



*Autorità di Bacino del Fiume Arno*



GOBIERNO  
DE ESPAÑA

MINISTERIO  
DE MEDIO AMBIENTE



## ***Flood Risk Assessment and Management in Italy***

### ***The case of the Arno River Basin***

*dott. ing. Michele CEDDIA*

*Arno River Basin Authority  
Planning and Development Office*

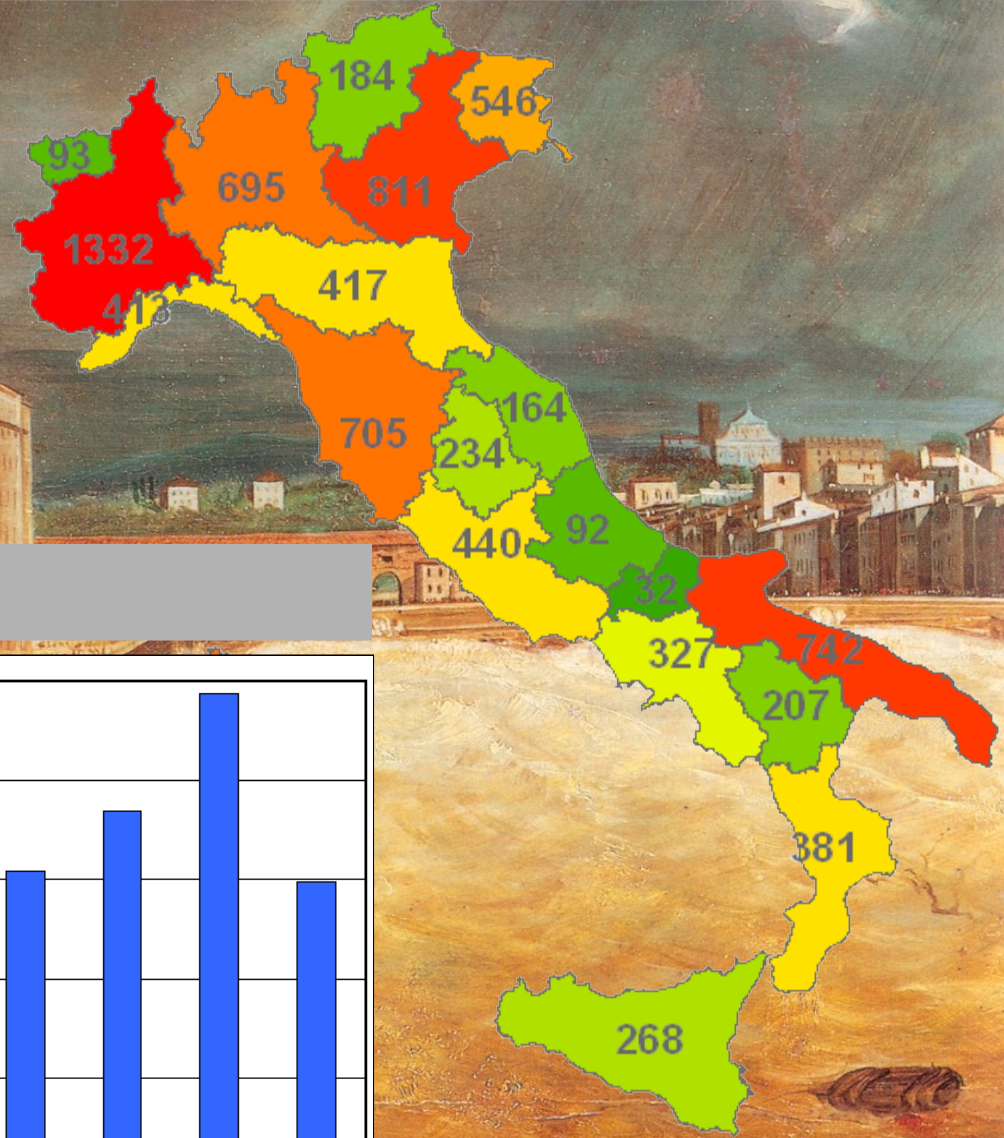
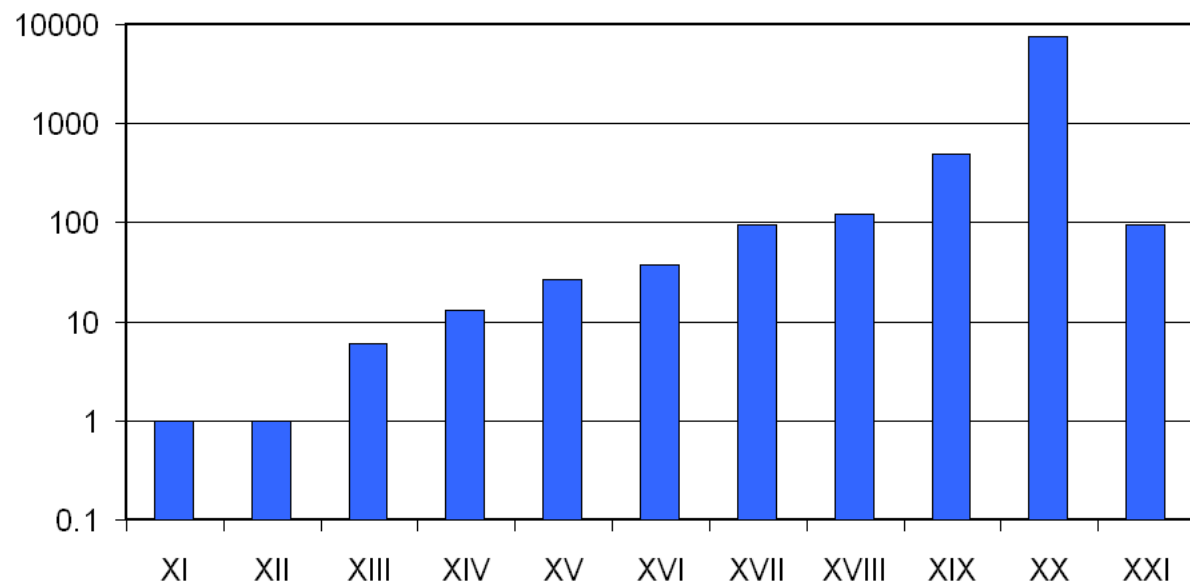
*Florence - Italy*

[www.adbarno.it](http://www.adbarno.it)  
[m.ceddia@adbarno.it](mailto:m.ceddia@adbarno.it)



# Flood events during Centuries

## # floods per Century





4 November 1966





# **Main Italian laws on Land Protection**

**1904: King Law no. 1523**

- **On management of river buffer zone**

**1989: national law no. 183/89**

- **It defined hydrological-based Basin Authorities (similar to Hydrographic Districts) and fixed the basin scale to assess hydrogeological risks, plan mitigation actions and manage water resources**

**1998: national law no. 267/98**

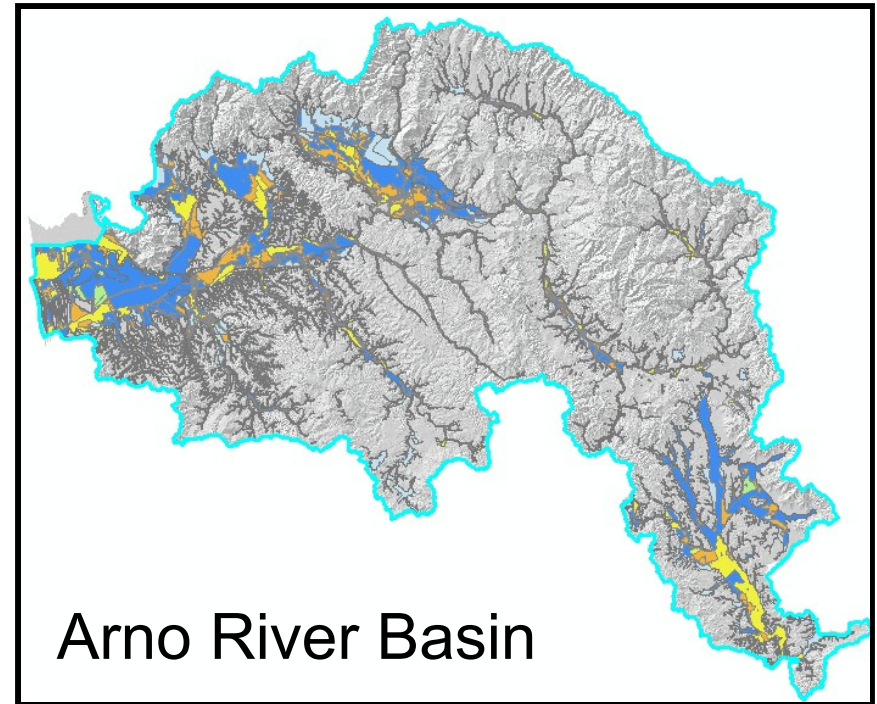
- **Basin Authorities drew up basin plans on hydrogeological hazard and risk and defined guidelines to manage and mitigate risk at local scale**




**NOW: European Directive 2007/60**

- **Assessment, management and mitigation of flood risks**



# Basin Authorities framework



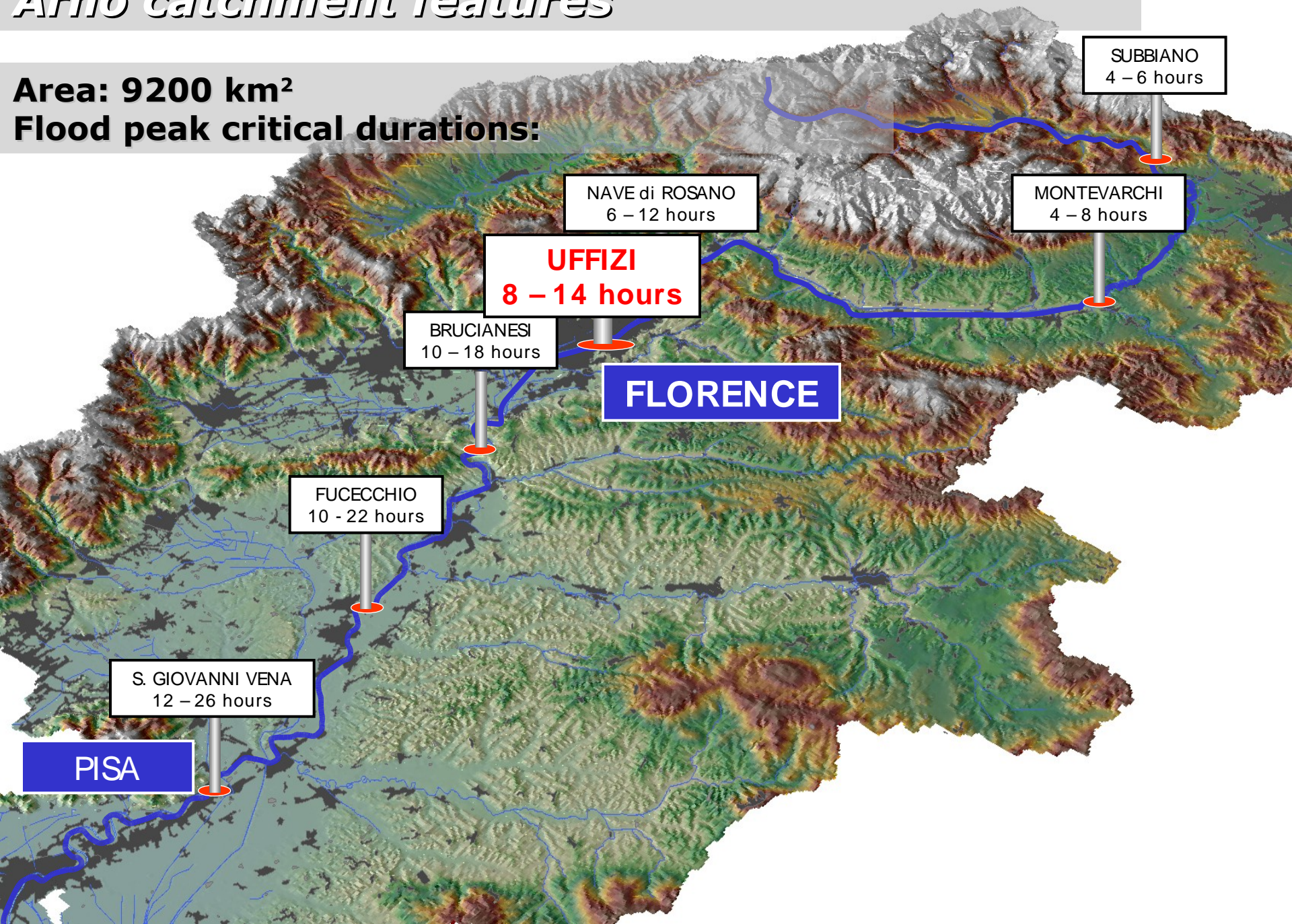
-  National Basin Authority
-  Interregional Basin Authority
-  Regional Basin Authority



# *Arno catchment features*

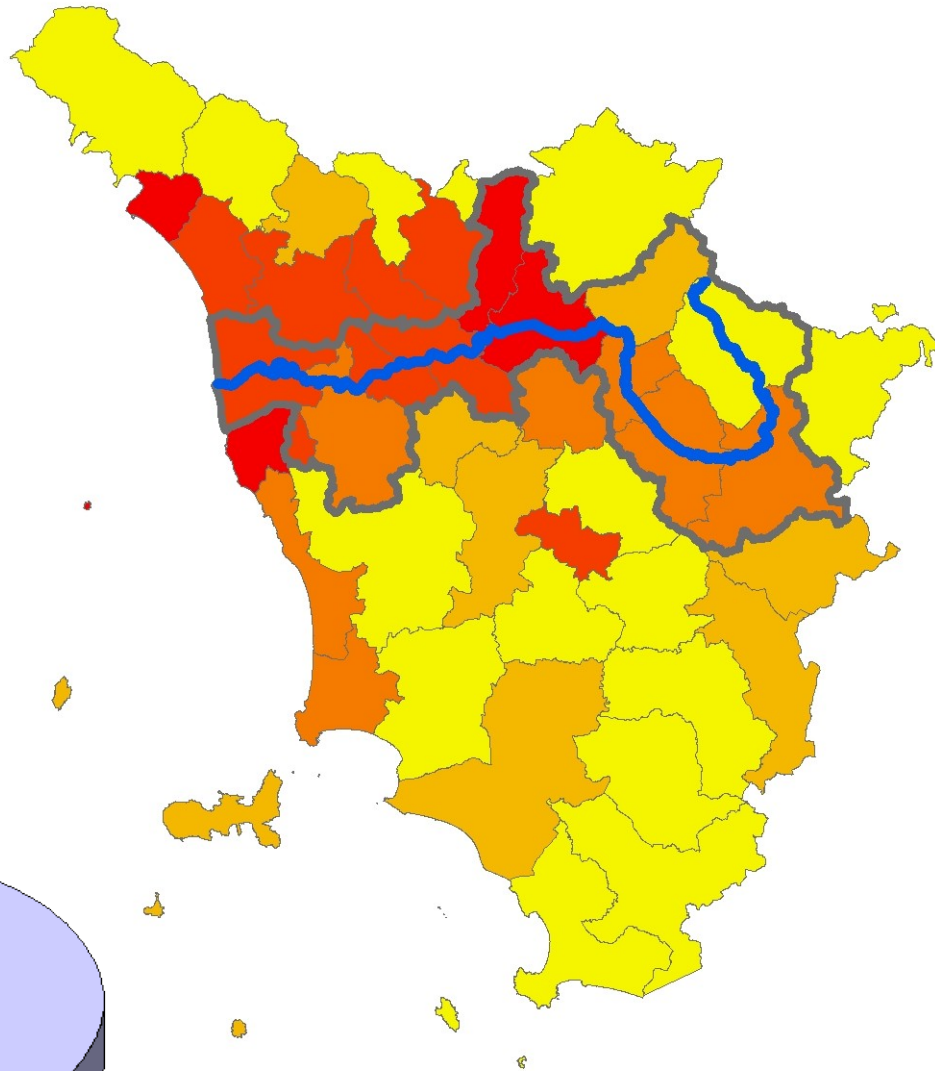
**Area: 9200 km<sup>2</sup>**

**Flood peak critical durations:**

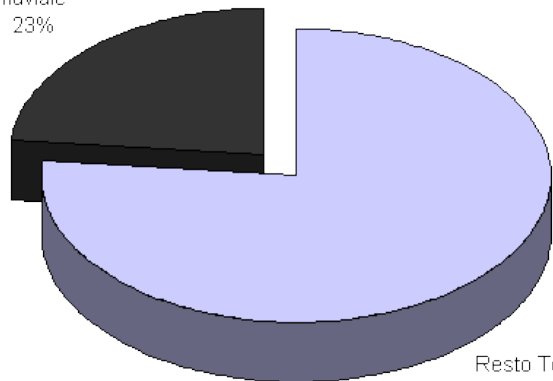




# *Population density (2004)*



SEL fascia  
fluviale  
23%



Resto Toscana  
77%



# ***PLANNING - Flood hazard assessment (H)***

## **Synthesis level**

Based on historic flood events data and geomorphological features.

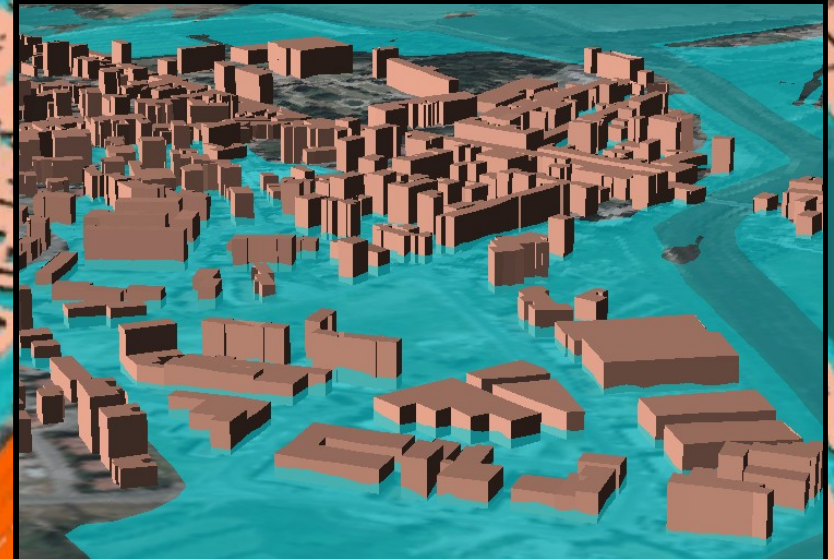
## **Detailed level**

### **Hydrologic modelling**

- Lumped and distributed rainfall-runoff models
- Geomorphological input

### **Hydraulic modelling**

- DEM-based
- Quasi-2D, unsteady flow models





# ***PLANNING - Flood hazard assessment (H)***

**1966 Flood Event  
2D numerical simulation**





# ***PLANNING - Flood hazard assessment (H)***

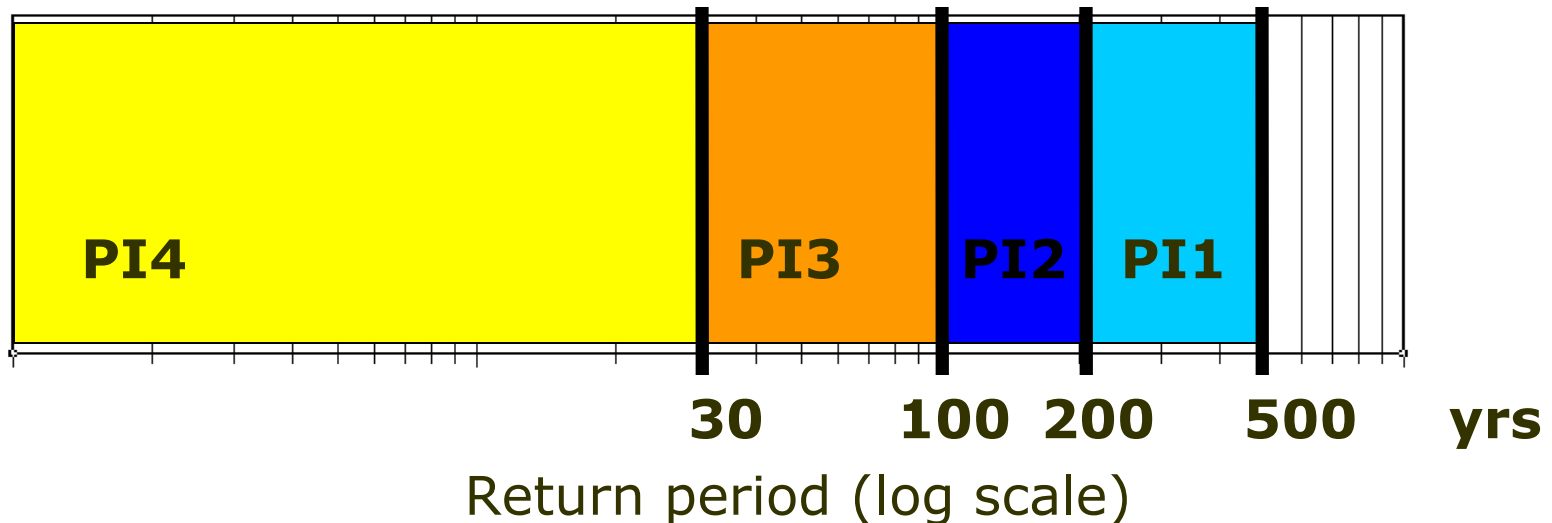
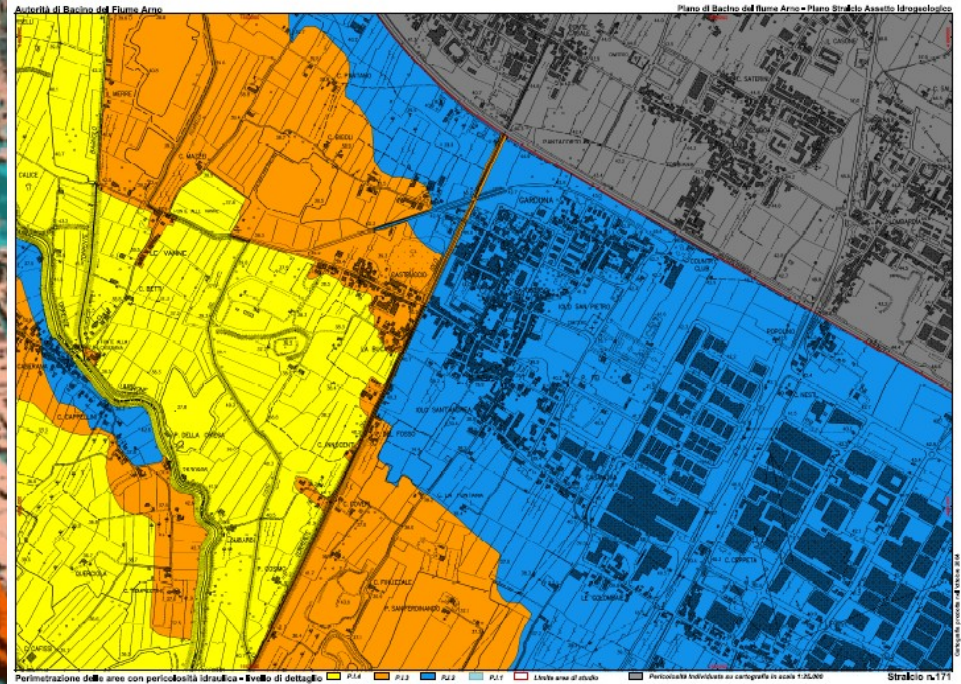
## **Hazard classes (PI)**

**PI4 < 30yr**

**30yr < PI3 < 100yr**

**100yr < PI2 < 200yr**

**200yr < PI1 < 500 yr**





# ***PLANNING – Risk (R)***

$$**R = H \cdot V \cdot E**$$



**E**



**V**



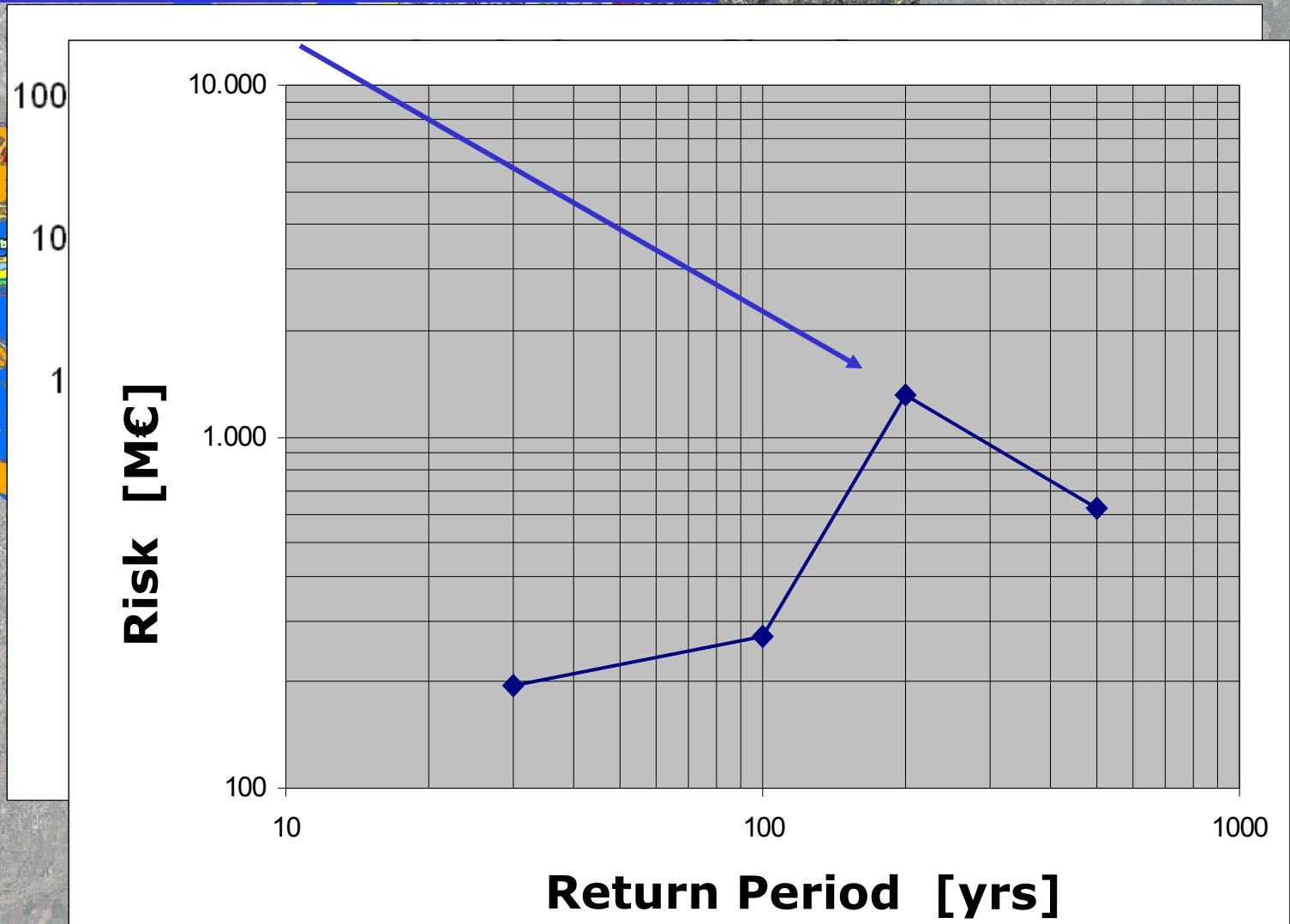
**H**





# ***PLANNING – Risk (R)***

**Maximum Risk in 50 years is related to events having RP = 200 years**





# ***MITIGATION and MANAGEMENT***

## **Logical chain of actions**

Evaluation of flood scenarios

**Hazard**

Economic value of exposed elements

Vulnerability

**Risk**

Cost – benefit analysis

Local scale protection actions

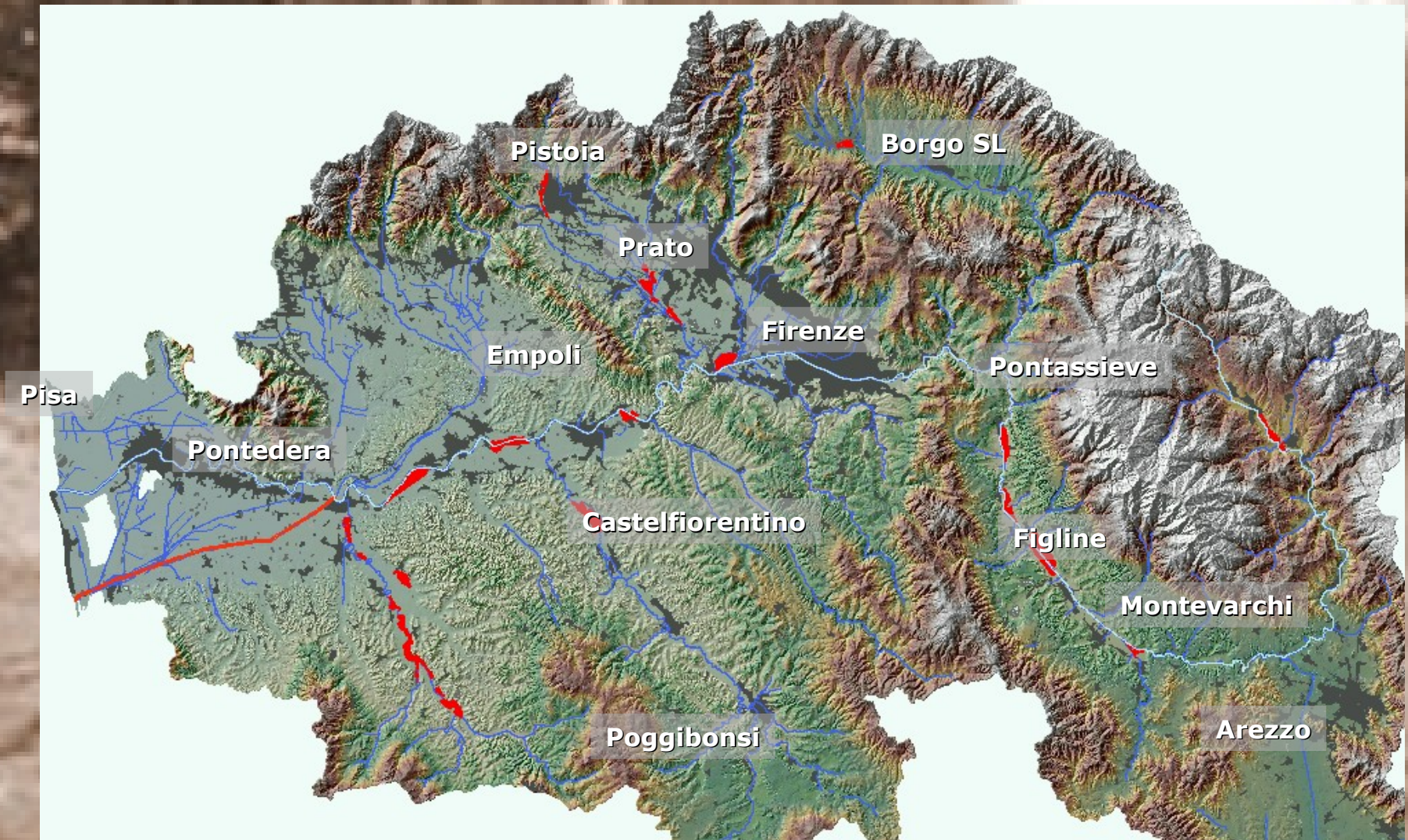
Basin scale protection actions

Emergency planning

**Mitigation &  
Management**



# ***MITIGATION – structural actions***



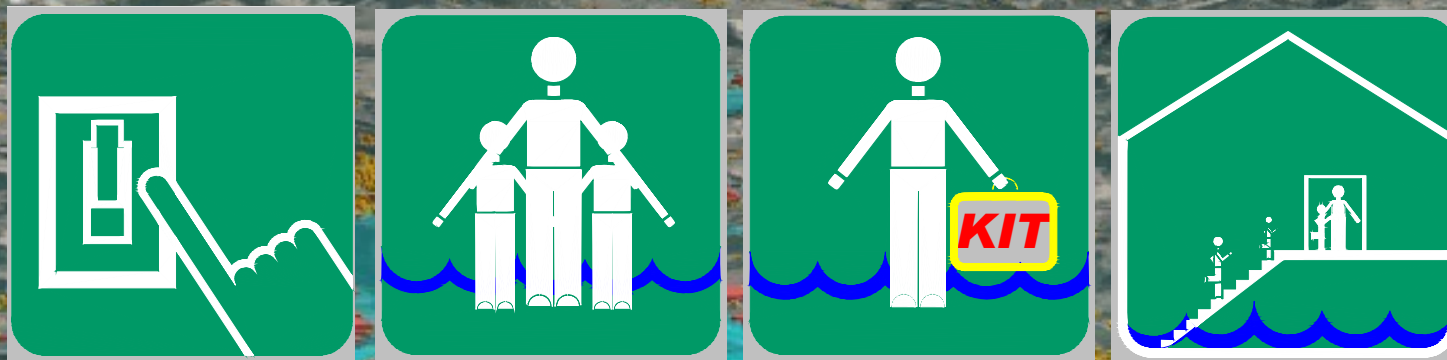
**Main actions plan**  
**200 M€**  
**55 Mmc for flood storage**



# ***MITIGATION – non structural actions***

## **Flood protection at the local scale**

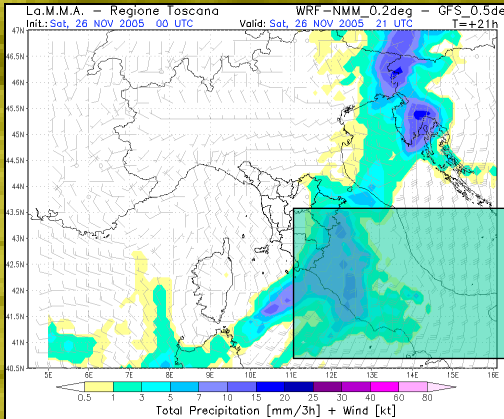
**Building plans, guidelines for retrofitting existing buildings and for the new ones**





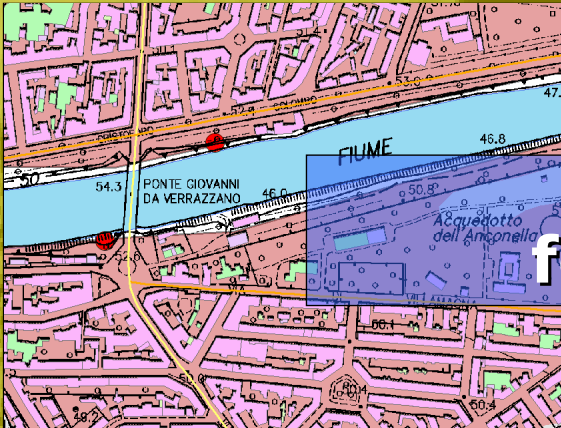
# MANAGEMENT – real time forecast system

## QRF Arno model: Quantitative Risk Forecast



**Weather  
forecast**

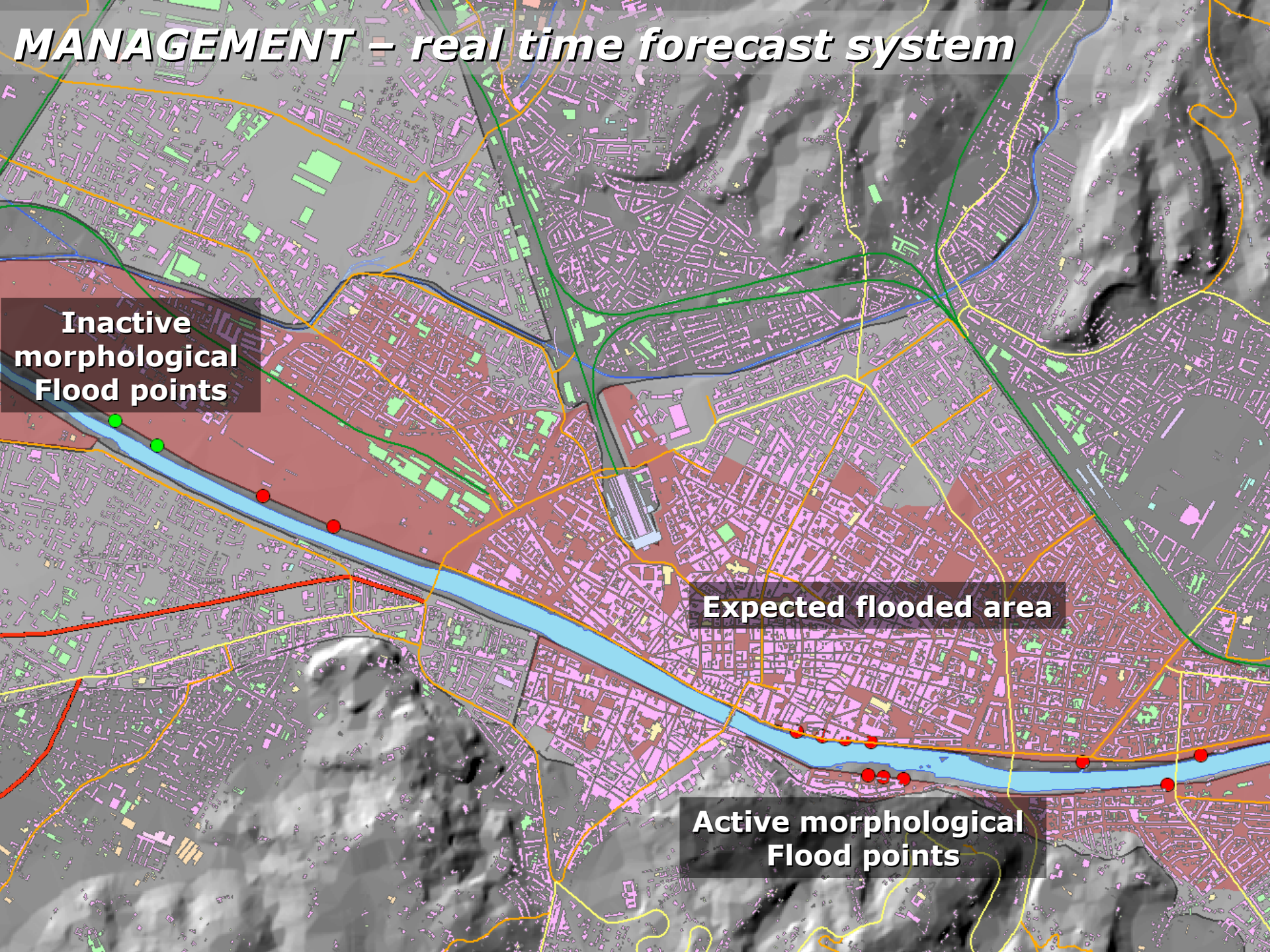
- Quantitative
- Spatially distributed



**Risk  
forecast**

- Quantitative
- Spatially distributed





# ***MANAGEMENT - real time forecast system***

**Inactive  
morphological  
Flood points**

**Expected flooded area**

**Active morphological  
Flood points**





**Inactive flood point**

*Flooding areas*

**Active flood point**

*Flooding areas*

*Expected flooded area*

*Flooding areas*





***[m.ceddia@adbarno.it](mailto:m.ceddia@adbarno.it)***