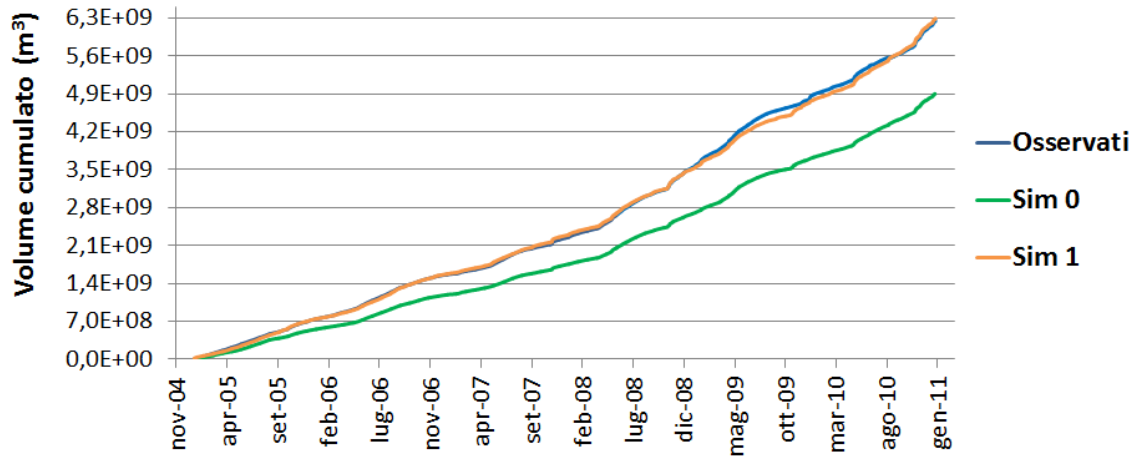


	Error
Sim 0	16.3%
Sim 2 (kprof*3, CN-5)	3.3%

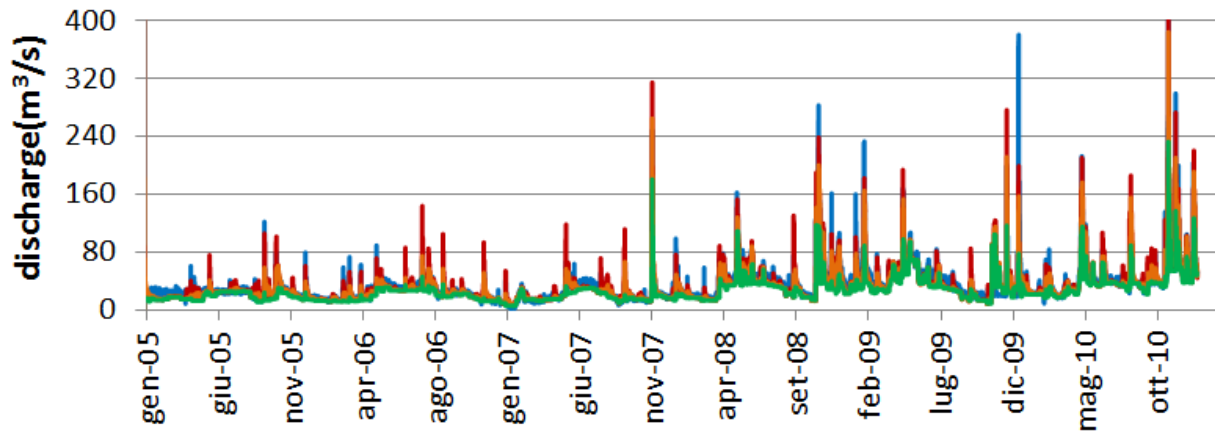


	NASH	Error % peak
Sim 0	0.87	7.3%
Sim 1	0.68	34.8%
Sim 1.1	0.87	-11.1%
Sim 2	0.89	-6.3%

## Observed discharge at Gavardo( mountain basin area)



	Errore
Sim 0	21.5%
Sim 1 (kprof*5000, CN+5)	-0.7%



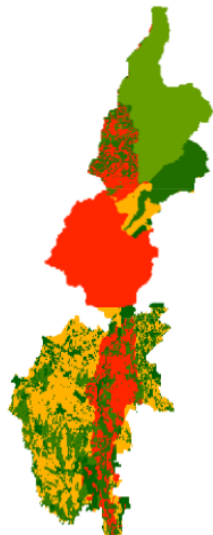
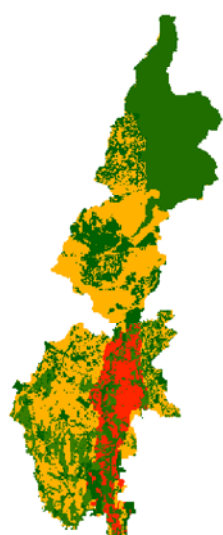
	NASH	Errore % picco
Sim 0	0.75	30.8%
Sim 1	0.78	-21.1%
Sim 2	0.91	-5.6%



**Kprof (cm/s)**

Not calibrated

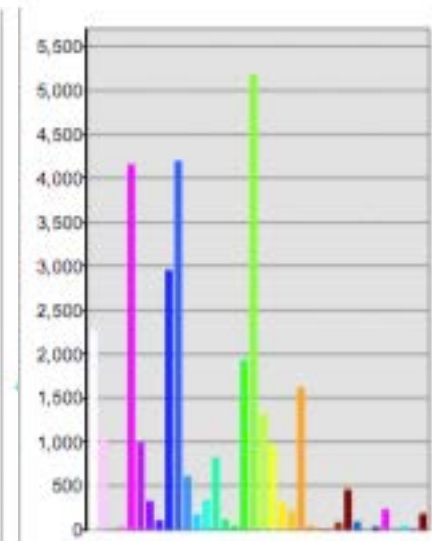
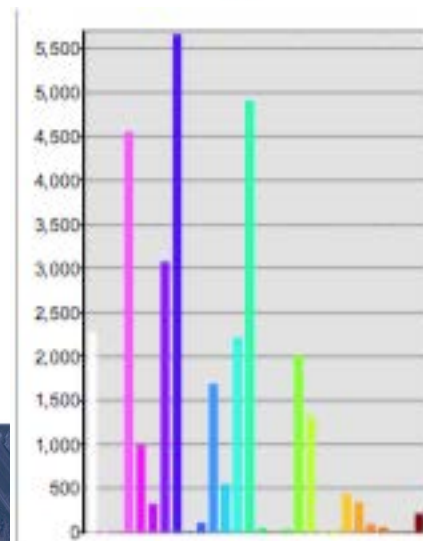
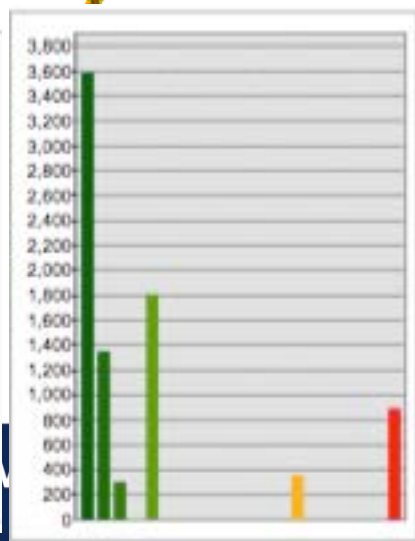
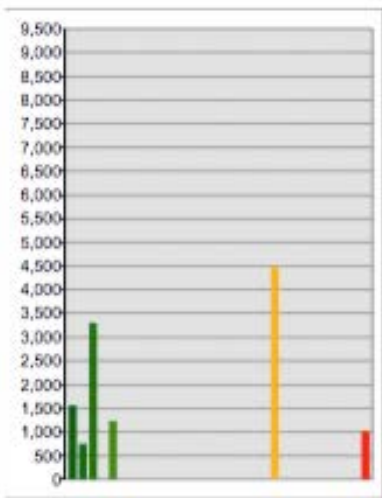
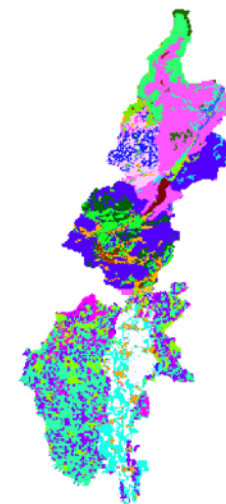
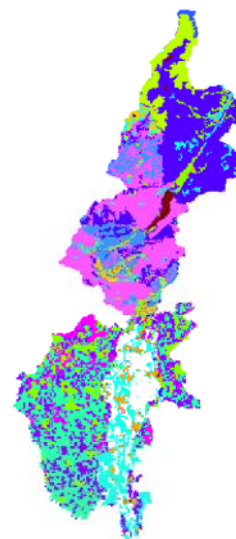
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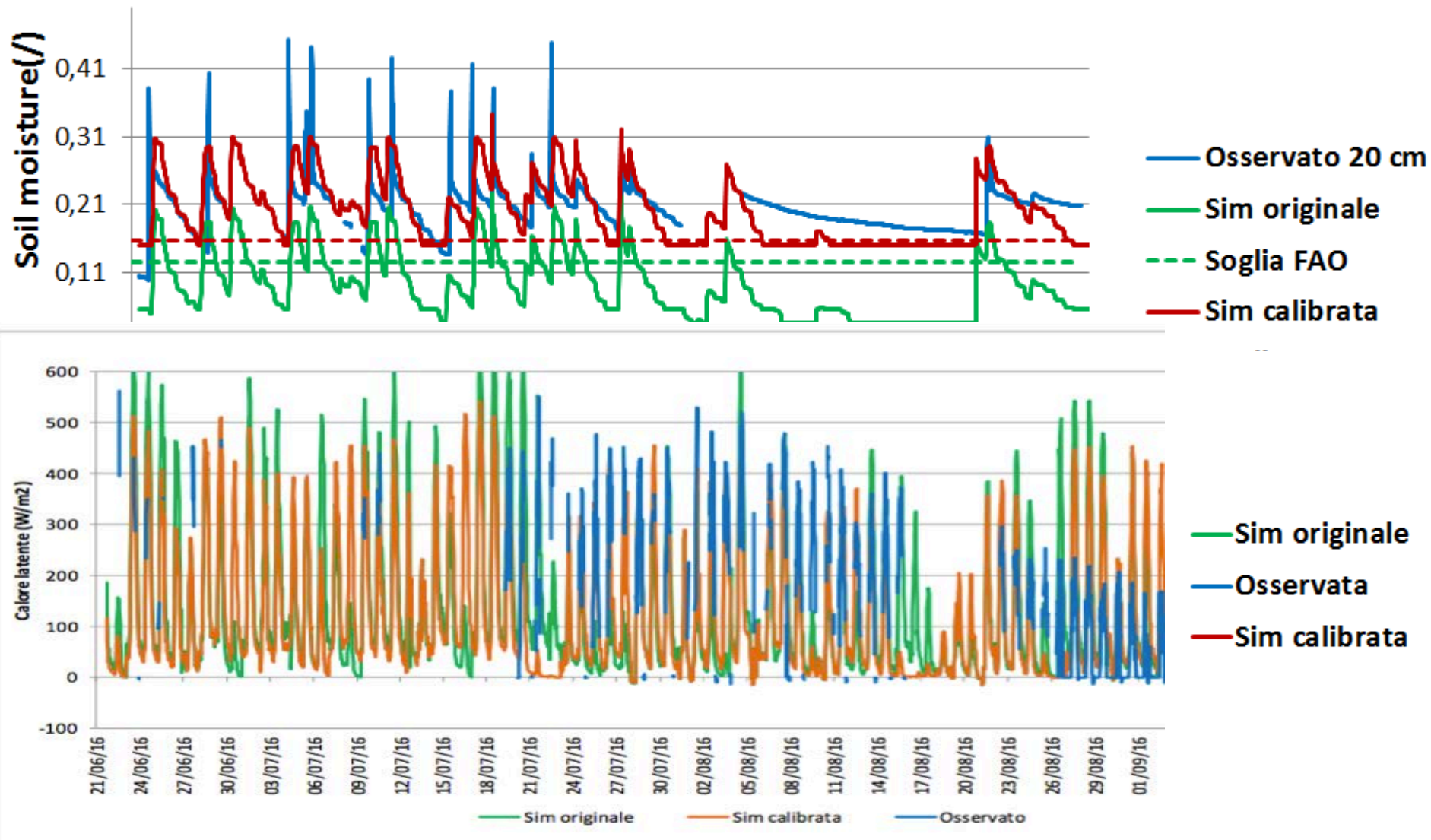


**CN**

Not calibrated

calibrated



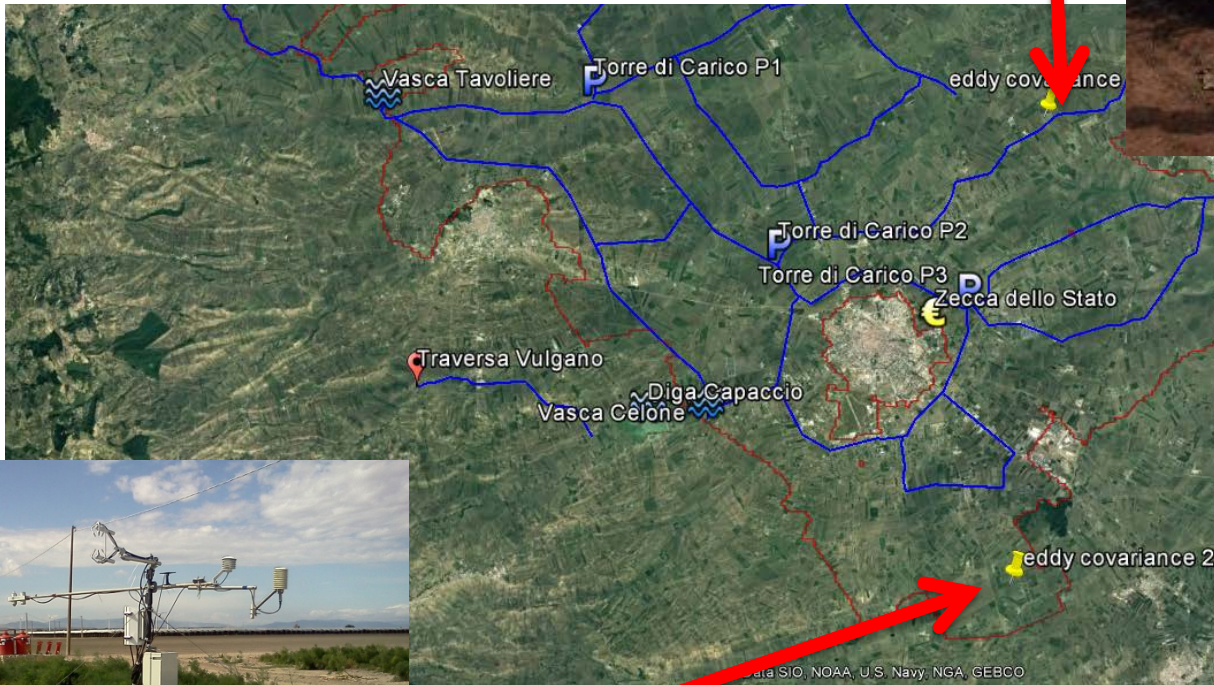




Eddy covariance from 2015 (tomatoes)



**Sud Fortore irrigation district (Southern Italy): experimental water distribution network**



Eddy covariance from 2013 (asparagus, tomatoes)

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CALIBRATION PROCEDURE BASED ON INNOVATIVE SATELLITE BASED LST IS PROVIDED IN SINERGY WITH TRADITIONAL CALIBRATION ON RIVER DISCHARGES.

OPERATIVE PRODUCT IRRIGATION WATER MANAGEMENT AT FIELD AND BASIN SCALE ARE PROVIDED USING EU MODEL (FEST EWB ) AND WILL BE UPDATED WITH CHINESE ONE ( ETMONITOR)

ESA SENTINEL DATA will be more intensively use in the next DRAGON PROJECT YEARS due to the lack of hydrological data series.

THE ACTIVITY ON CHINESE HEIHE BASIN IS GOING ON THANKS TO THE CHINESE COLLEGUES