



**POLITECNICO**  
MILANO 1863

# Warning system for flood risk mitigation: the Milan case study



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WEBINARS

**SECURITY  
FOR SOCIETY**

**28.04.2021**

WEBINAR

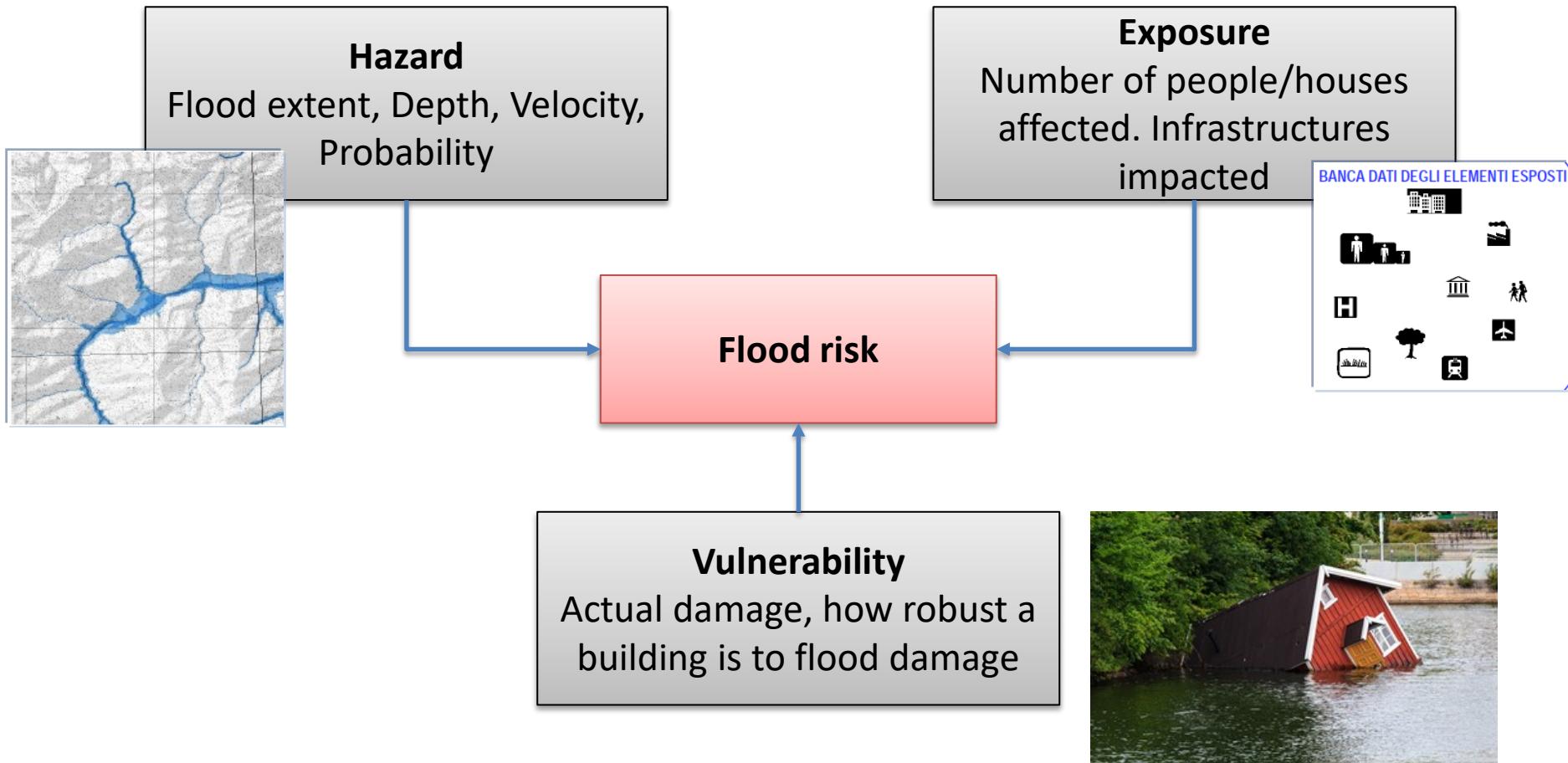
**LAND  
SECURITY**

# Flood risk occurrence

Whenever and wherever flood interacts with human habitats flood risk may occur



# Flood risk definition



$$\text{Risk} = \text{Hazard} \times (\text{Exposure} \times \text{Vulnerability})$$

# Flood risk mitigation

$$\text{Risk} = \text{Hazard} \times (\text{Exposure} \times \text{Vulnerability})$$



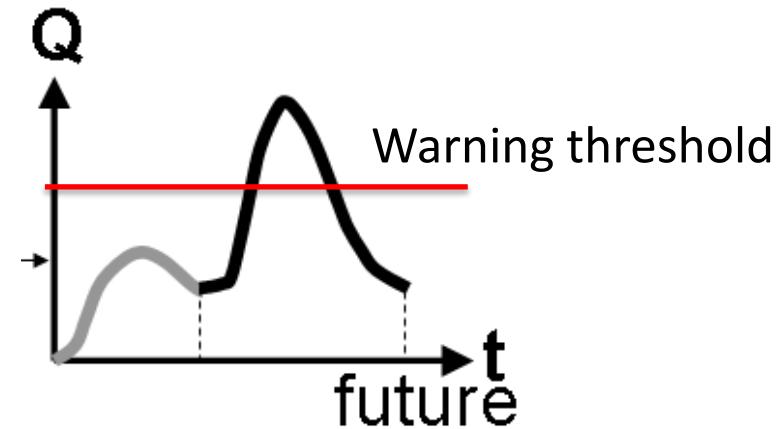
Structural measures



Flood detention reservoir  
on the Olona river



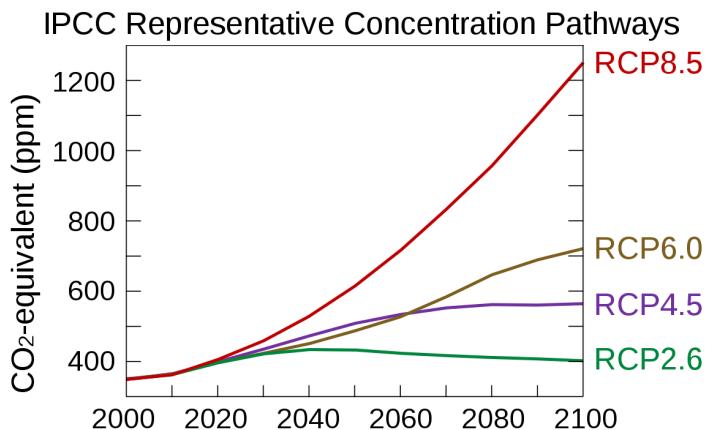
Non-Structural measures



# Flood risk increase

$$\text{Risk} = \text{Hazard} \times (\text{Exposure} \times \text{Vulnerability})$$

Climate change



Increase of the frequency  
of occurrence of floods

Urban development



Increase of exposed  
elements/damage

# FLOOD IN MILAN

1976



2018



2010



2014



Credits:

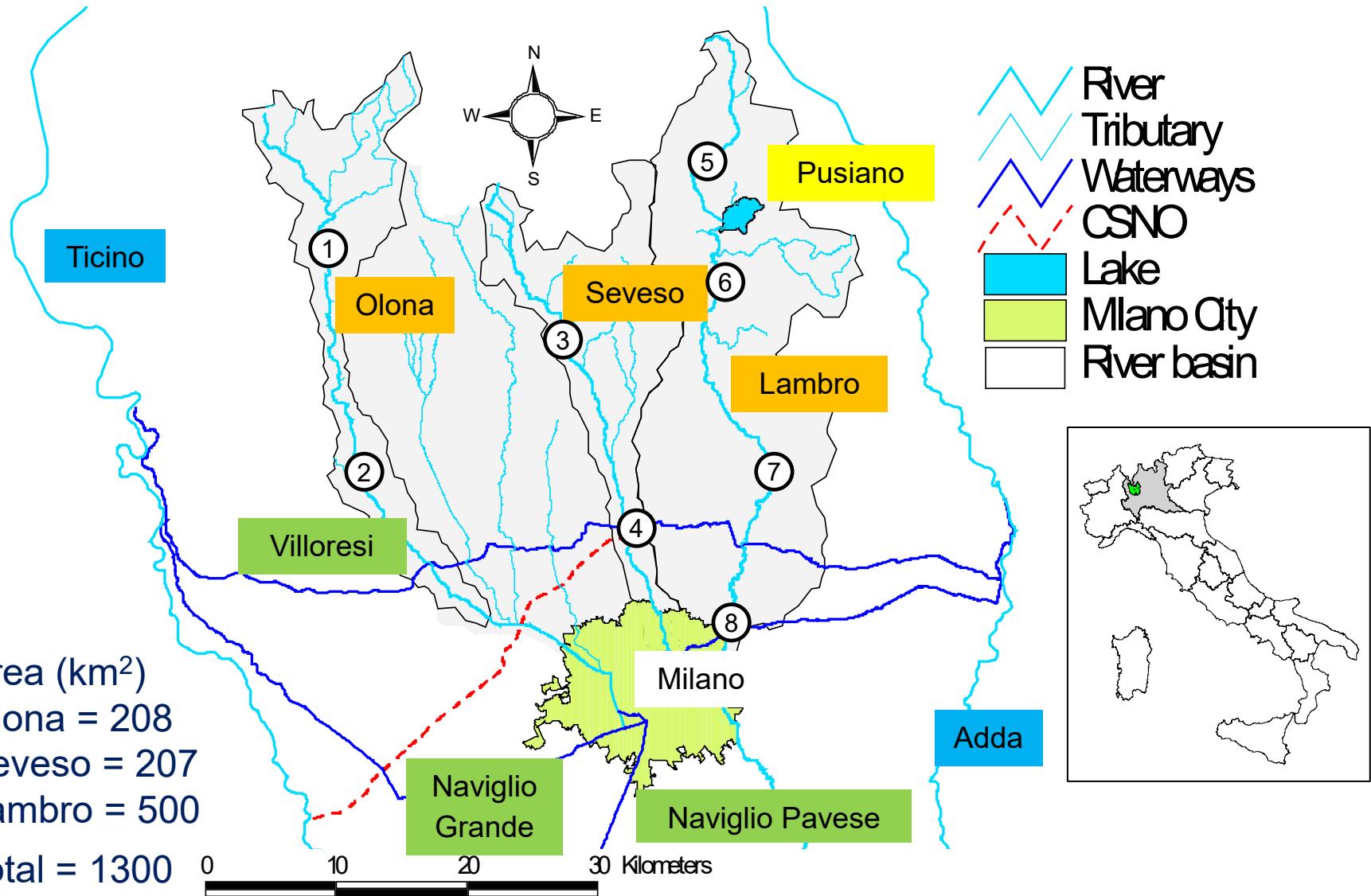
[milano.repubblica.it](http://milano.repubblica.it)

[ansa.it](http://ansa.it)

[milanotoday.it](http://milanotoday.it)

[LaPresse/Federico Ferramola](http://LaPresse/Federico Ferramola)

# Rivers in Milan

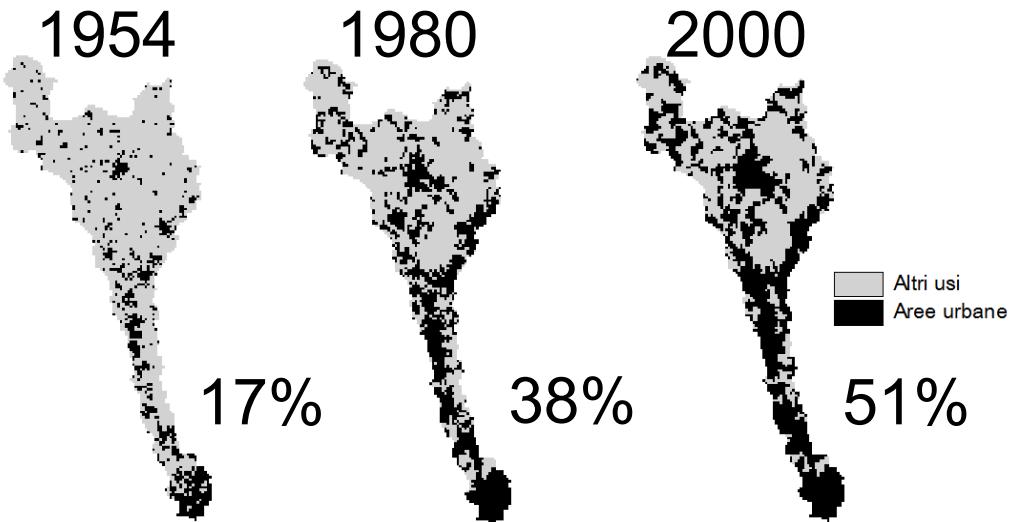


# The bypass channel on Seveso river

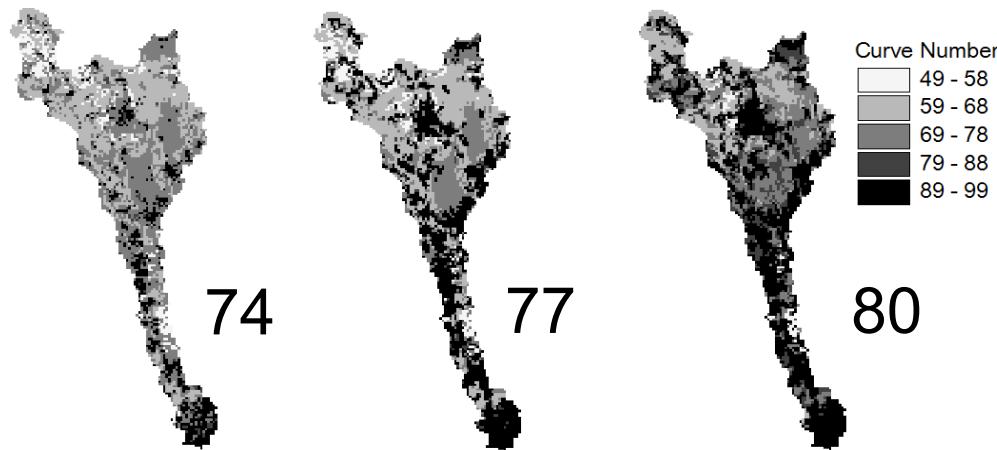


Bypass channel (CSNO, acronym from Italian “Canale Scolmatore di Nord Ovest”). Built from 1954 to 1980. Discharge capacity 30 m<sup>3</sup>/s

# Land use change on the Seveso river basin



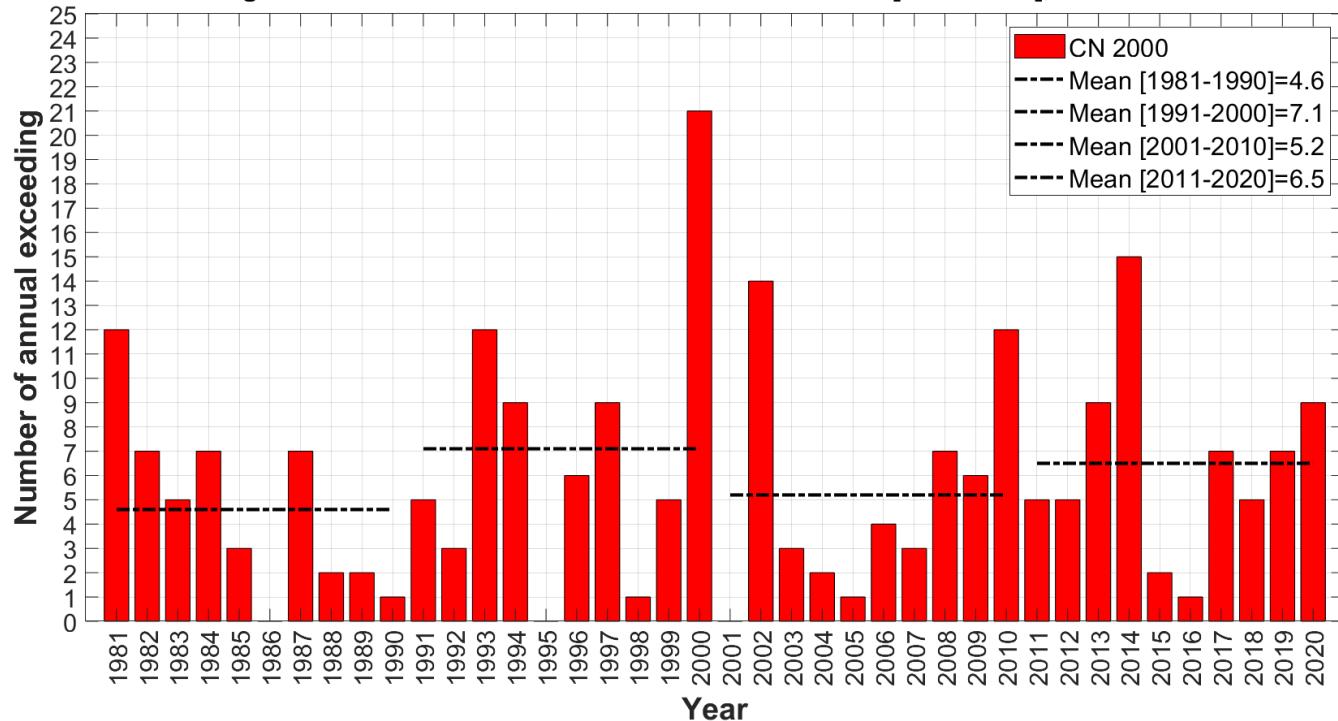
Urban area coverage  
increases



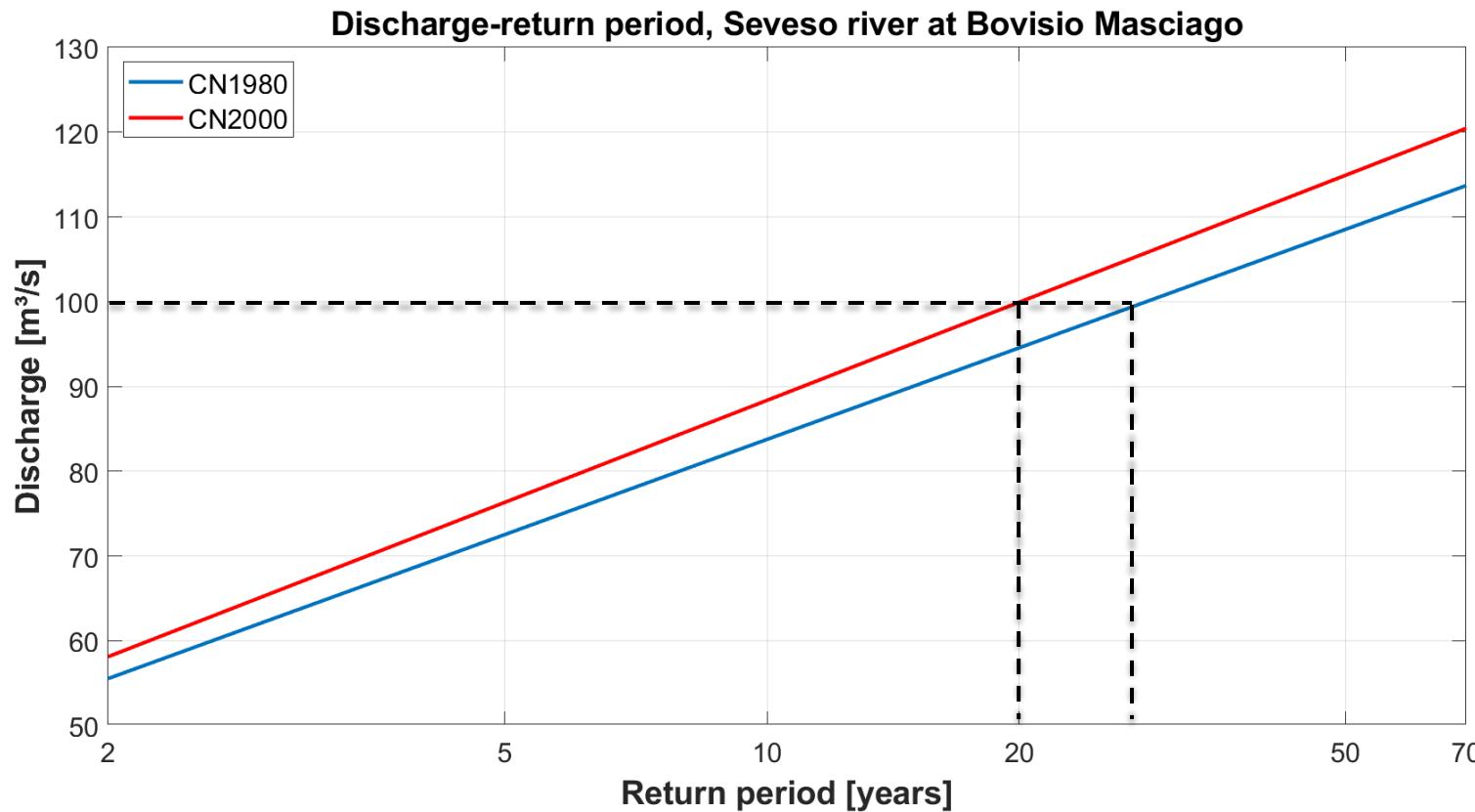
Runoff propensity  
increases

# Climate change impact ?

Number of annual exceeding of  $35 \text{ m}^3/\text{s}$  threshold under 2000 CN conditions [1981-2020], Seveso river at Bovisio Masciago



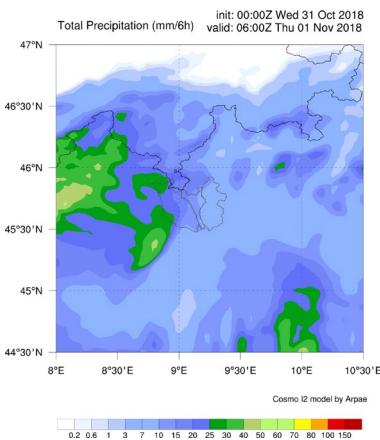
# Land use impact ?



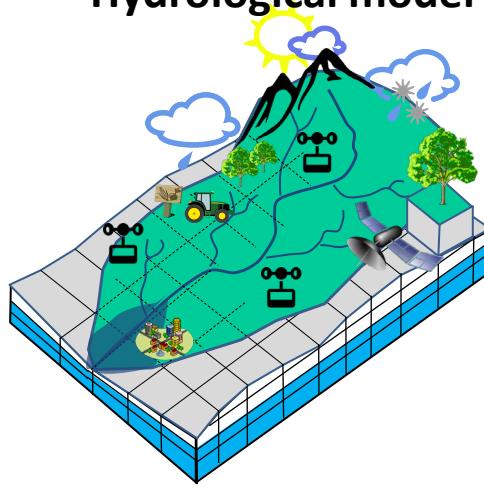
How much is the effect of CN condition change on the discharge/return period relationship?  
On average, the increasing of CN from the year 1980 till 2000 led to diminish the return period of about 7 years.

# REAL TIME FORECST

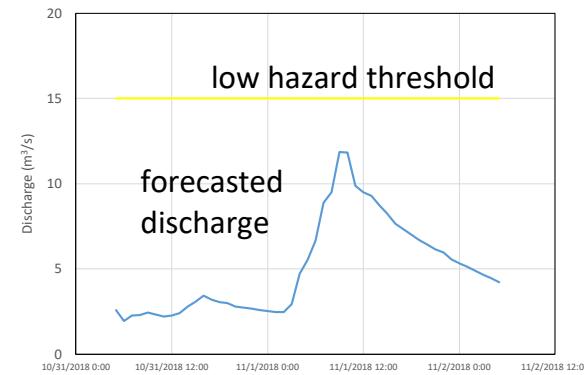
## Precipitation forecast



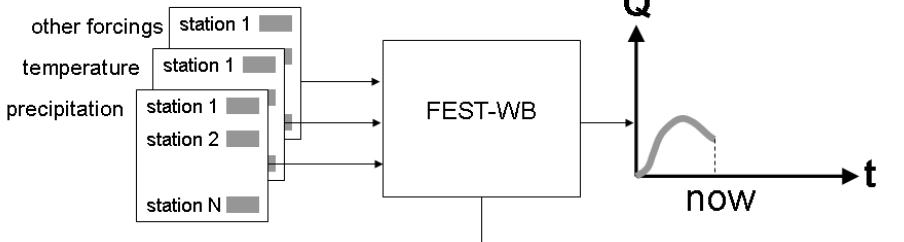
## Hydrological model



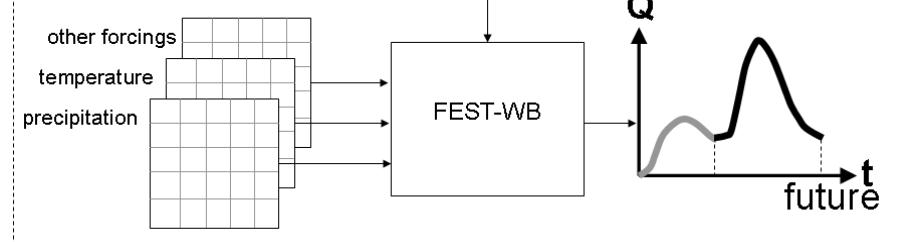
## Flood forecast



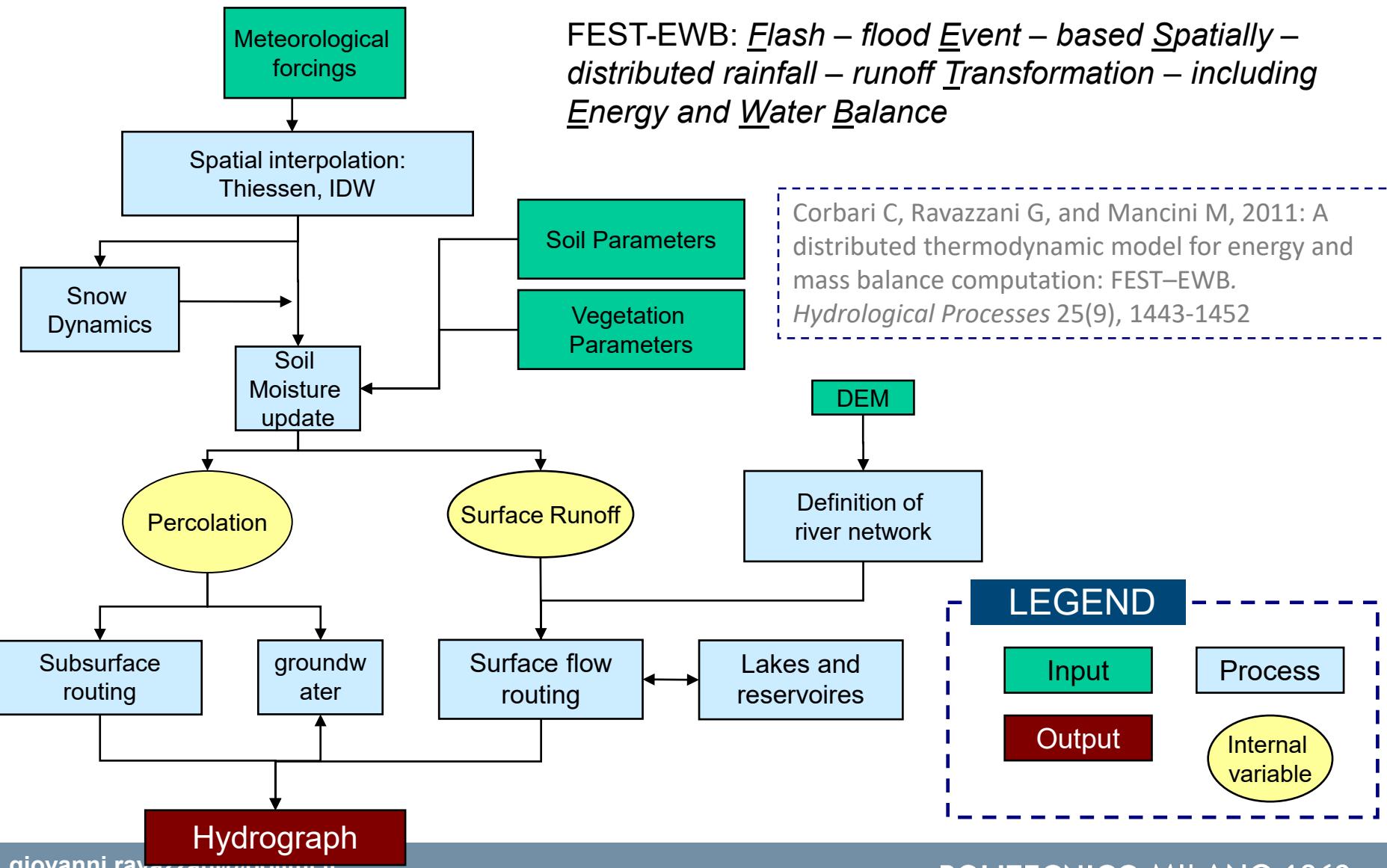
### INITIALIZATION RUN



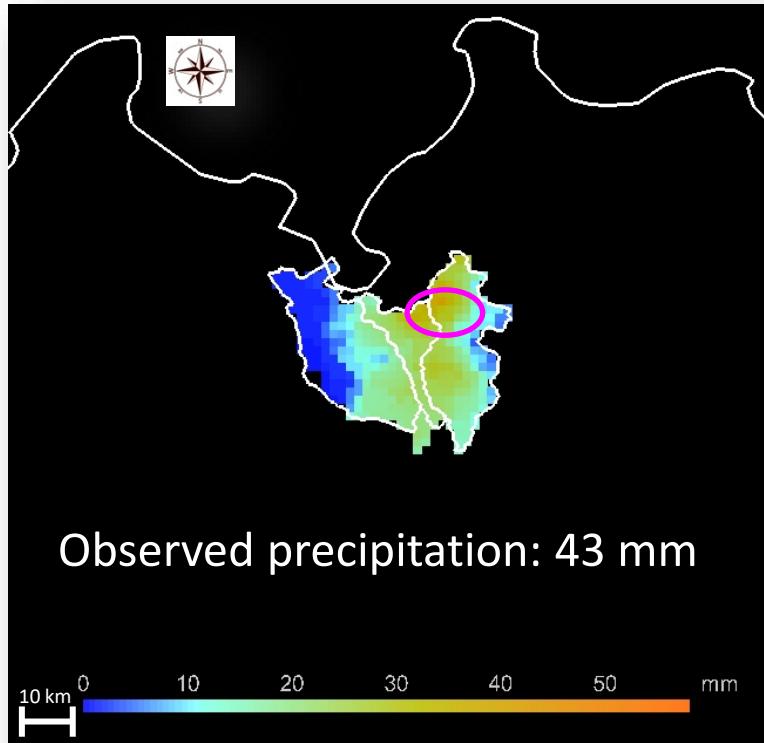
### FORECASTING RUN



# THE FEST HYDROLOGICAL MODEL

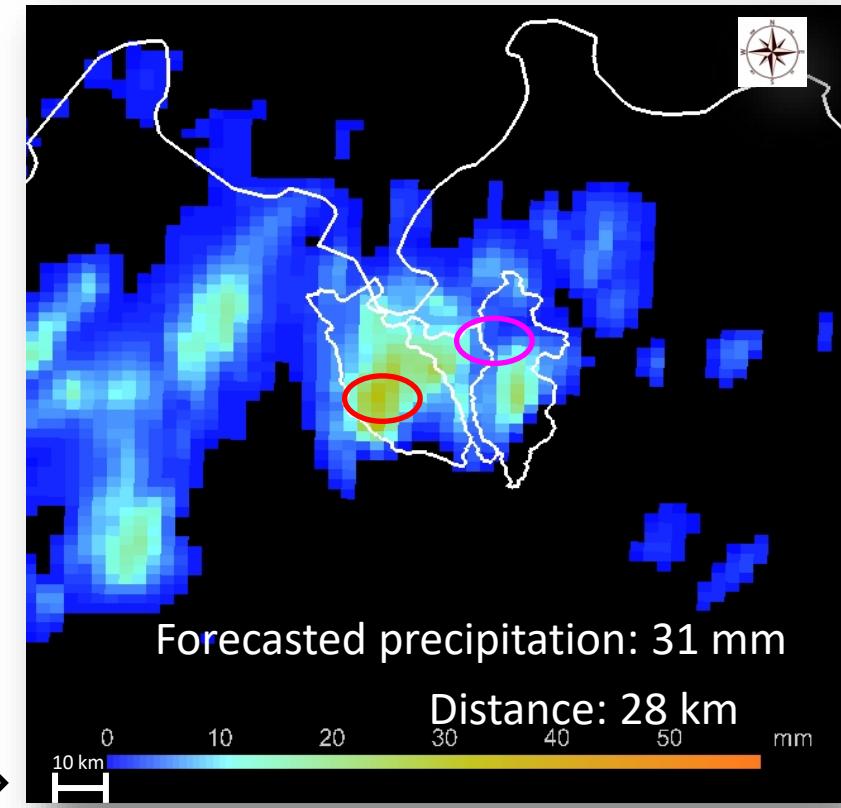


# Uncertainty of deterministic forecast



00:00UTC-08/07/2014

01:00UTC-08/07/2014

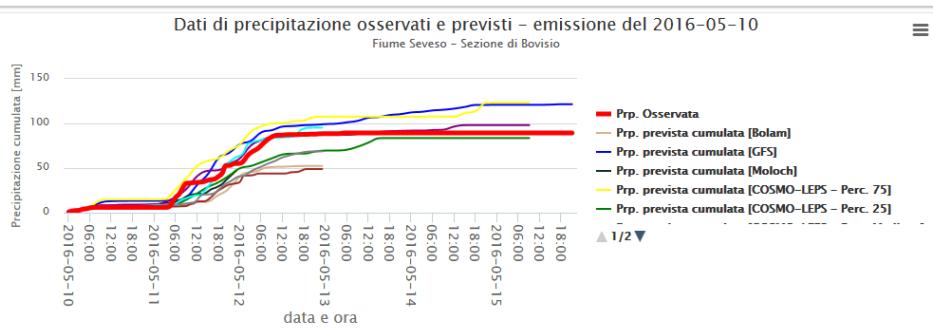


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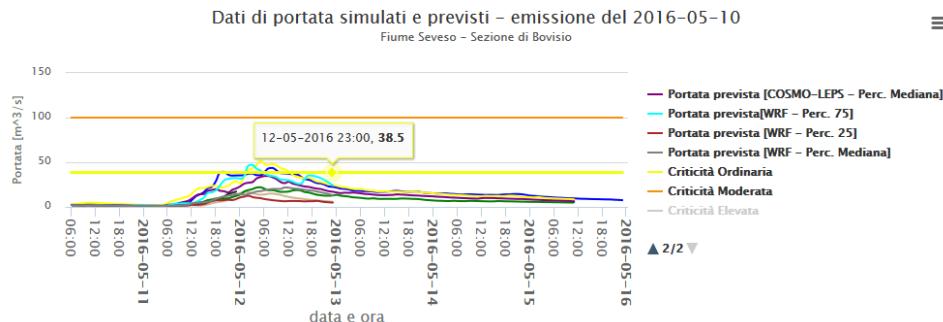
21:00UTC-07/07/2014

# SOL multimodel approach

## Multi-model precipitation forecast



## Hydrograph forecasts & discharge thresholds



## Deterministic models

GFS

50 km, Δt 3h, +144h

Bolam

11 km, Δt 1h, +72h

Moloch

1.5 km, Δt 1h, +45h



Cosmo-i2

2 km, Δt 3h, +48h

Cosmo-i7

7 km, Δt 3h, +72h



## Ensemble models

COSMO-  
LEPS

7 km, Δt 3h, +132h  
16 ensemble



WRF

5.5 km, Δt 1h, +72h  
8 ensemble



# Performance of 2010 event

## SEPTEMBER 2010

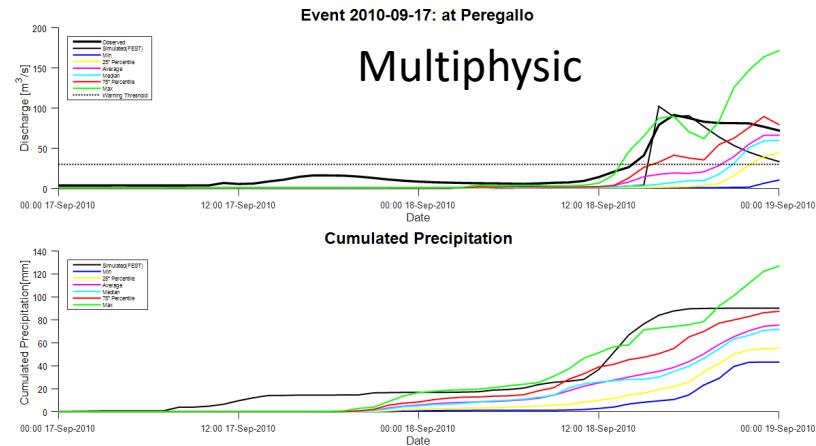
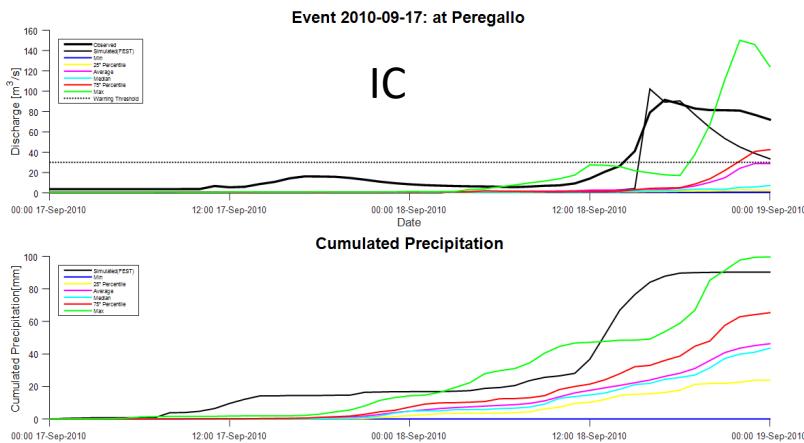
percentage of ensemble members exceeding the warning threshold



**Universitat**  
de les Illes Balears

Exceeding Threshold		Seveso	Lambo	
		Cantu	Peregallo	Milano
9/17/2010	IC	20.0%	35.0%	10.0%
	Multiphysic	50.0%	85.0%	40.0%

Multiphysic has the best performance



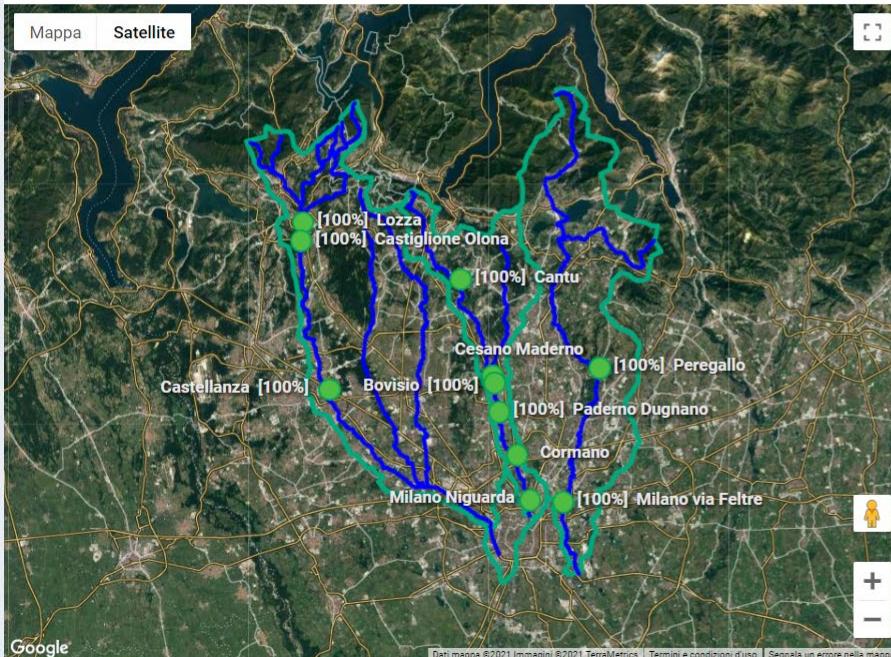
# Real time flood forecast for Seveso-Olona-Lambro - SOL

<http://padus.dica.polimi.it/Bacini>

QUANDO ARRIVERÀ LA PROSSIMA PIENA?

**SOL ti fornisce** in tempo reale una previsione sulla possibile futura esondazione con un anticipo di **24-36 ore**.

Clicca sui pallini nella mappa per maggiori dettagli - Vuoi approfondire? [CLICCA QUI](#)

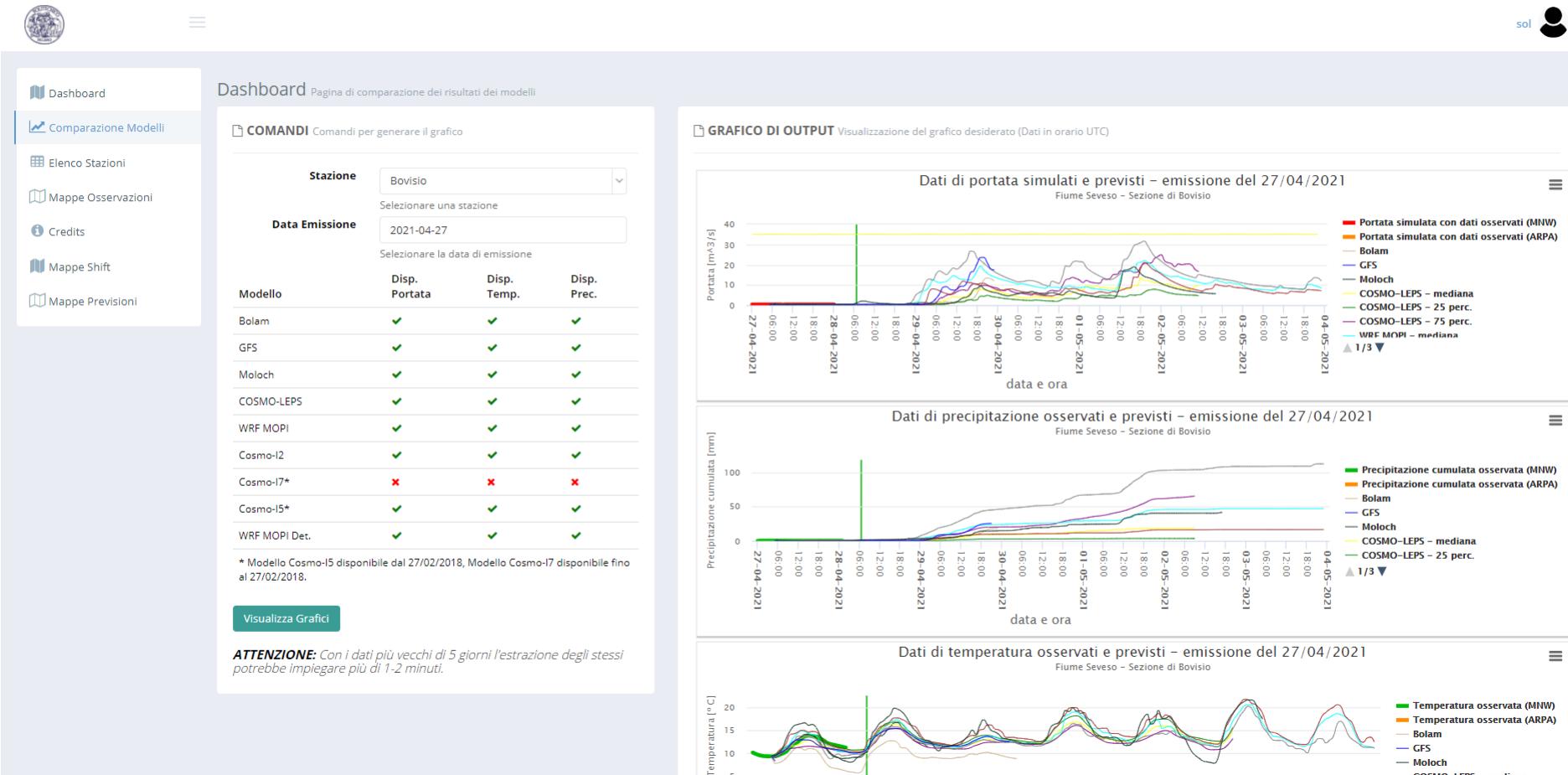


Stazione	27/04/2021	28/04/2021	Shift	29/04/2021
	(100 %)	(100 %)	28/04/2021	(100 %)
Lozza				
Castellanza				
Cantu				
Paderno Dugnano				
Peregallo				
Milano via Feltre				
Bovisio				
Castiglione Olona				
Modelli disponibili:	33	33	--	33

# Real time flood forecast for Seveso-Olona-Lambro - SOL

<http://padus.dica.polimi.it/Bacini>

Comparazione modelli



## **Research group**

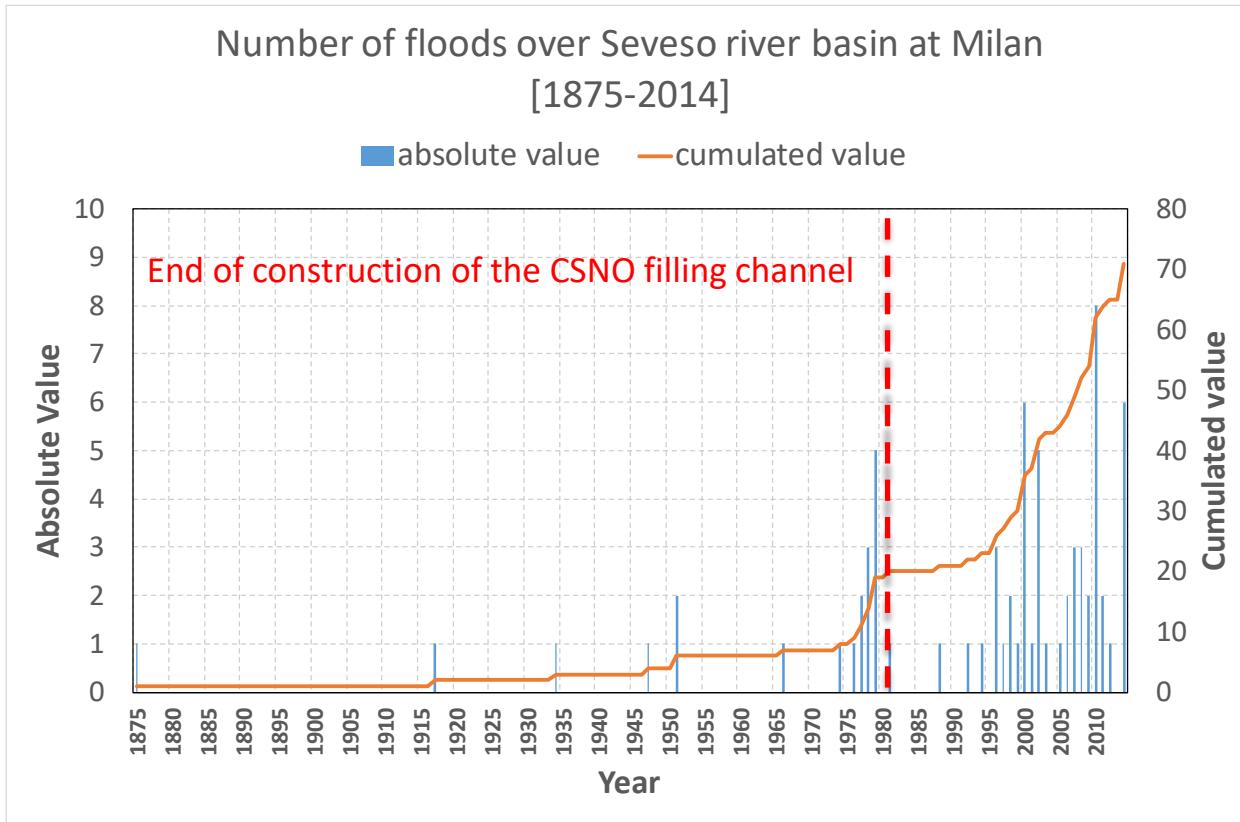
Mancini, M., Corbari, C., Ceppi, A.,  
Lombardi, G., Feki, M., Herrera-  
Gomez, V.L., Paciolla, N., De Rosa, I.

**THANK YOU  
FOR YOUR  
ATTENTION**

contact  
*giovanni.ravazzani@polimi.it*



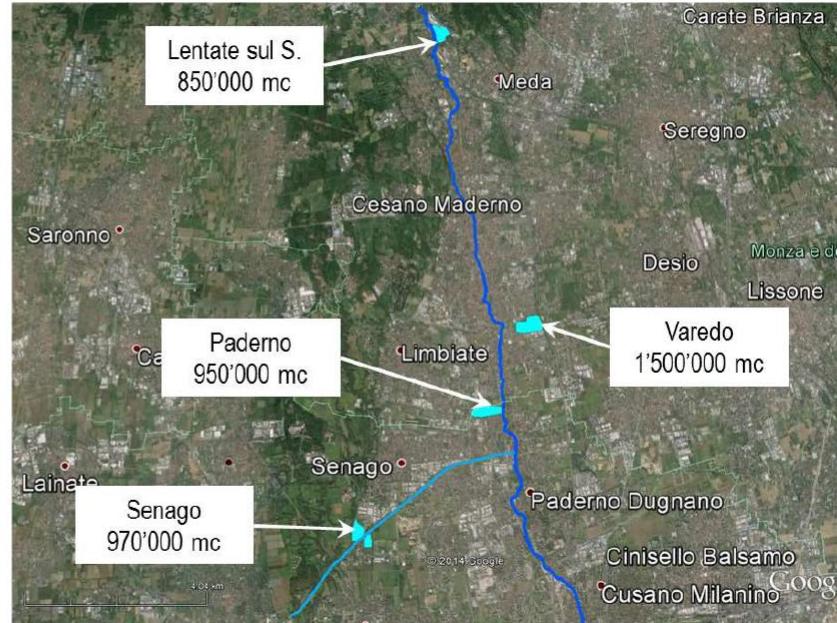
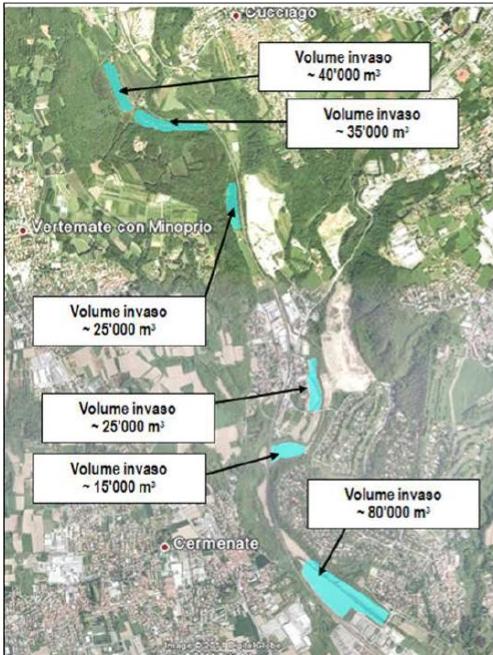
# Number of floods over the Seveso river



Source:

#italiasicura – Progetto Seveso, 2014  
Becciu et al. 2017

# New flood detention reservoirs under construction

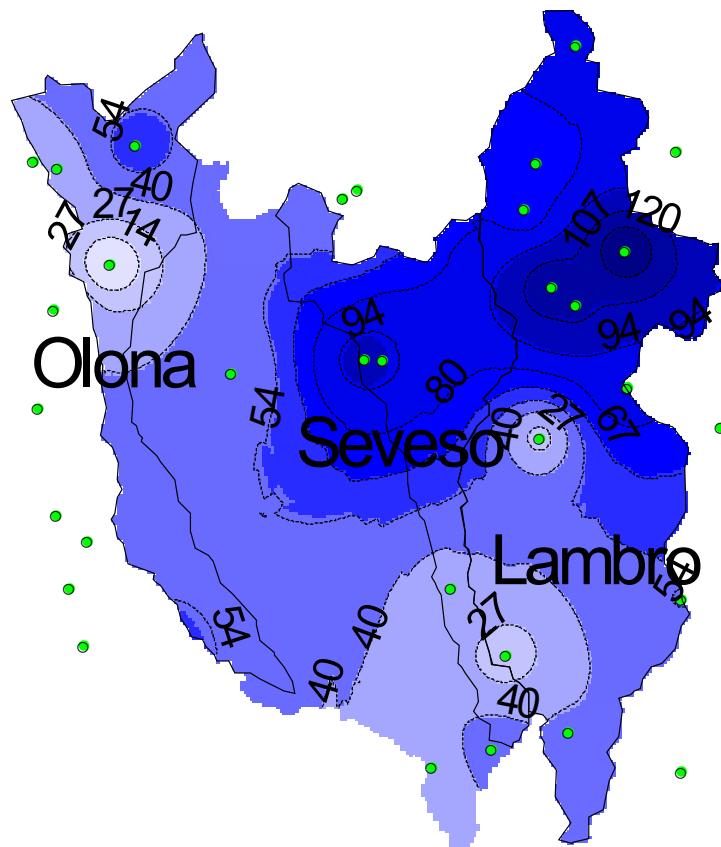


About  $4.5 \cdot 10^6$  m<sup>3</sup> of storage volume

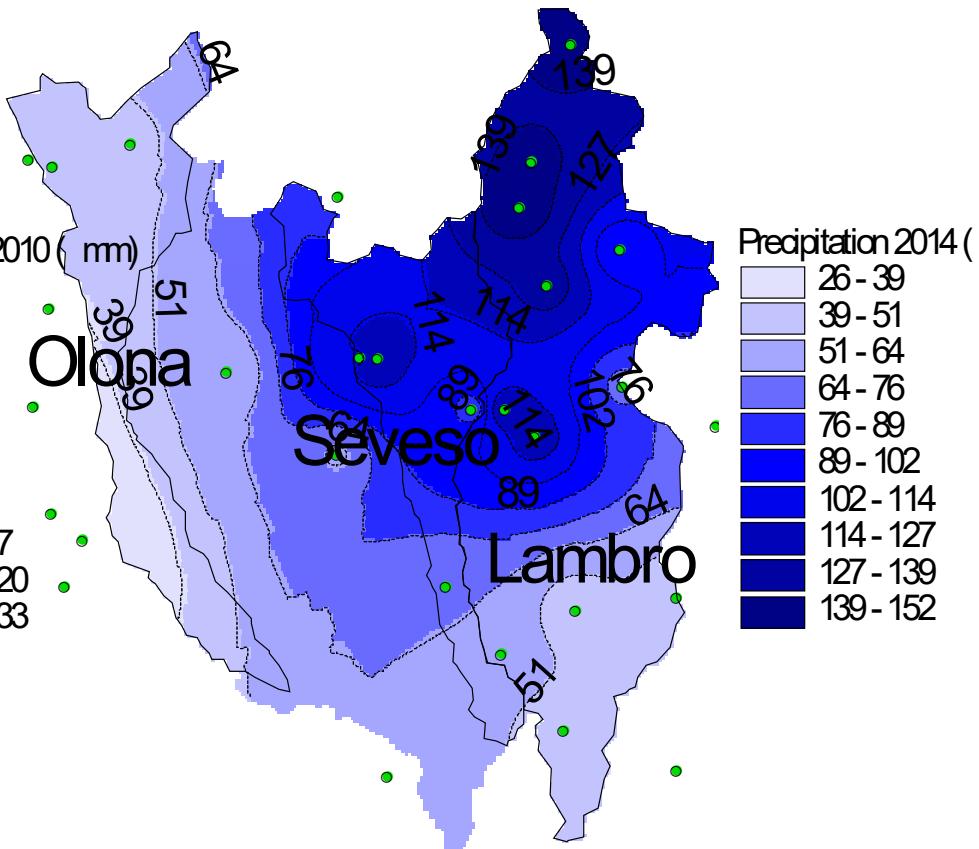
# Re-analysis of two major convective flood events

Ravazzani et al., J. Hydrol., 2016

SEPTEMBER 2010



JULY 2014



Warning threshold exceeded on Seveso and Lambro basins

# Performance of 2014 event

JULY 2014

percentage of ensemble members exceeding the warning threshold



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Exceeding Threshold		Seveso		Lambro	
		Cantu	Peregallo	Milano	
7/7/2014	IC	25.0%	50.0%	10.0%	
	Multiphysics	25.0%	50.0%	10.0%	

IC and Multiphysics perform the same  
Event very difficult to predict

