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Giovanni Ravazzani presents:

Integrated systems for real time irrigation management and flood forecasting

Resilience and Territorial Safety

Venice

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Citizen Observatories for Water Management

Motivation and Objectives

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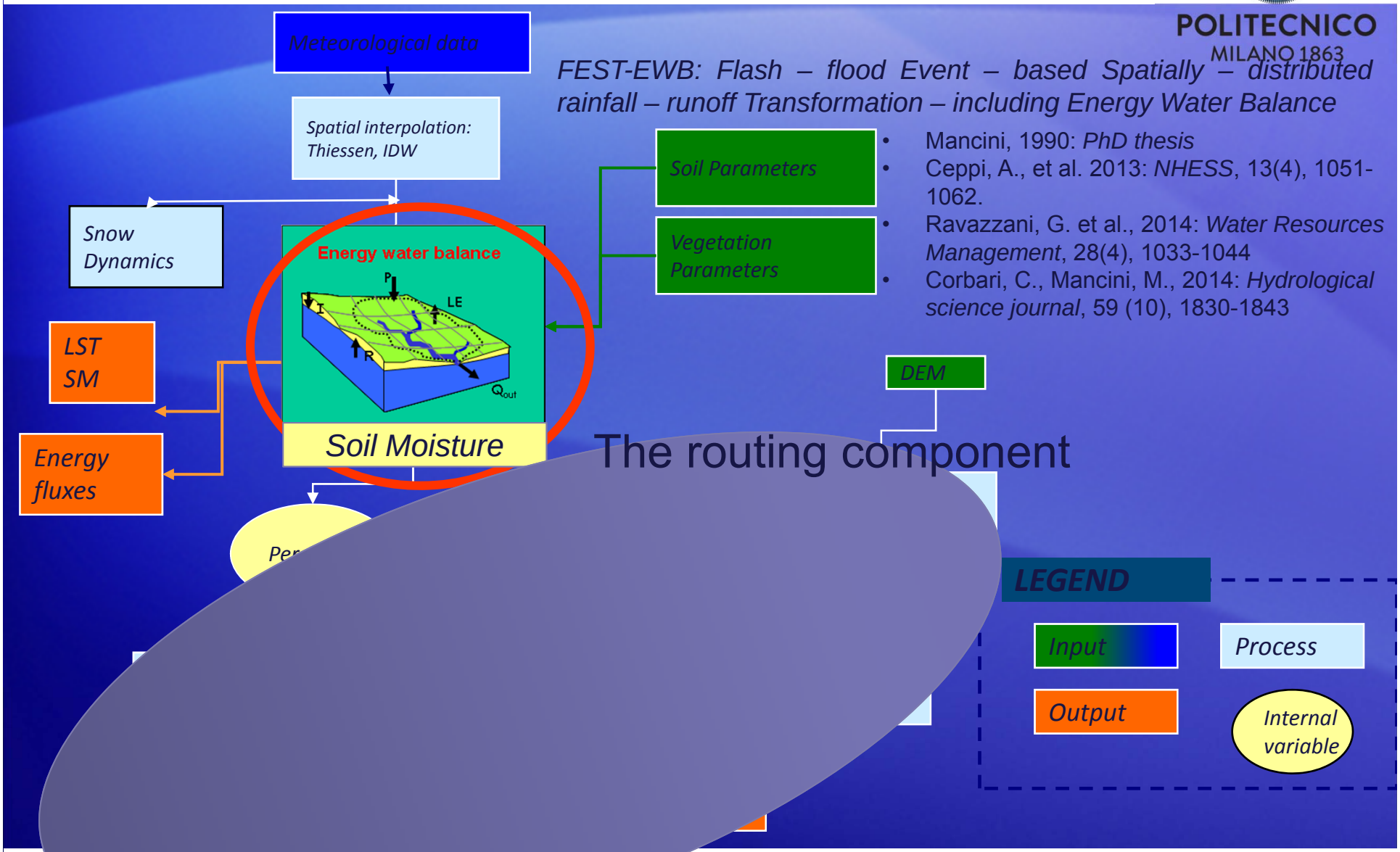
- Impact of climate and land use change on water resources availability and intensity and fequency of flood events
- Flood and water scarcity may occur in the same area in different time
- Increase of conflicts between water uses
- Need to adopt integrated systems for managing both water scarce and flood episodes
- Need to use spatially distributed information from citizens, crowdsourcing

Continuous hydrological modelling



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

- Mancini, 1990: *PhD thesis*
- Ceppi, A., et al. 2013: *NHESS*, 13(4), 1051-1062.
- Ravazzani, G. et al., 2014: *Water Resources Management*, 28(4), 1033-1044
- Corbari, C., Mancini, M., 2014: *Hydrological science journal*, 59 (10), 1830-1843

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...t and flood forecasting

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Coupling hydrological and meteorological

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Model initialization

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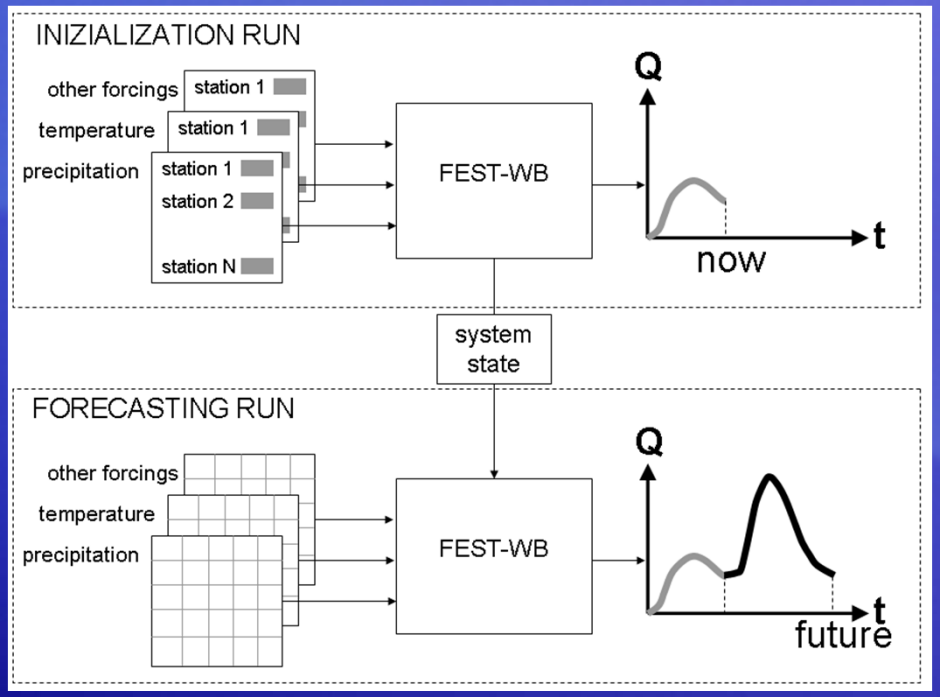
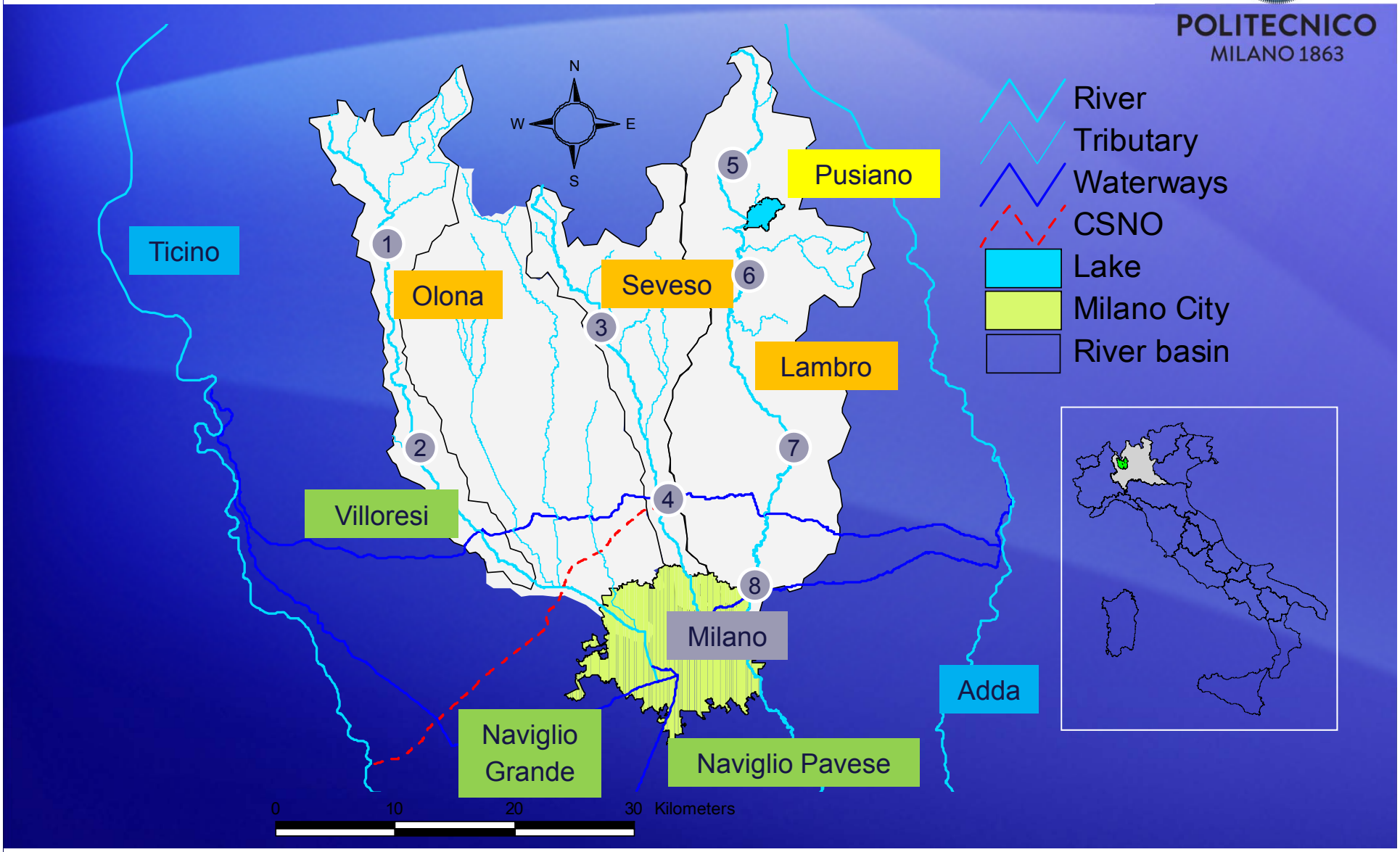
The Hydro-Meteorological chain → Observations: Weather and Hydro data → Local M ~al Modelling → Basin H ~al Modelling

Data from citizens are an important source of information for models initialization



Flood warning system for Milano



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Impact of land use change

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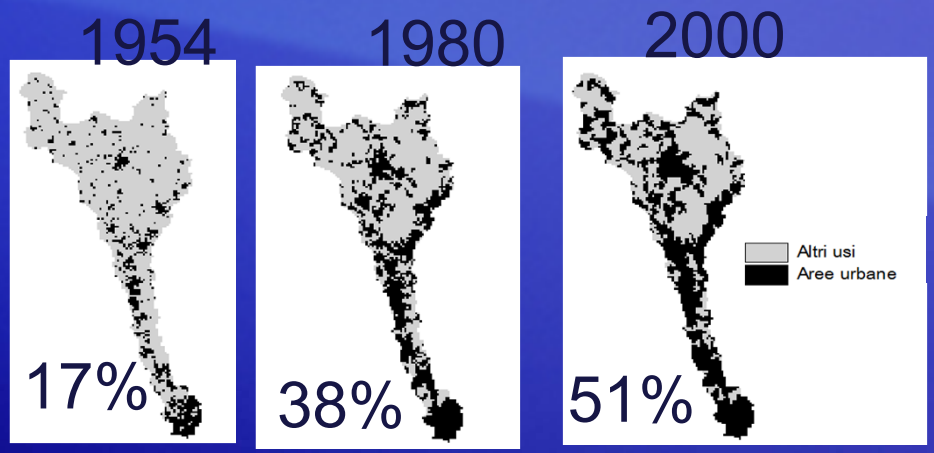
Milan city is a flood prone area that has been frequently flooded in the past and recent years.

ESONDAZIONI TORR. SEVESO

ANNI	N.	DATA	DURATA
1976	1	03.10.1976	13,50
	2	05.10.1976	4,00
	3	13.10.1976	2,00
	4	30/31.10.1976	24,50
1977	5	31.07.1977	5,25
	6	29.08.1977	5,25
	7	29/30.08.1977	12,50
	8	30.08.0977	4,00
	9	17.09.1977	0,50
	10	07.10.1977	2,17
1978	11	25.02.1978	17,83
	12	26.02.1978	15,00
	13	22.05.1978	5,50
	14	22.05.1978	8,17
	15	17.06.1978	0,50
1979	16	28/29.03.1979	13,50
	17	02.07.1979	1,00
	18	13.07.1979	0,75
	19	18.08.1979	1,17
	20	24.08.1979	1,00
	21	21.09.1979	3,33
	22	21.09.1979	3,25
	23	21/22.09.1979	12,83
	24	13.10.1979	4,17
	25	14.10.1979	10,75
	26	17.10.1979	7,25
	27	28.10.1979	7,42
	28	22.10.1979	1,75
	29	23.12.1979	6,25
1980	30	10.06.1980	1,33
	31	08.08.1980	2,00
	32	17.10.1980	4,00
1981	33	24.09.1981	5,00
	34	27.09.1981	1,01
1982	35	07.09.1982	0,50
	36	21.09.1982	0,50
1983			0,00
1984			0,00
1985			0,00
1986	37	29.05.1986	2,50
1987	38	24.08.1987	4,42
	39	08.09.1987	2,33
1988	40	12.10.1988	1,66
1989			0,00
1990	41	17.10.1990	0,50
1991	42	29.05.1991	0,75
1992	43	11.07.1992	3,00
	44	09.09.1992	7,25
1993	45	23.06.1993	0,17
	46	27.06.1993	0,67
	47	24/25.09.1993	9,83
1994	48	28.07.1994	0,83
1995			0,00
1996	49	22.06.1996	2,50
	50	02.07.1996	5,00
	51	14.11.1996	5,00
1997	52	17.07.1997	1,50
	53	06.09.1997	1,00



URBAN AREA

List of main floods in the 70s, 80s and 90s

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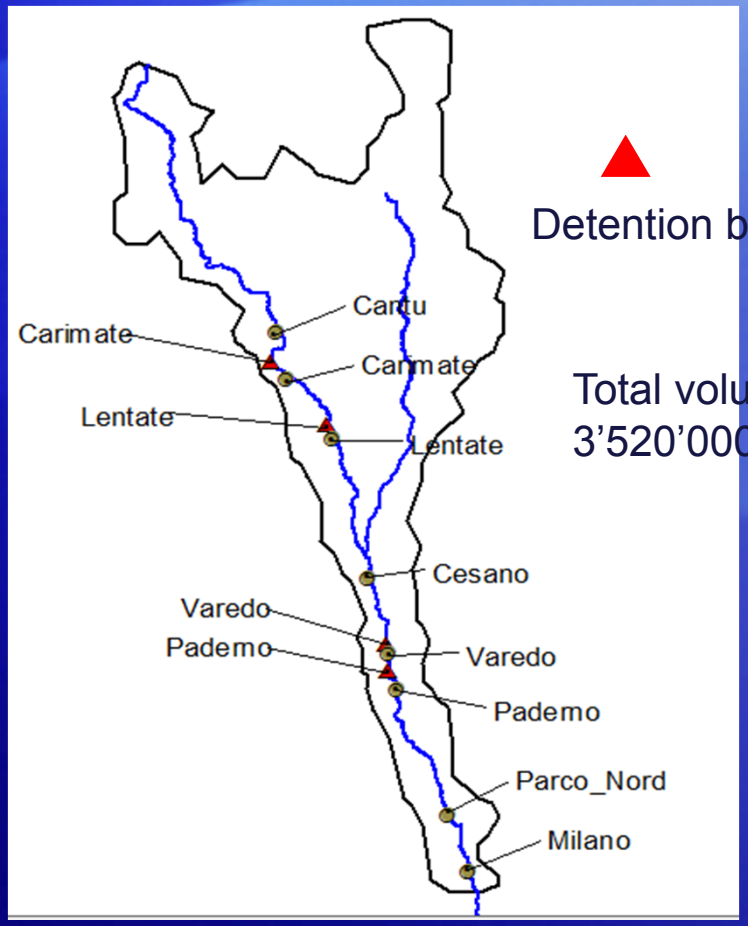
Structural measure

Bypass channel (CSNO, acronym from Italian “Canale Scolmatore di Nord Ovest”). Built from 1954 to 1980. Discharge capacity 30 m^3/s

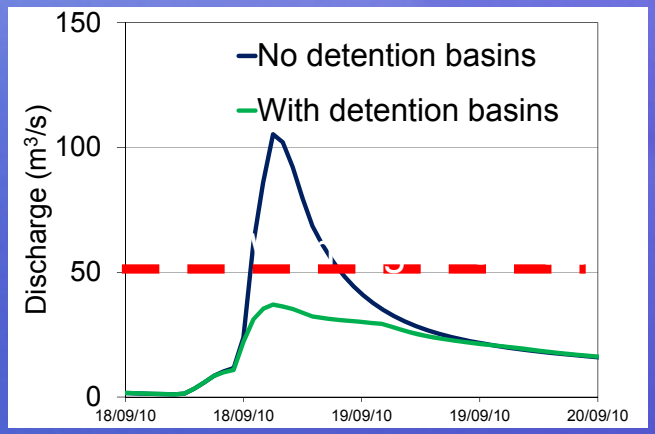
Planned detention basins



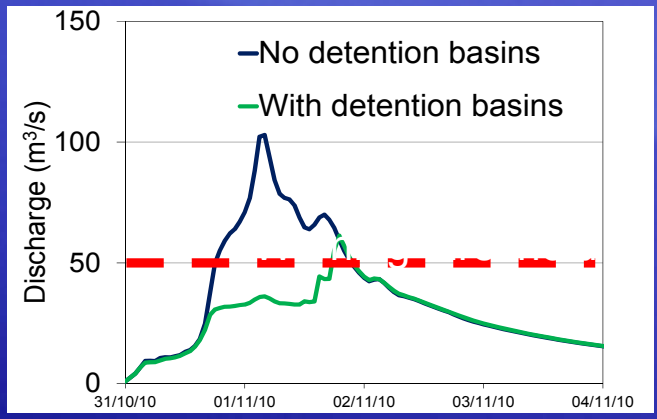
Detention basin

Total volume:
3'520'000 m^3

September 2010



October 2010



Web application

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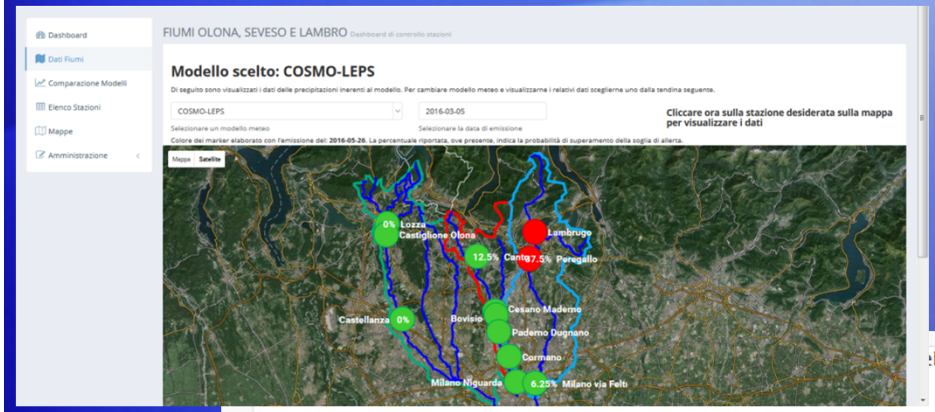
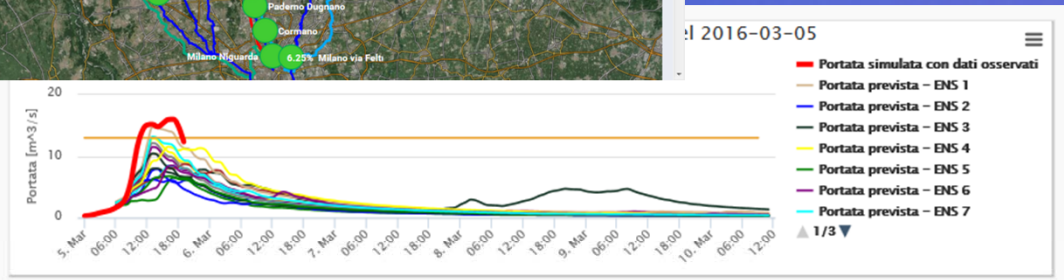
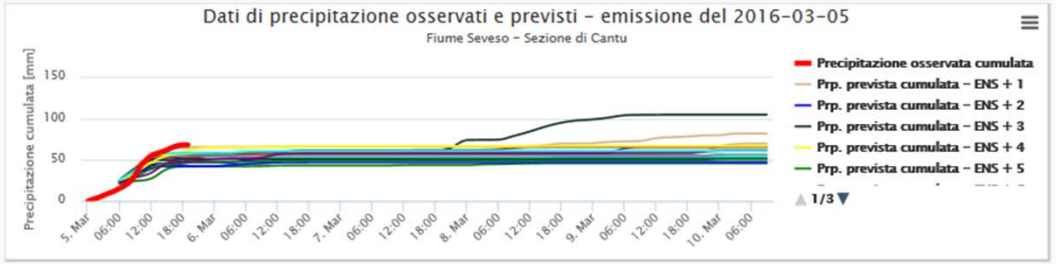
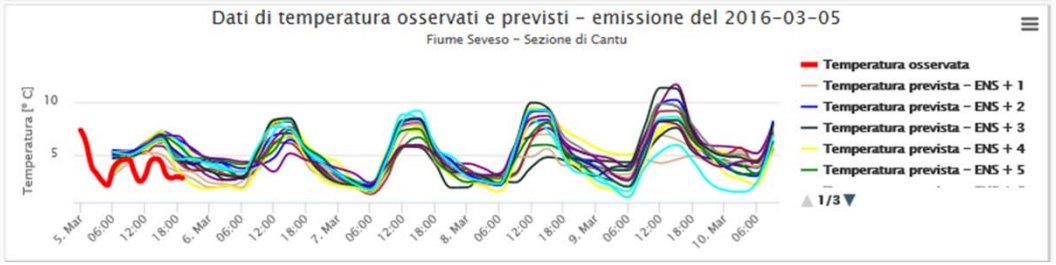
Hydro-Meteo Forecasts based by
CLEPS + FEST
Initialized on 2016-03-05









Discharge

Cumulated Precipitation

Temperatur e

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Hydro-Model initialization: data from citizens

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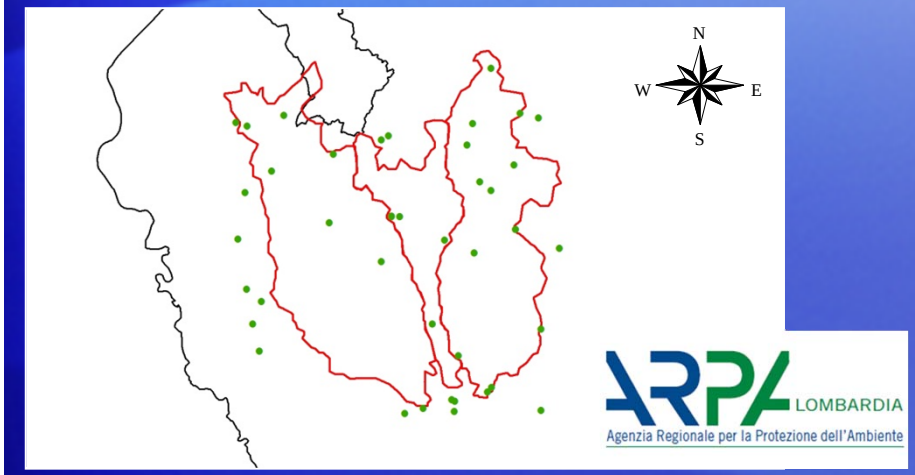
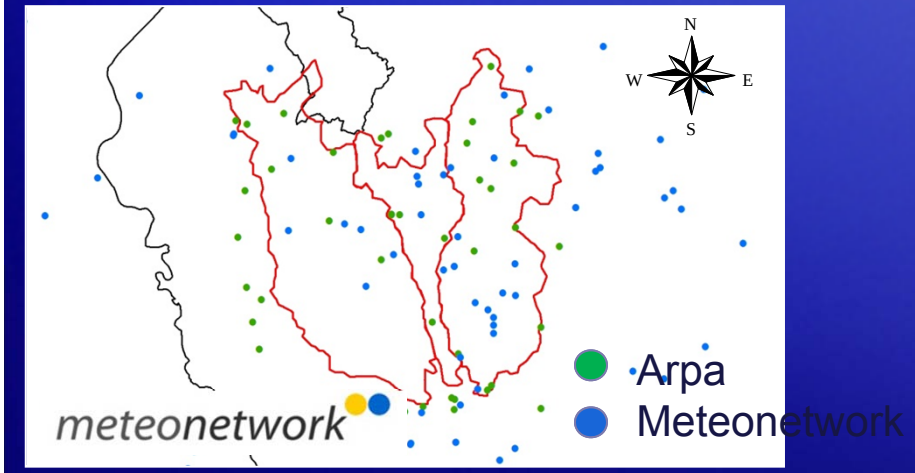
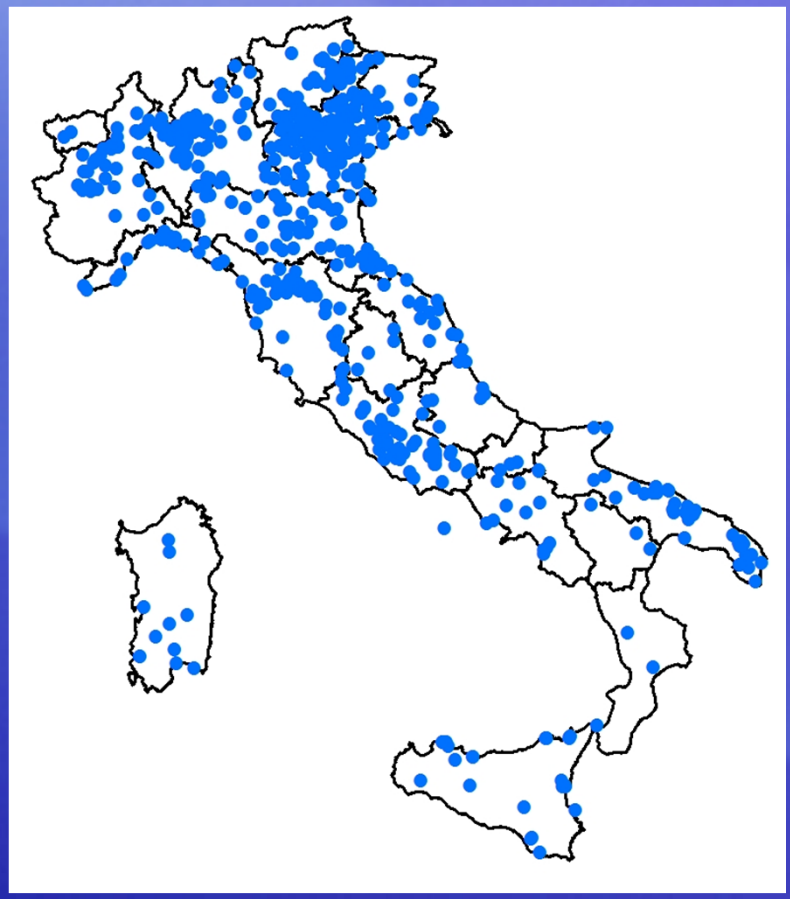
Official ARPA Lombardy stations



ARPA + Meteonetwork stations





- ~ 850 weather stations
- real time data every 20 minutes

The 7-8 July 2014 event on the Seveso basin

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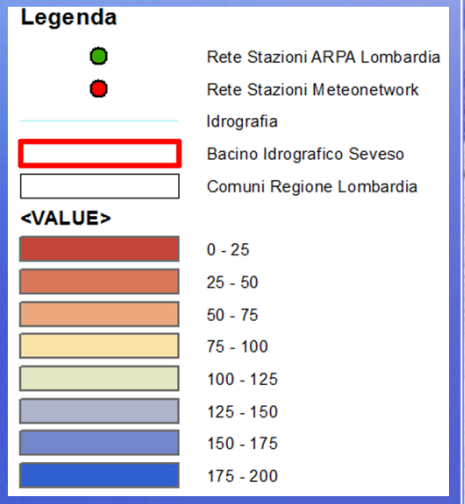
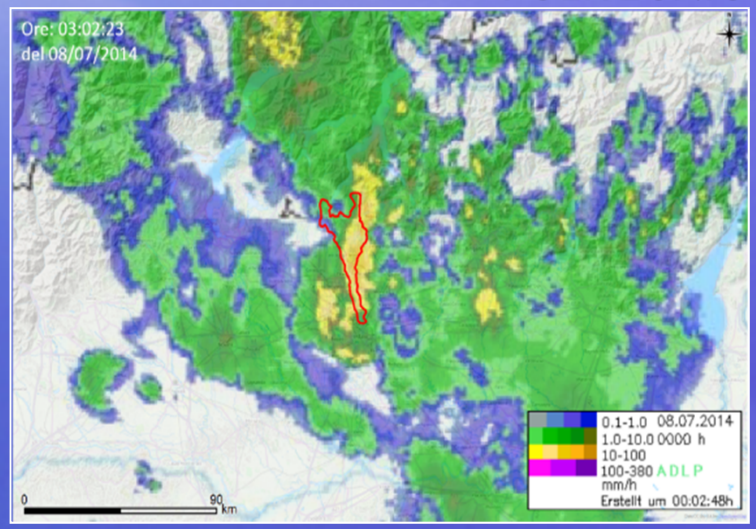
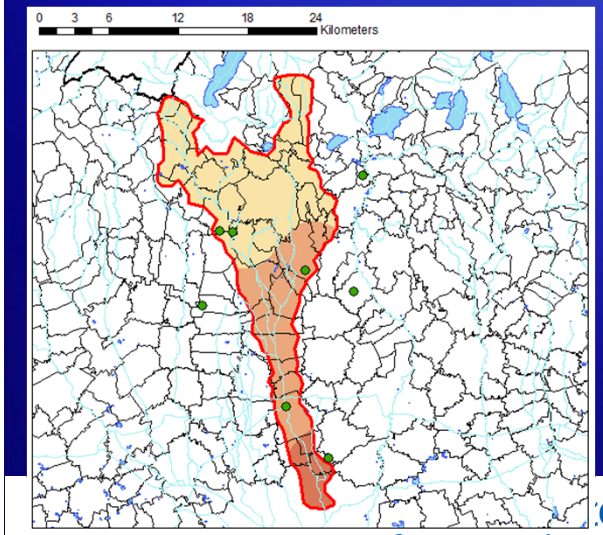
Severe rainfall hit the North-East area of the Seveso basin between 00:00 and 04:00 (local time). Adding MNW station to the ARPA network, we were able to better estimate the return period for precipitation on the Seveso basin.





ARPA



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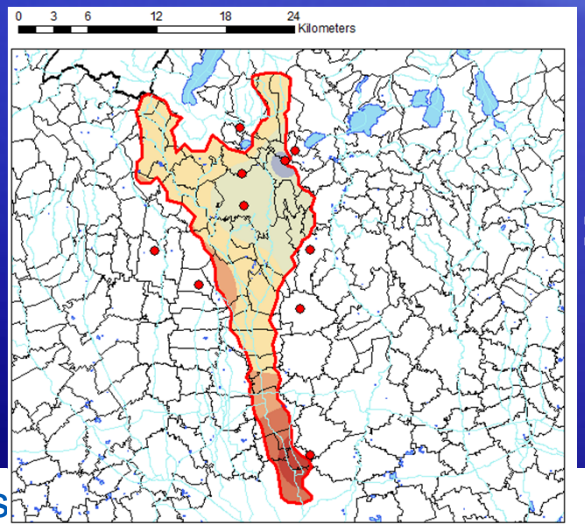
Meteonetwork



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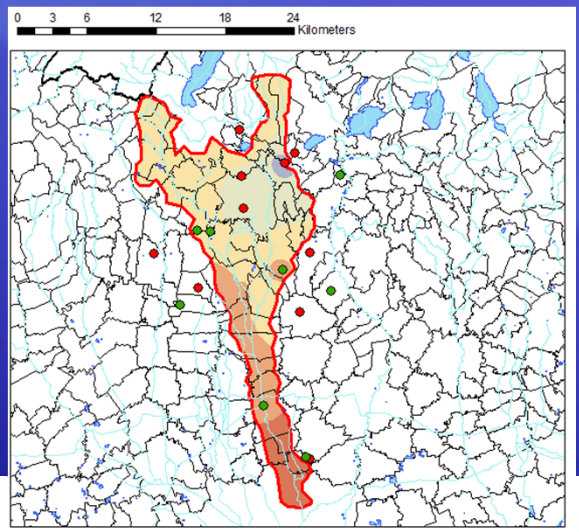
Combined



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Meteorological models

GFS	Deterministic models by ISAC-CNR spatial resolution: 50 km, Δt 3h, forecast horizon +144h
Bolam	spatial resolution: 11 km, Δt 1h, forecast horizon +72h
Moloch	spatial resolution: 1.5 km, Δt 1h, forecast horizon +45h
COSMO-LEPS	Probabilistic model by ARPA Emilia-Romagna spatial resolution: 7 km, Δt 3h, forecast horizon +132h 16 ensemble
WRF	1. spatial resolution: 3 km, Δt 1h, forecast horizon +246h, by Terraria company 2. spatial resolution: 2.5 km, Δt 1h, forecast horizon +48h, by University of Baleari Islands 3. spatial resolution: 5.5 km, Δt 1h, forecast horizon +72h, 8 ensembles, by Epson Meteo Centre

Recent events reanalysis

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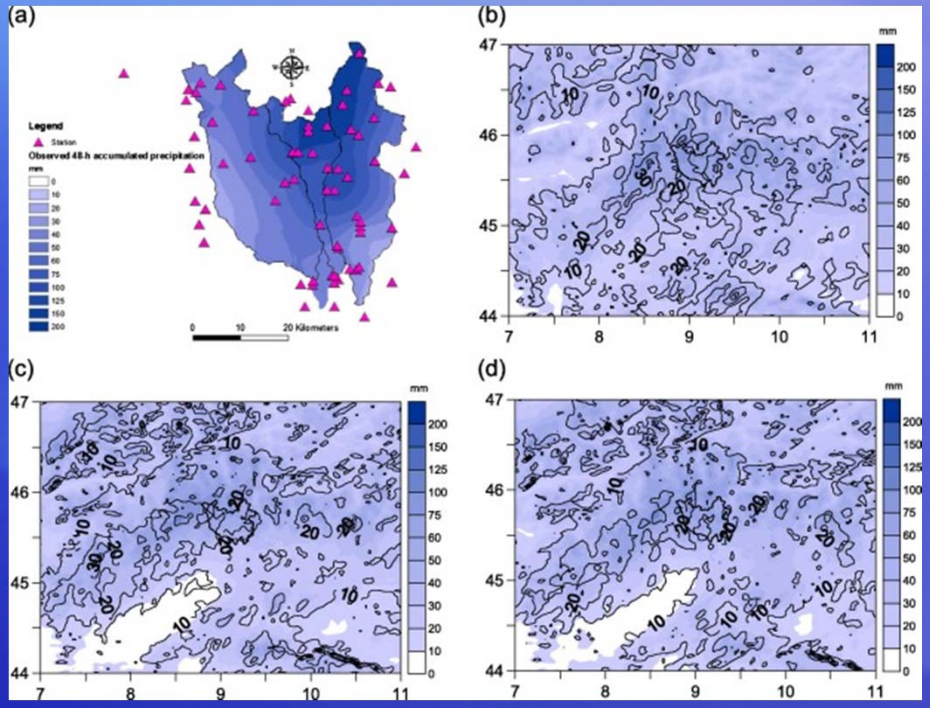


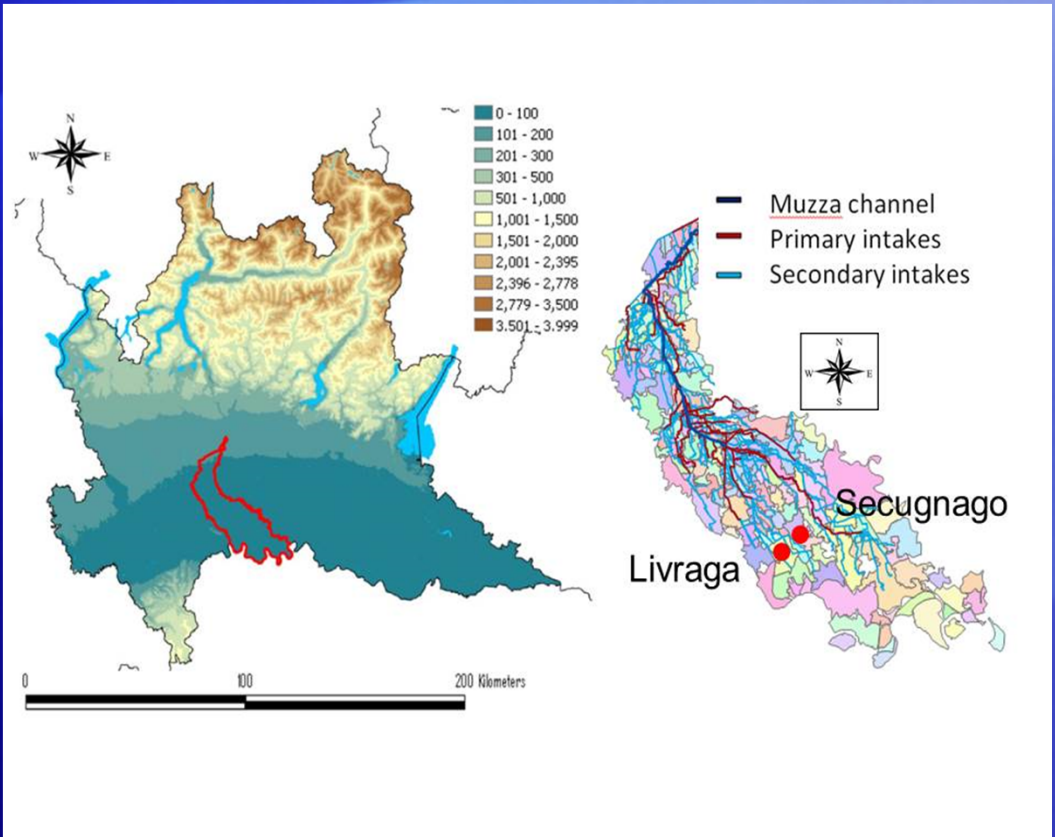
Giovanni Ravazzani, Arnau Amengual, Alessandro Ceppi, Víctor Homar, Romu Romero, Gabriele Lombardi, Marco Mancini

Potentialities of ensemble strategies for flood forecasting over the Milano urban area

Journal of Hydrology, Volume 539, 2016, 237–253

http://dx.doi.org/10.1016/j.jhydrol.2016.05.023

Irrigation management



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SEGUICI
Smart tEcnologie
per la Gestione
delle risorse idriche
ad Uso Irriguo e
CIvile

http://www.seguici.eu/

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Crowdsourcing

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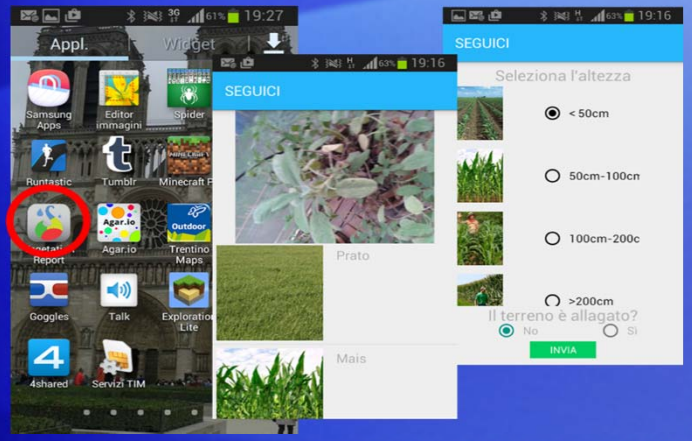

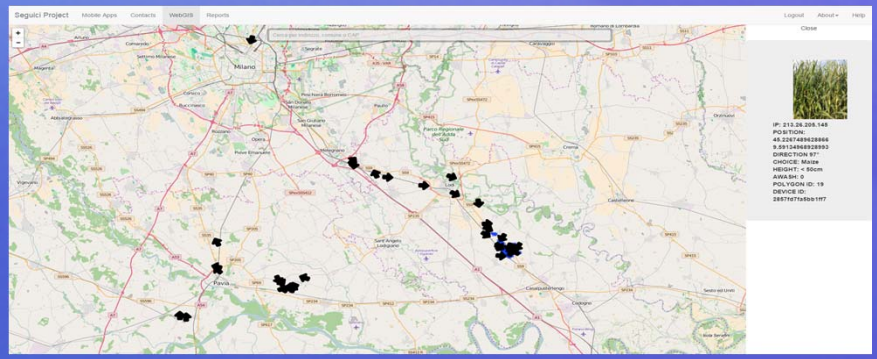

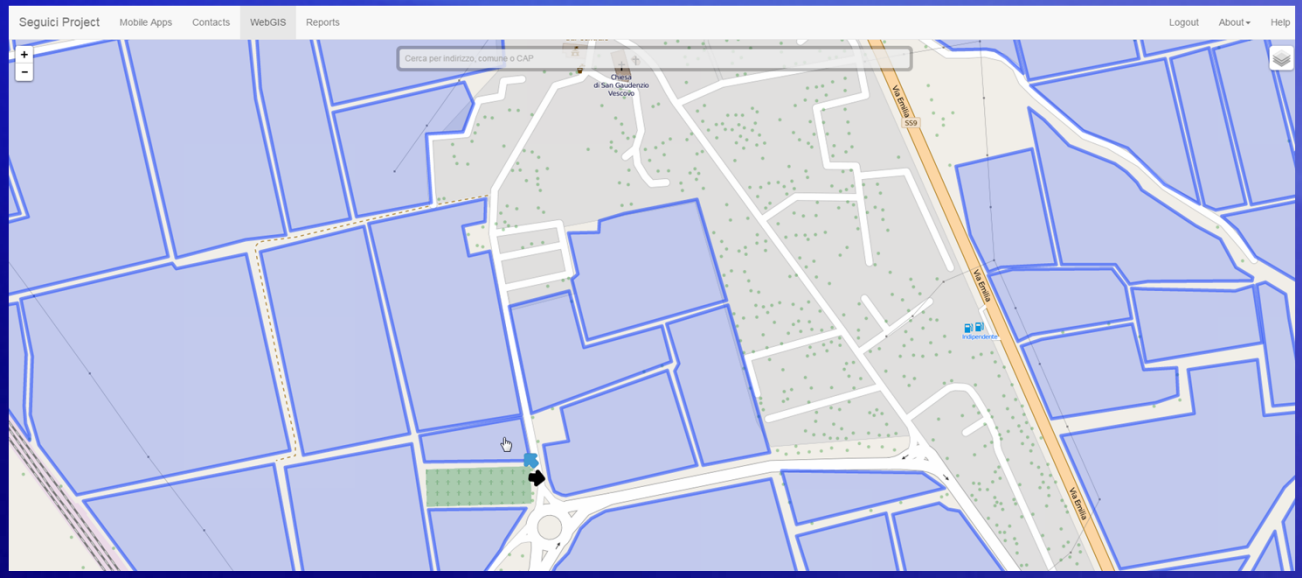

Ravazzani - Integrated systems for real time irrigation management and flood forecasting

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Irrigation management

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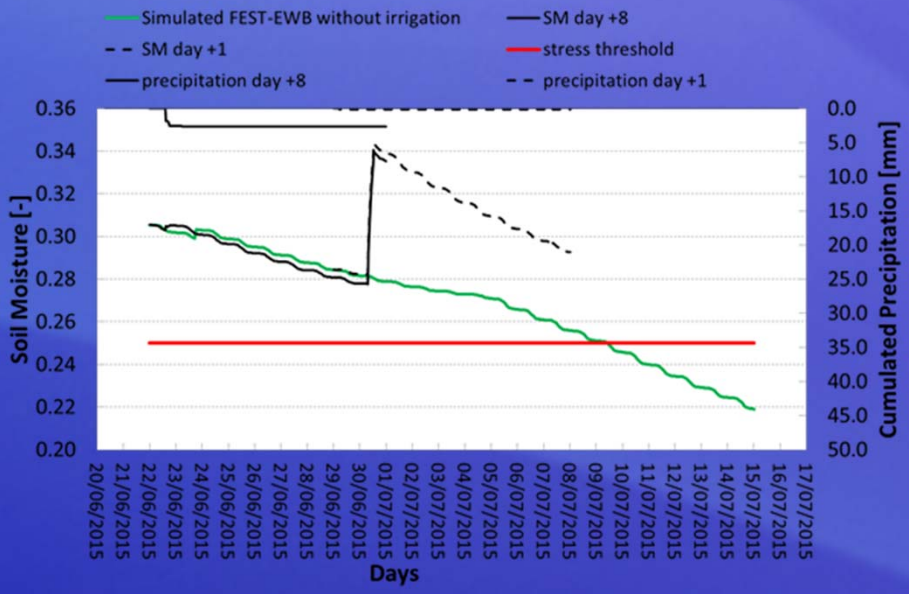
Secugnago test site



Concluding remarks

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- Integrated hydrological models are useful for simulating multiple processes such as river flood and soil moisture
- Coupling hydrological models with meteorological models provide the forecast of the variable of interest useful for flood early warning and irrigation scheduling
- Data from citizens are useful to increase or are an alternative to traditional monitoring networks

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THANK YOU FOR YOUR ATTENTION