

(Flood) Risk in Cities: The Case of Florence



*A risk-aware
welcome to
town*

Evidence for policy school:
Disaster Risk Management

13-15 January 2020 / Florence (Italy)





*Flooding of the city of Florence, Italy
November 4th, 1966*

Evidence of urban
contribution to Hazard,
not just Exposure and
Vulnerability



Magra River near Aulla (North Tuscany) *Flooded in 2011*

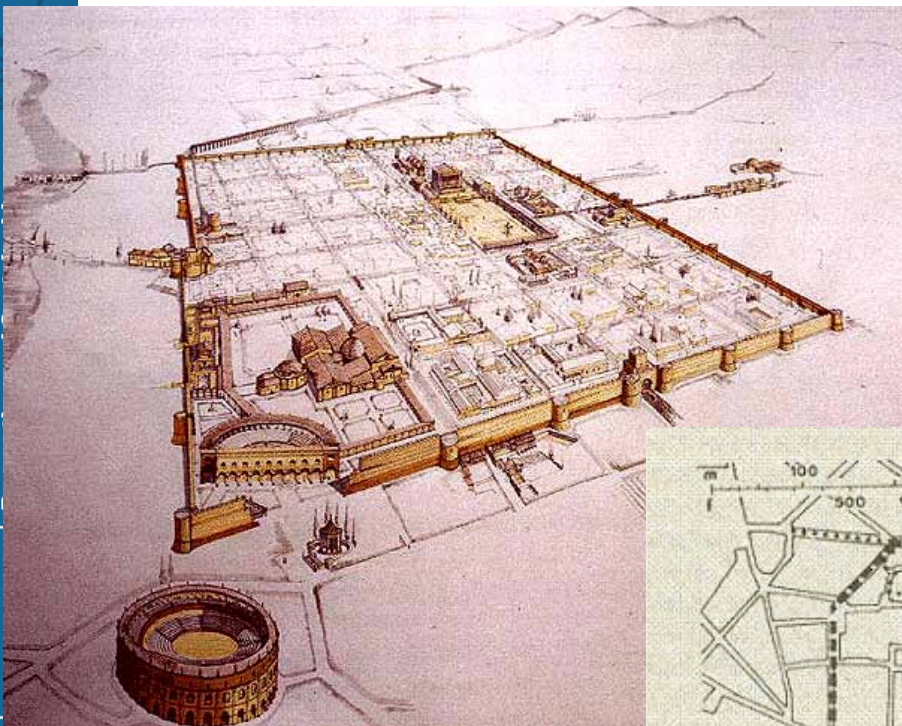


*How would you
draw the river
in the missing
part of the
image?*

Magra River near Aulla (North Tuscany) *Flooded in 2011*

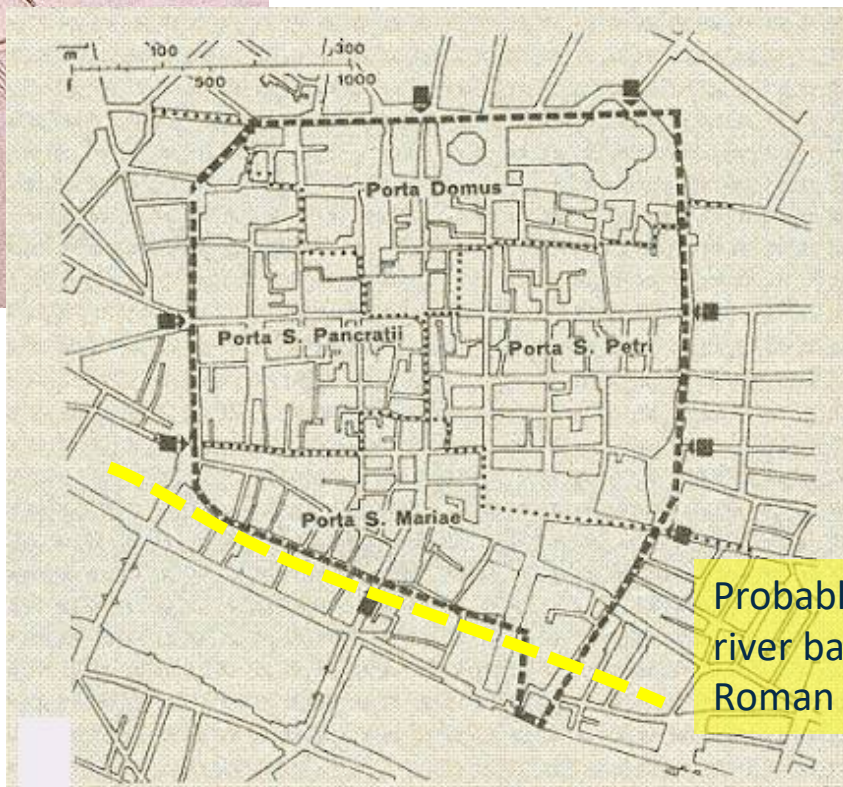
Hazard and
exposure are
really
independent?





Florentia at
Roman times

Matilde walls
(1078 ca.)

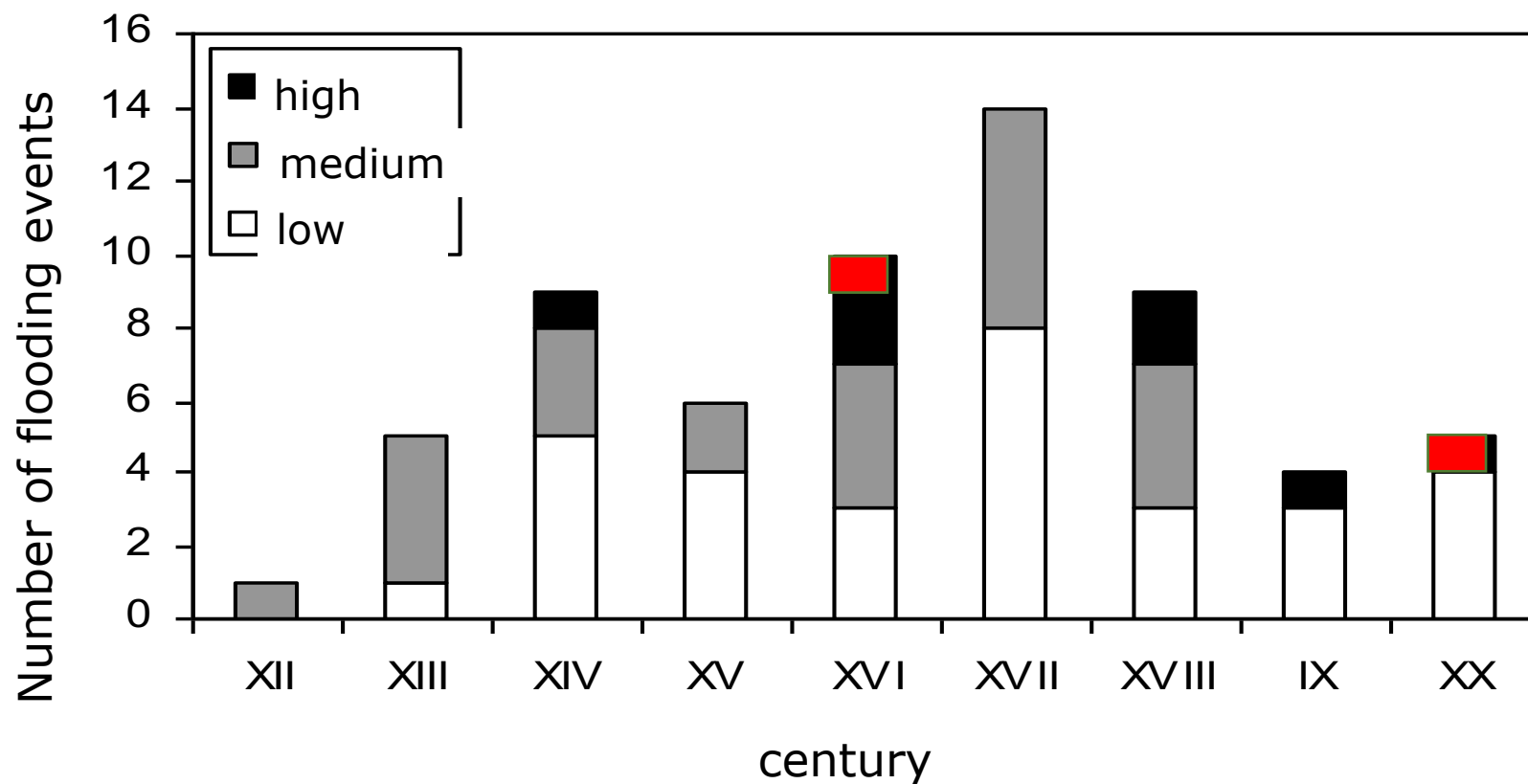


Probable right
river bank at
Roman times

*Bad planning choices
may be dated way
back in the past*

Florence in 1822





Starting **XII century**, evidences of **57 flood events** inundated Florence downtown. **Eight** of these are classified as **excpetional** (the more recent ones: 1740, 1758, 1844, 1966)

1740

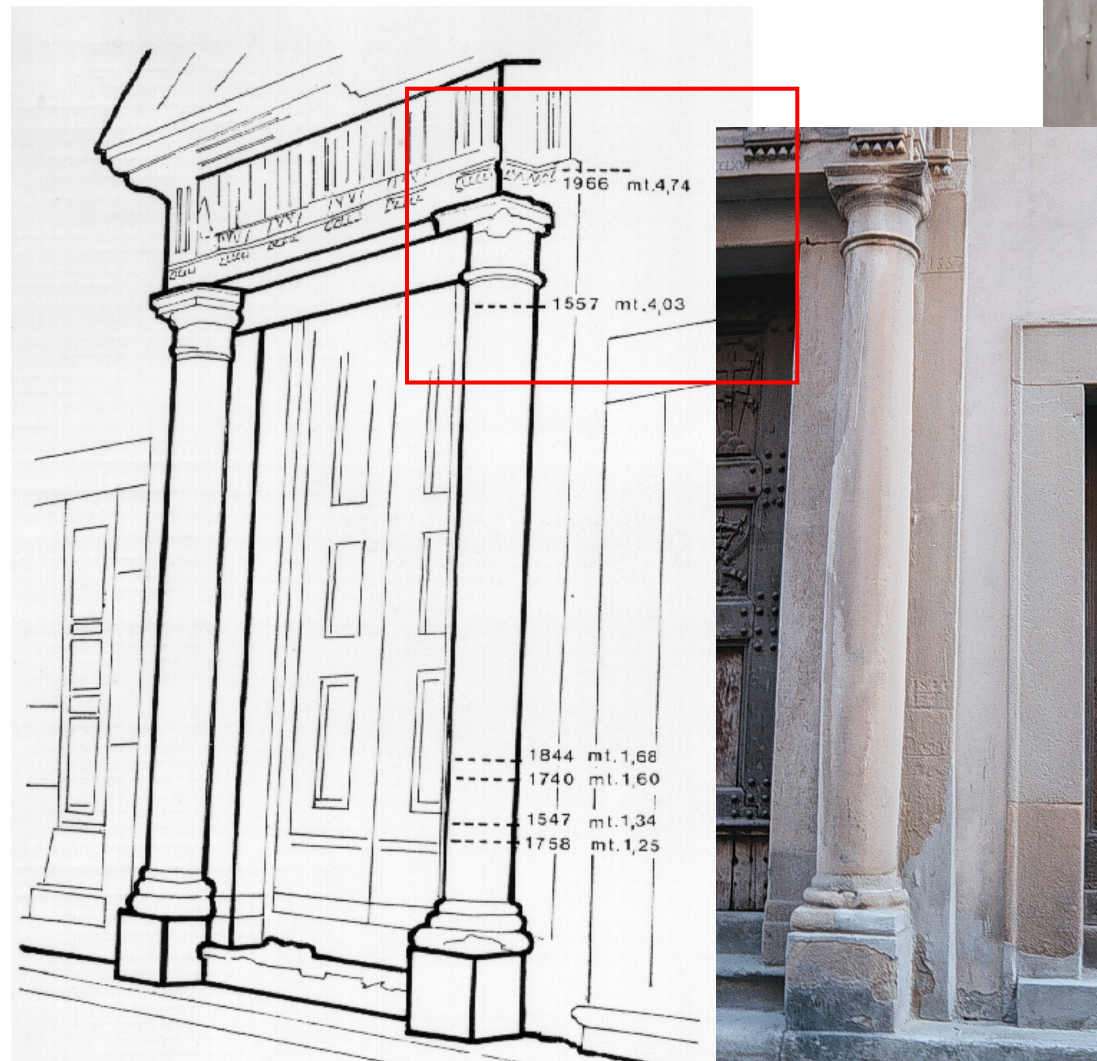


1844



FIGURE 2.14 Unknown artist, Florence Invaded by the Arno on November 3, 1844, oil on canvas, 35.5 × 45.5 cm, Florence, Museo Firenze com'era. IMAGE: FOTO SCALA.

The catastrophic 1557 and 1966



Chiesa di San Jacopo in Via Ghibellina



You may walk
around city and
look for
watermarks



Conservation of cultural heritage and landscape as a constraint in their defense from flood hazards



Florence:

Restoring the original river width without destroying part of the monuments ?

Venice:

Separating the lagoon from the sea during tides without changing the lagoon landscape and ecology ?

Florence structural partial remedies

Lowering of the bridge
foundations

(a few years after the '66 flood)

In picture: the S. Trinita bridge, reconstructed on the original Michelangelo design after WWII destruction

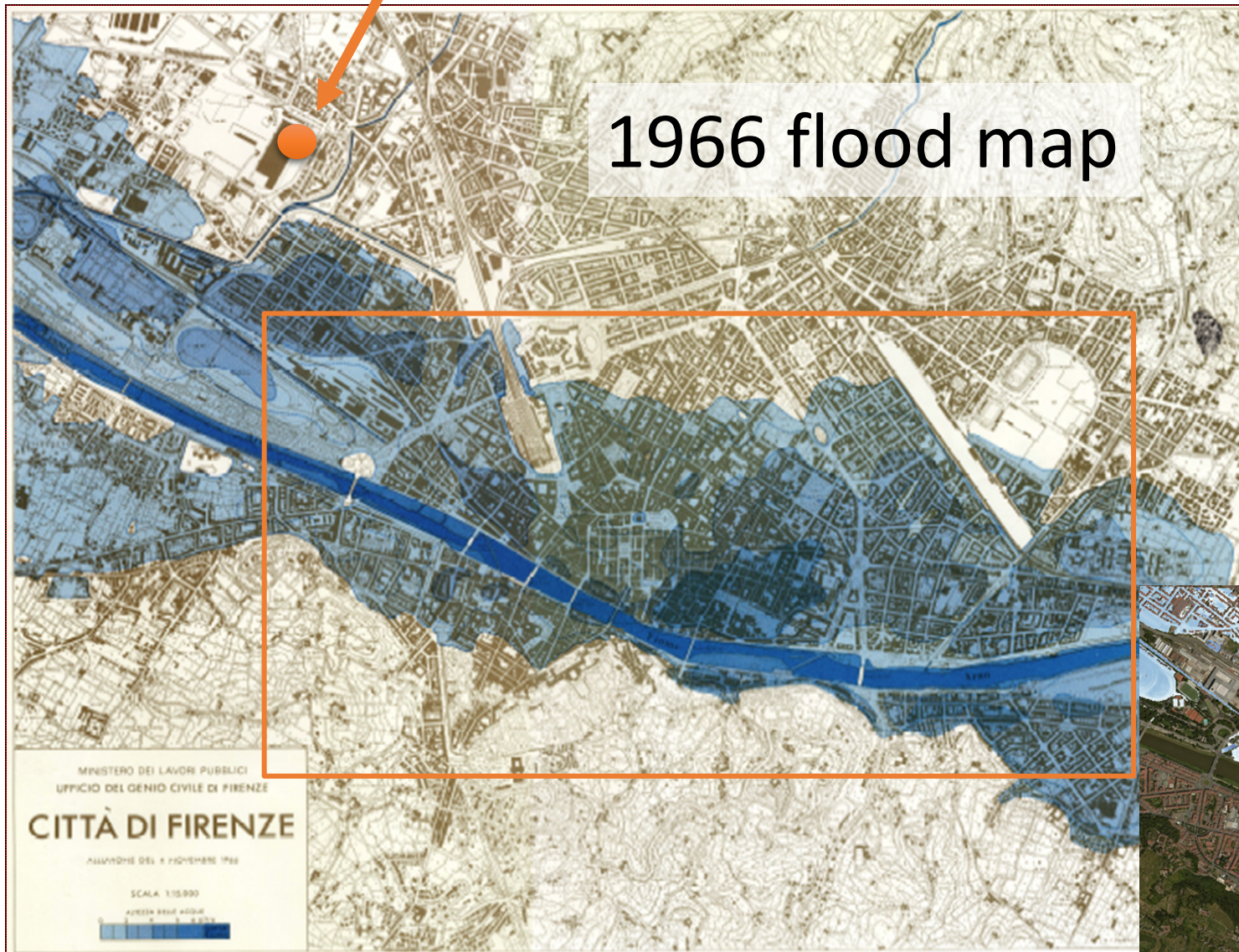
Upstream small flood retention
basins

*(recent, landscape conservation
requirements)*



We are here

1966 flood map



The 'residual risk'

Flood map for a similar
events after completion
of structural remedies





Structural remedies diminishing
(... not dissolving) the Hazard

... with evidences of Exposure (and Vulnerability?)
increase

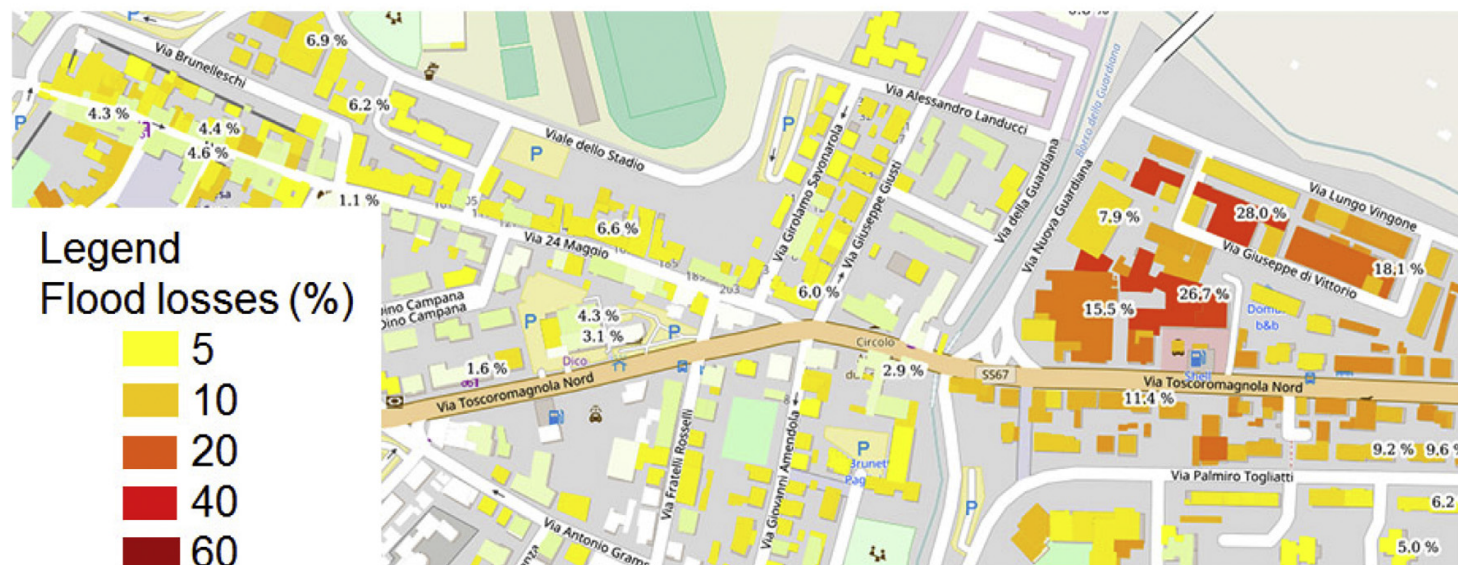




Key analysis, even more
when risk reduction is partial



Scenario without flood retention basins



Scenario with flood retention basins

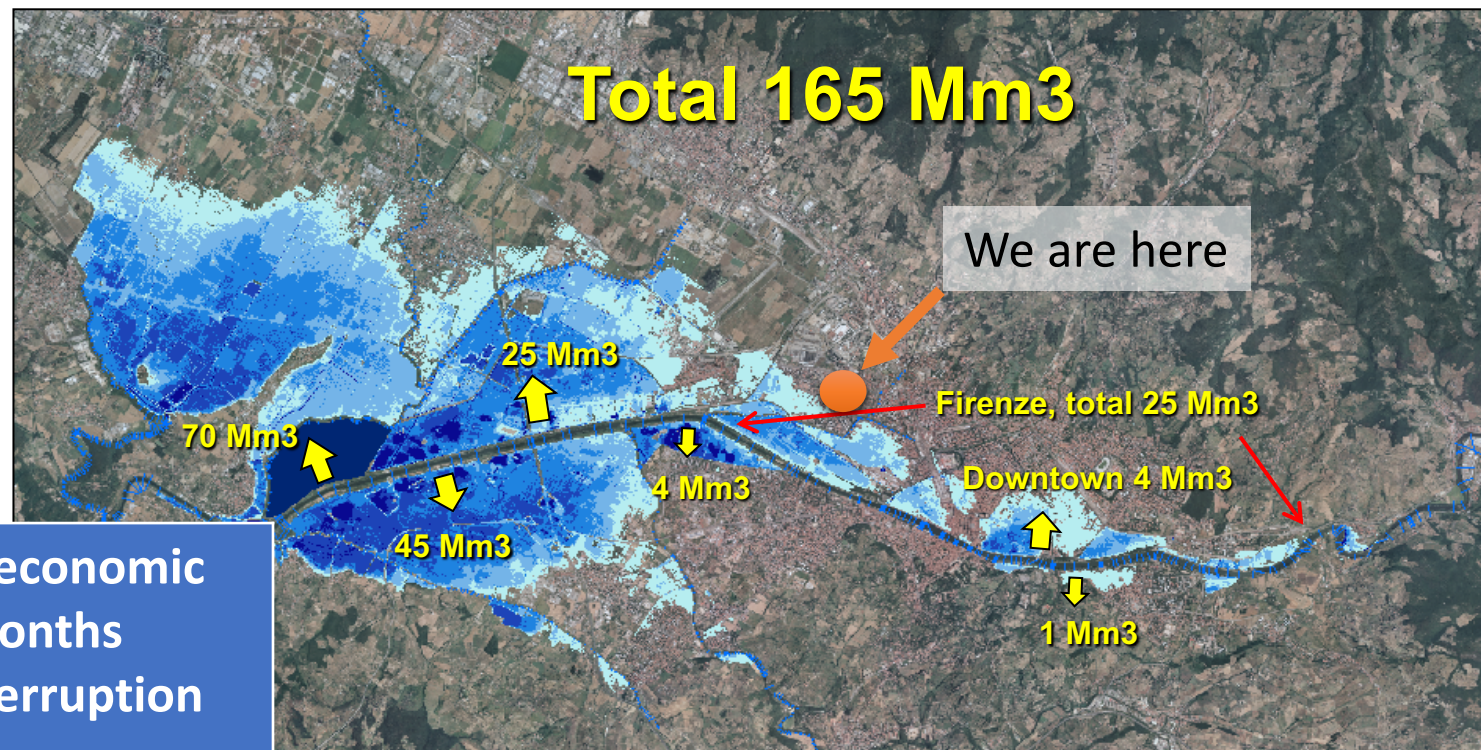
Arrighi *et al.*, 2018,
J. Env. Manag., 207, 92-104.

1966 flood damage has
been estimated as about
4 Billion-Eur,
including fine
art restoration



Vittorio Granchi mentre restaura il
Crocifisso di Cimabue 1966-1967.

Flooding volumes for a 1966-like event



*Today Scenarios,
assuming full
safeguard of artistic
heritage*

Total direct economic
losses + 2 months
business interruption
Billion-€

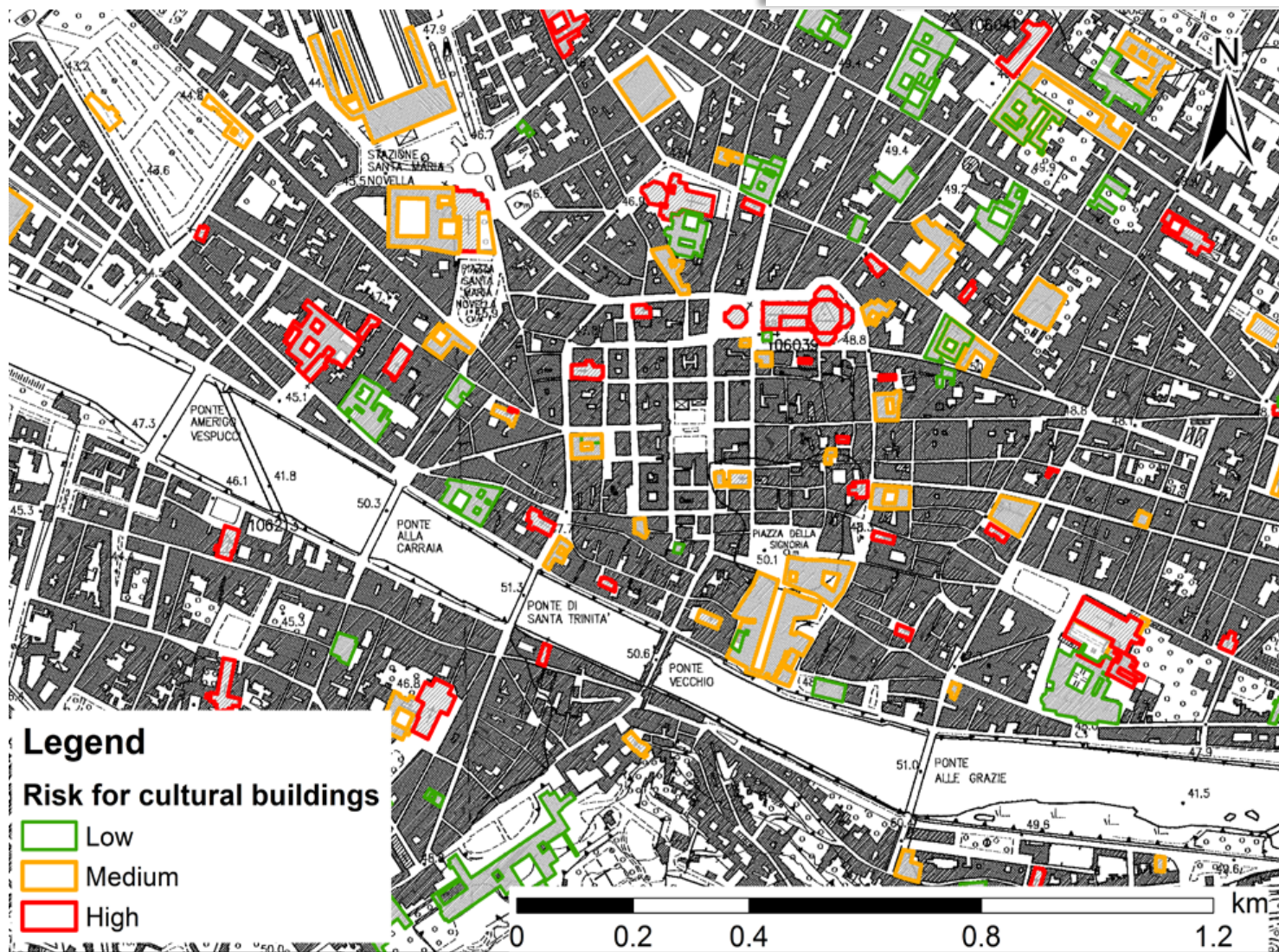
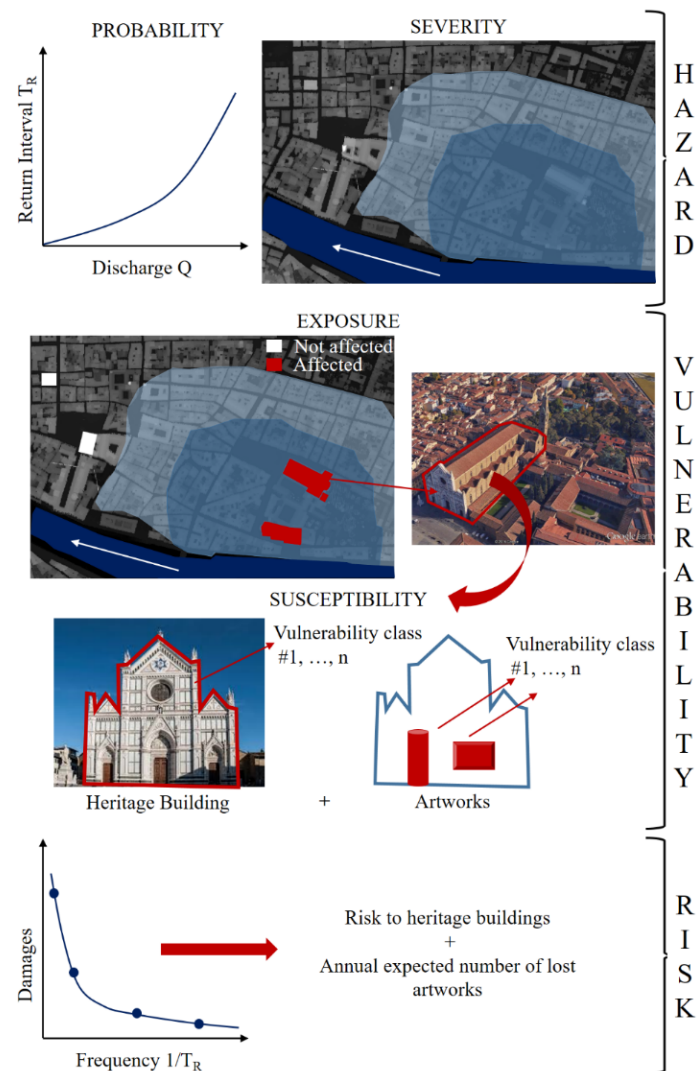
1966-like	14.52
200-year design (without retention basins)	9.27
200-year design (with retention basins)	8.33

Today **marginal monetary loss** can be
estimated in about $14,520/165 \cong$
88 Eur per cubic meter of flooding water

*Can you guess a gross estimate of the cost for
retaining upstream 1 cubic meter of water?*

Exposure and vulnerability of cultural value: *mapping risk at building scale*

Arrighi et al., 2018,
J. Flood Risk Manag., 11, S616-S631.





Festa della protezione civile: prove virtuali d'alluvione al museo Bardini

sabato 05 ottobre 2019 ore 19:24 | Cronaca

Mi piace 1

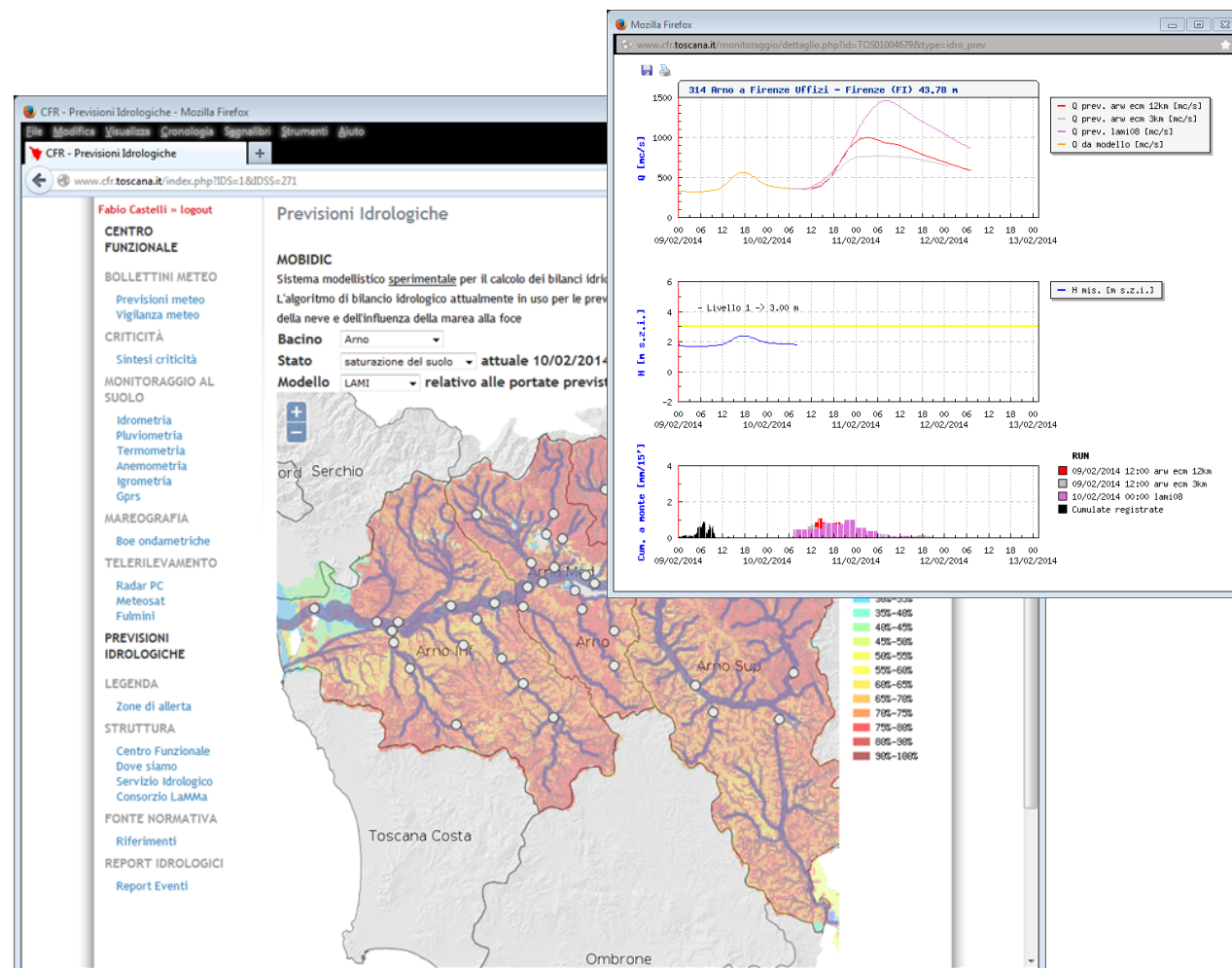
Condividi

Tweet



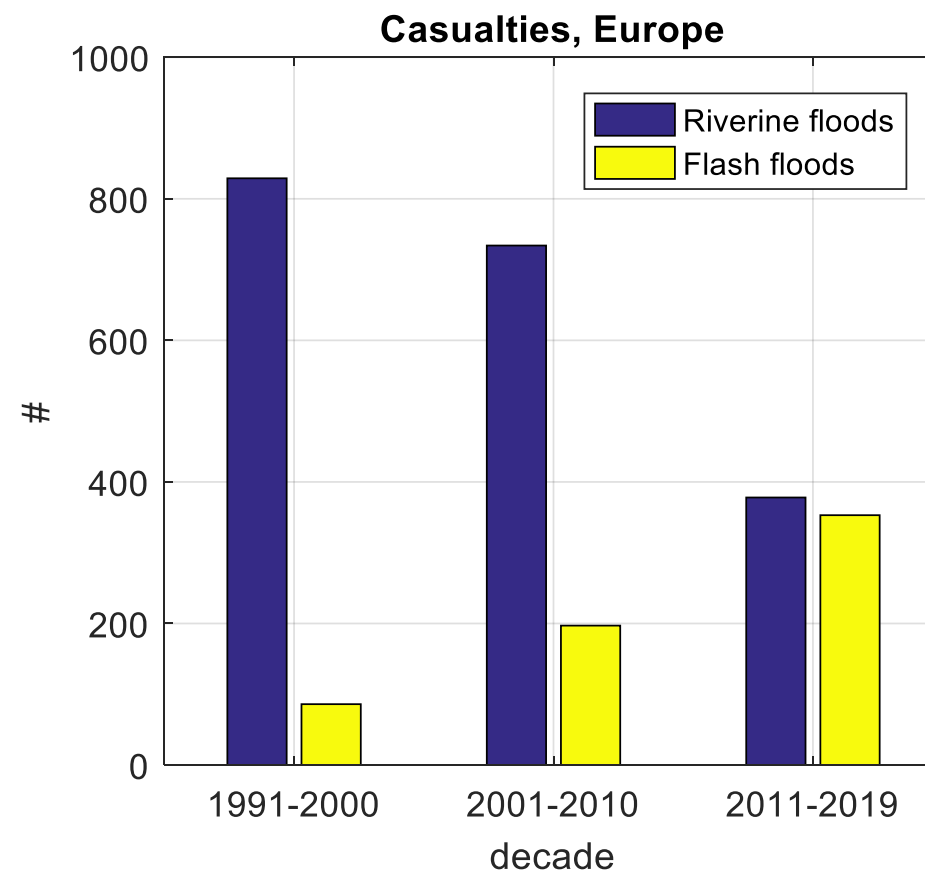
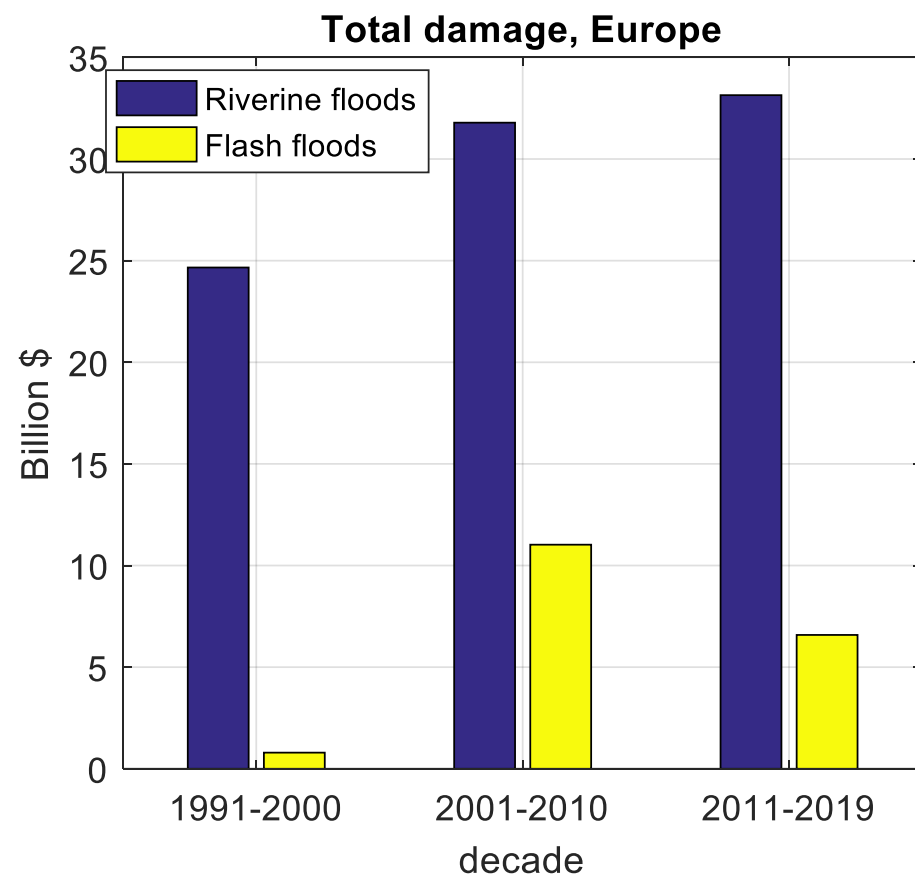
Stamani allarme simulato nell'ambito della I edizione della 'Festa della protezione civile'. Test con una diga anti inondazioni. Al centro commerciale San Donato allestito il 'villaggio' della prevenzione e della sicurezza. Stand e percorsi guidati per conoscere tutto quello che si fa per fronteggiare le emergenze

Synergy with non-structural remedies (early warning, emergency plans) for non-transferable residual risk

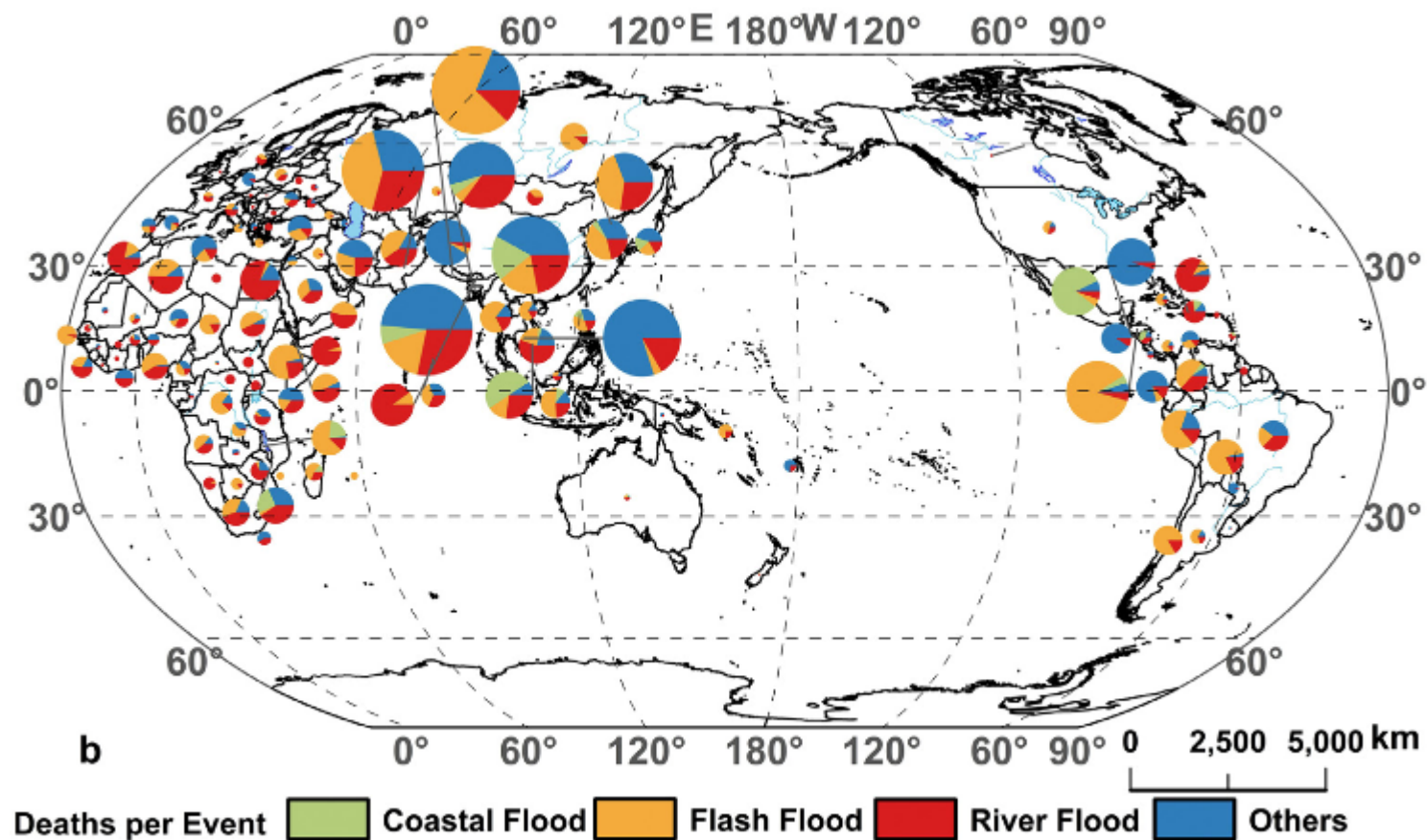


Exposure and vulnerability of people:

Some evidences at European scale on the increasing risk from Flash Floods



Flood type	Occurrence	Total affected People/event	Total deaths/event
		Mean	Mean
Coastal flood	41	499,308.805	60.439
Flash flood	398	420,068.779	138.751
Riverine flood	1653	1,489,342.276	67.987



Hu *et al.*, 2018,
Sci. Total Env., 643, 171-182.

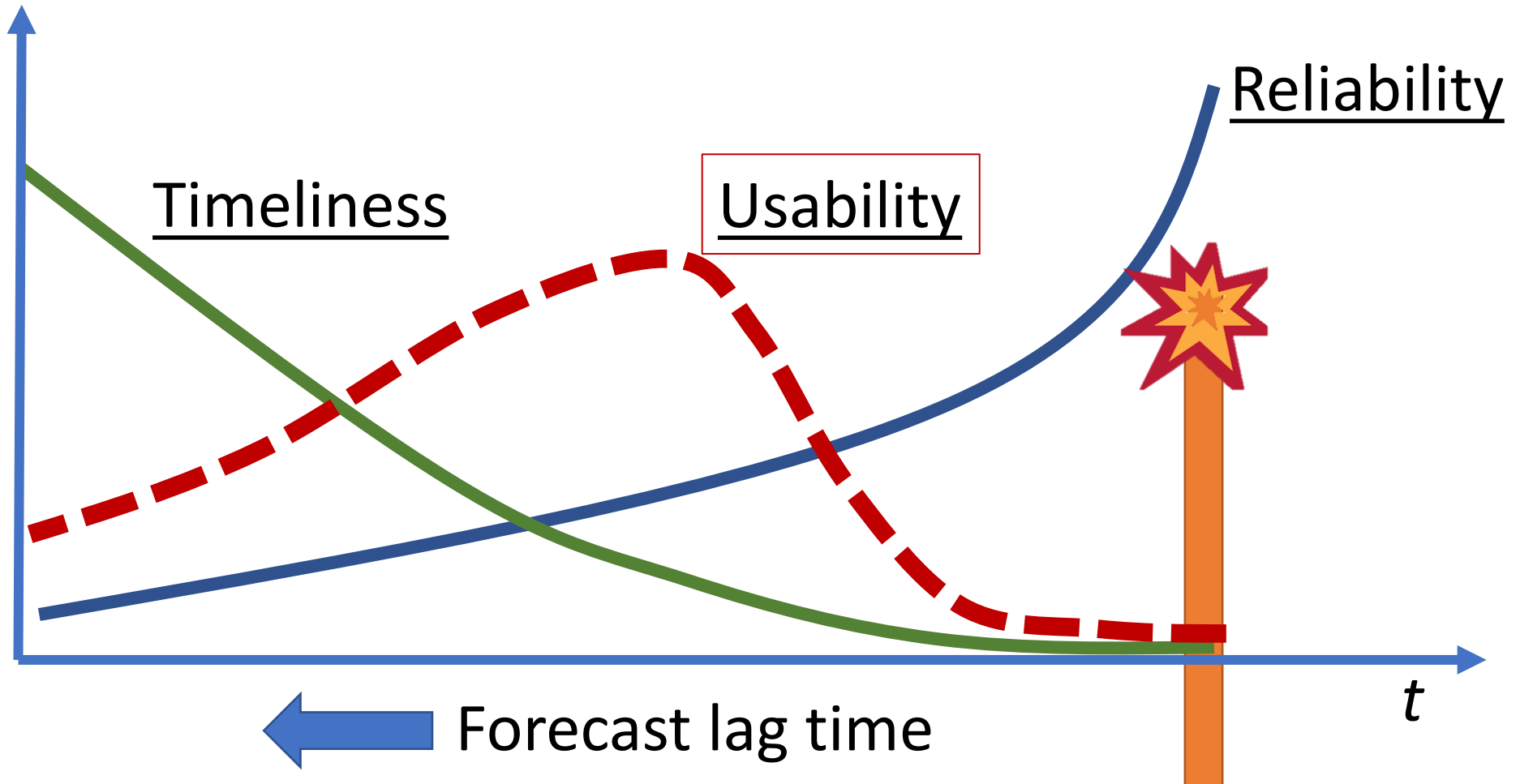
Flash Floods from a risk management, early warning perspective ?



alamy stock photo

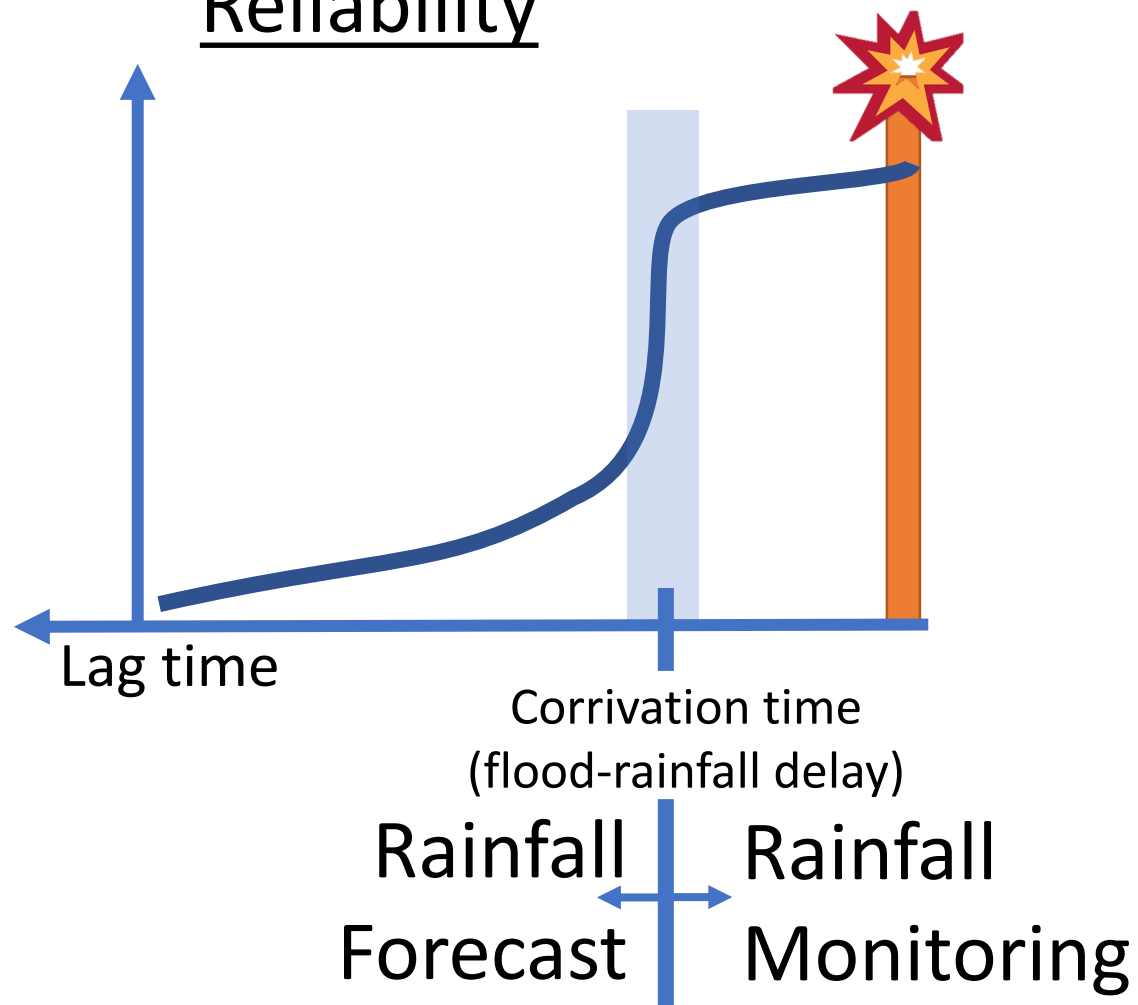
FODRIKX
www.alamy.com

Key characteristics of a warning system

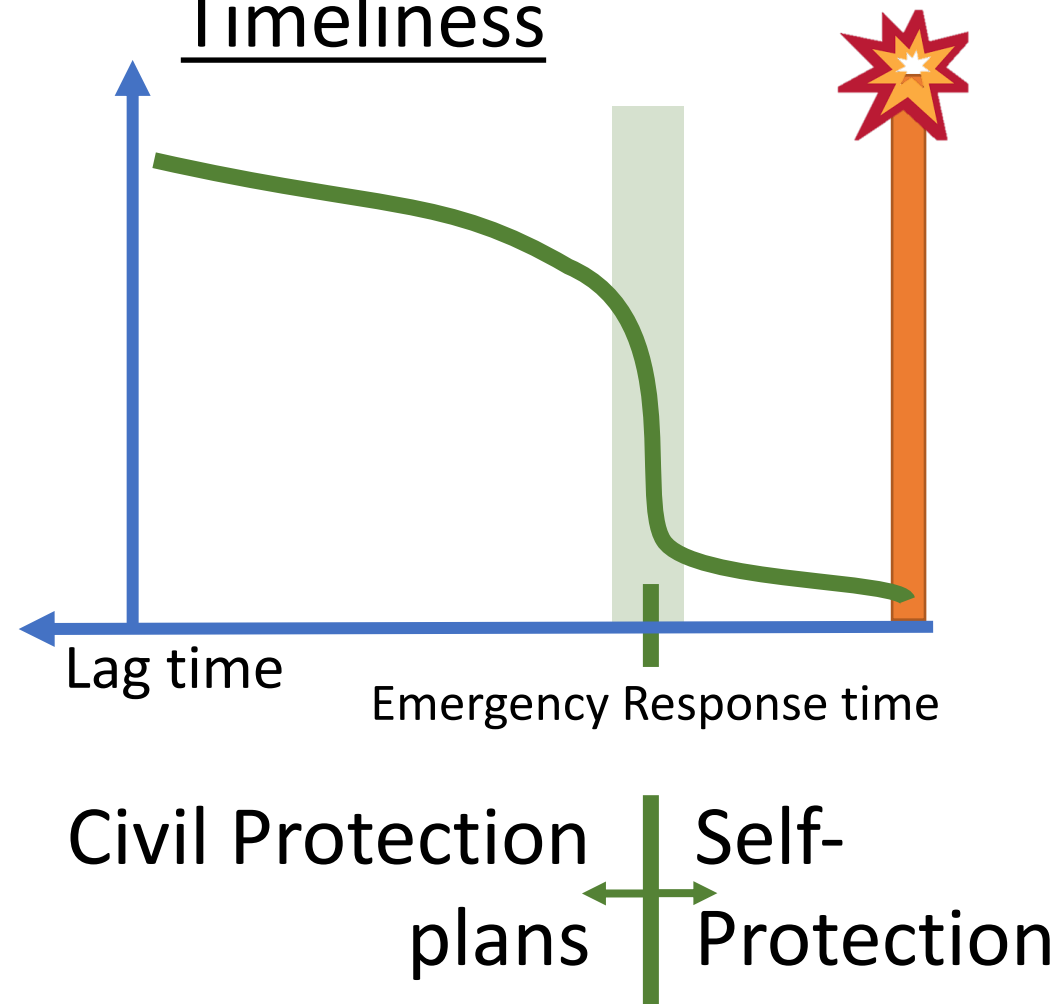


True behavior is highly non-linear, threshold like

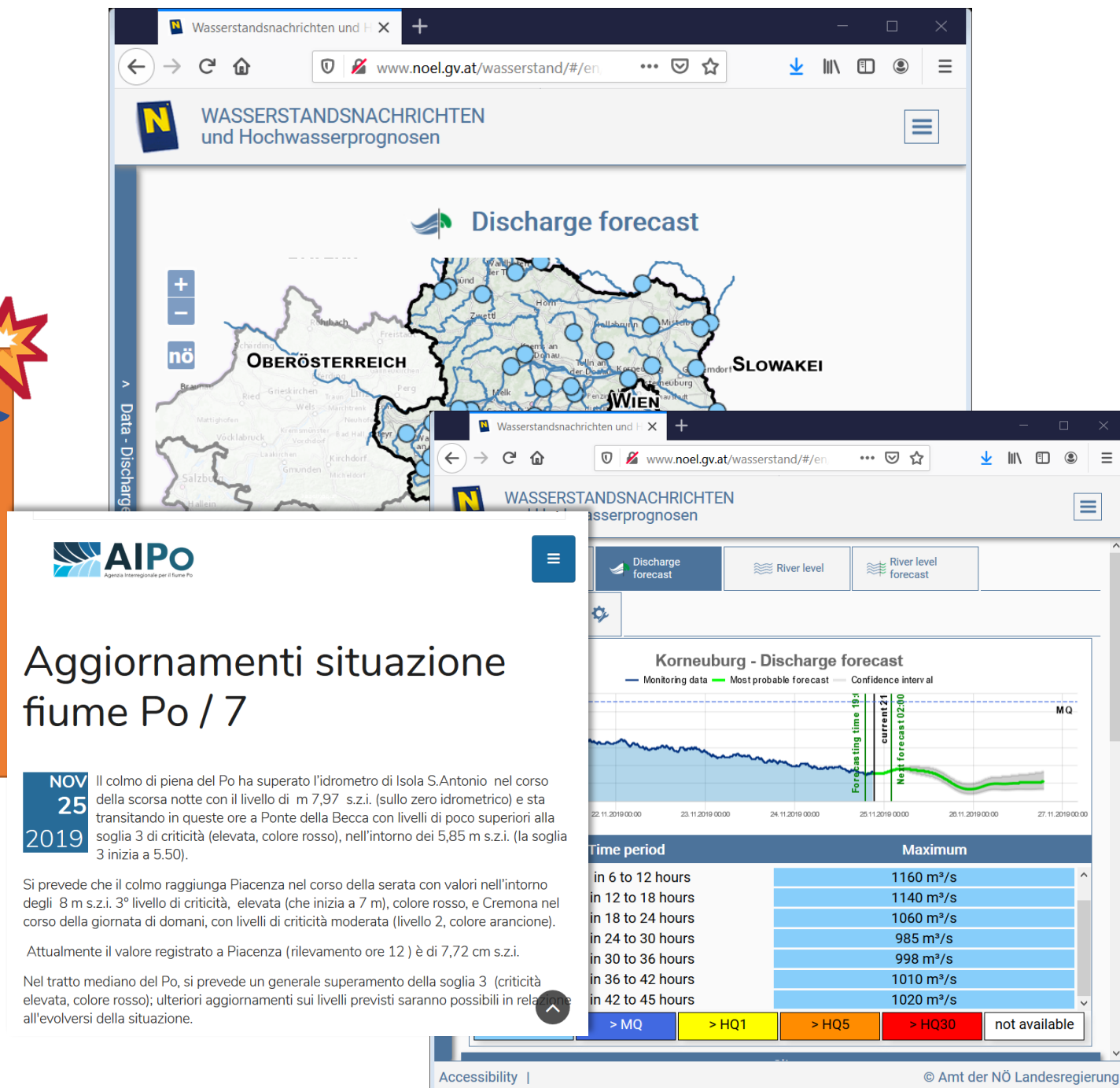
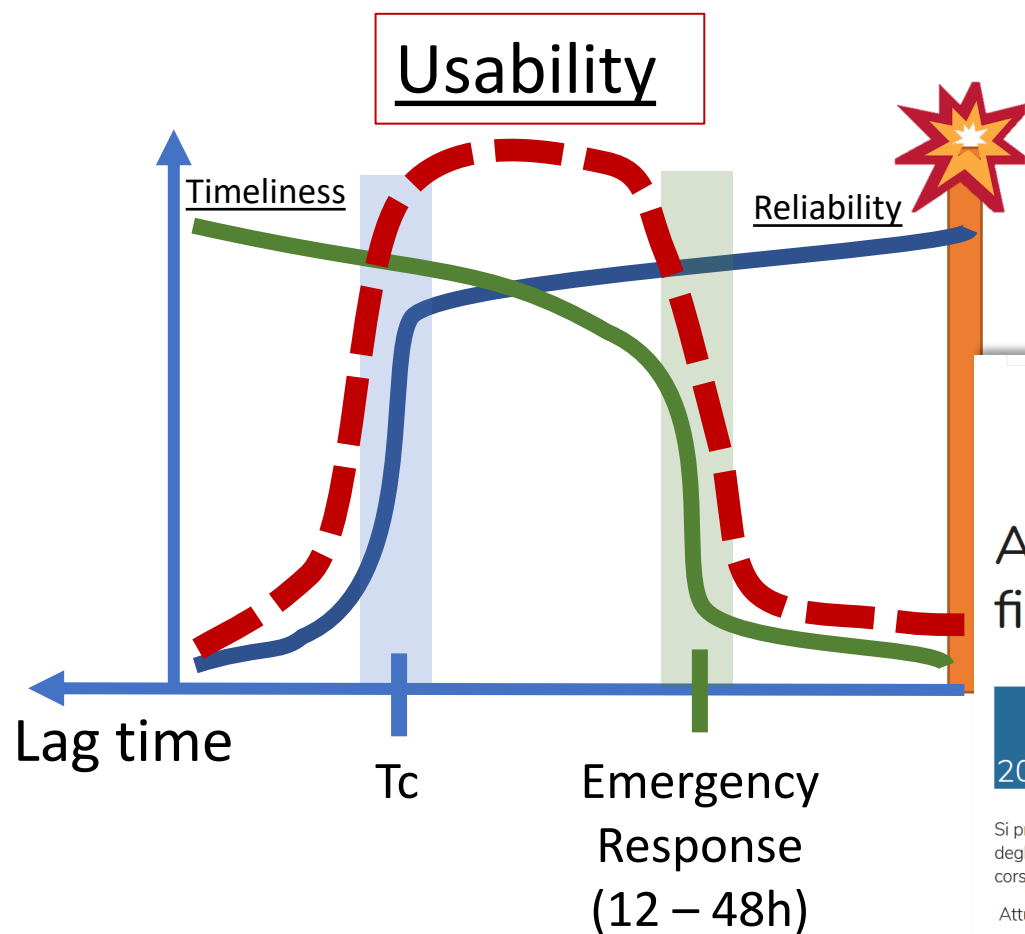
Reliability



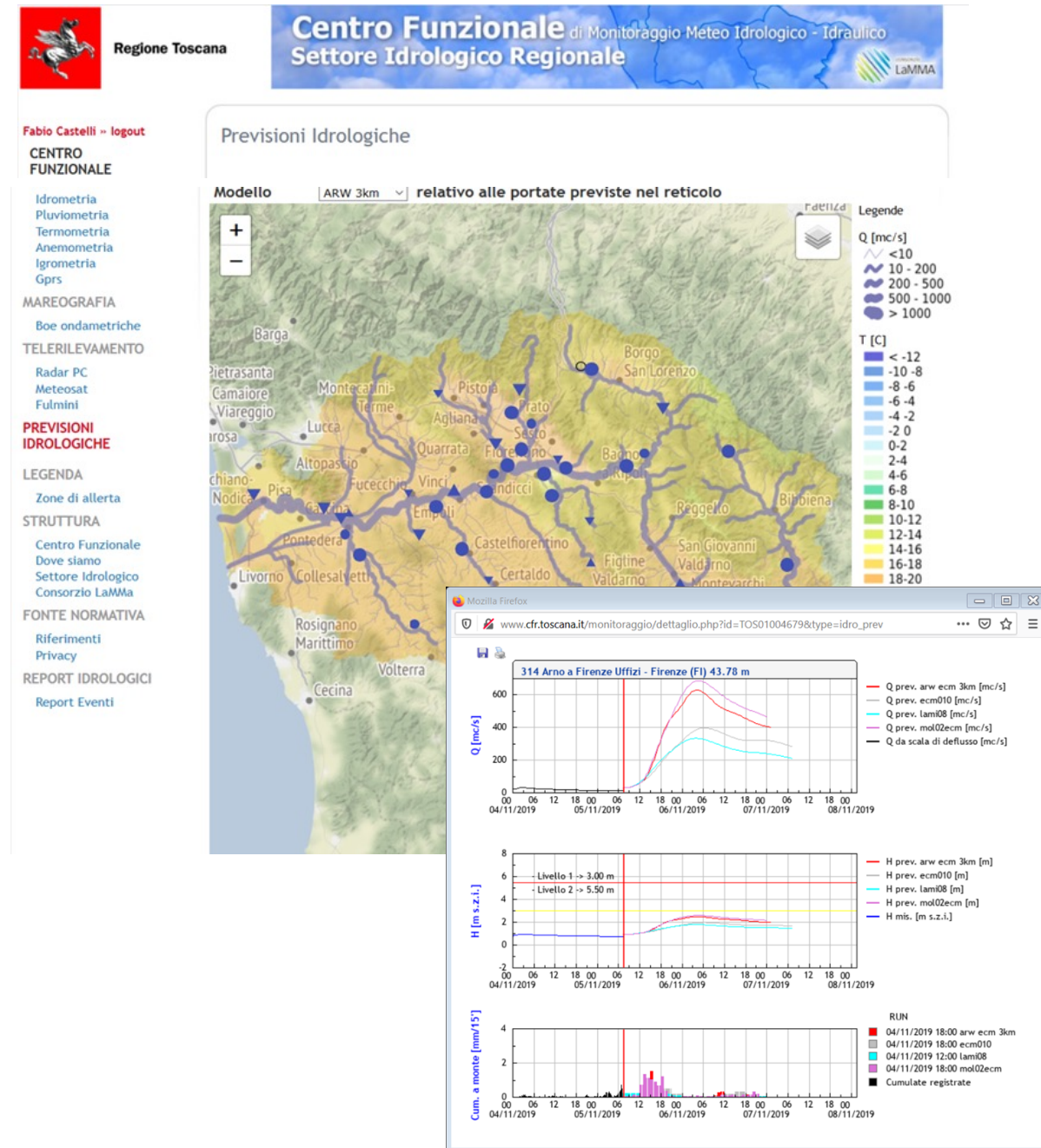
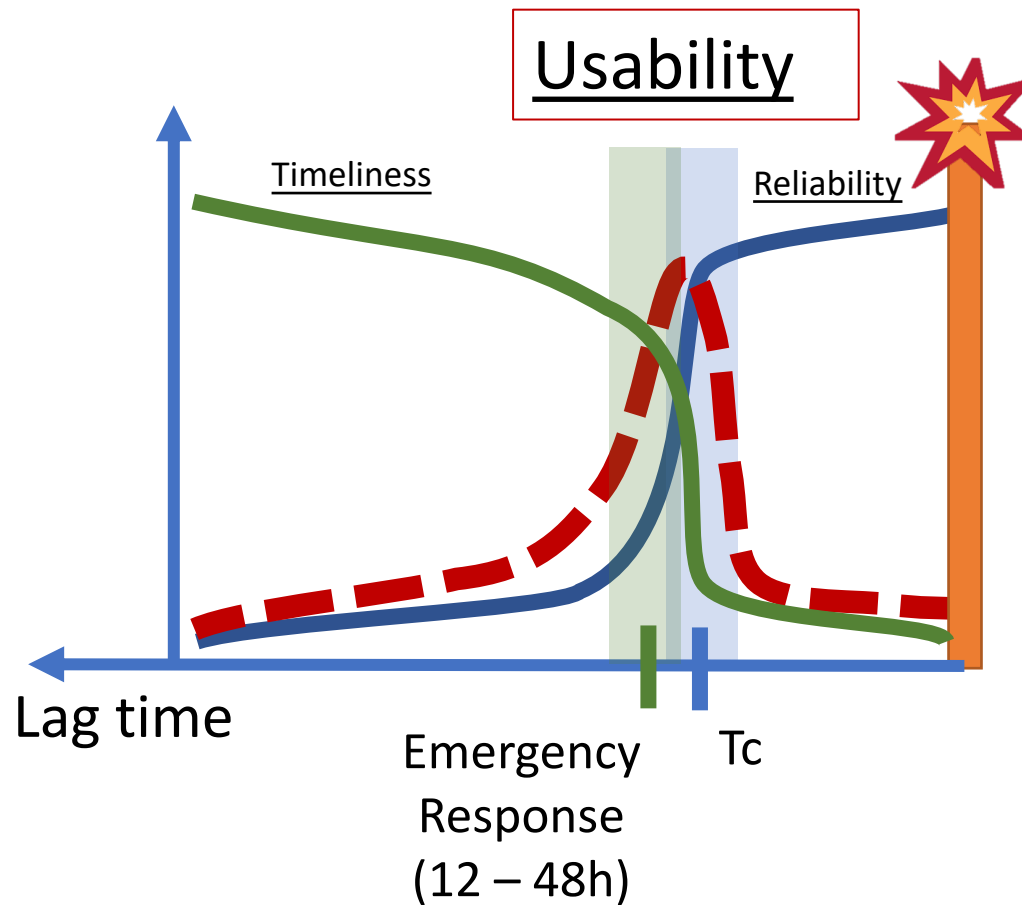
Timeliness



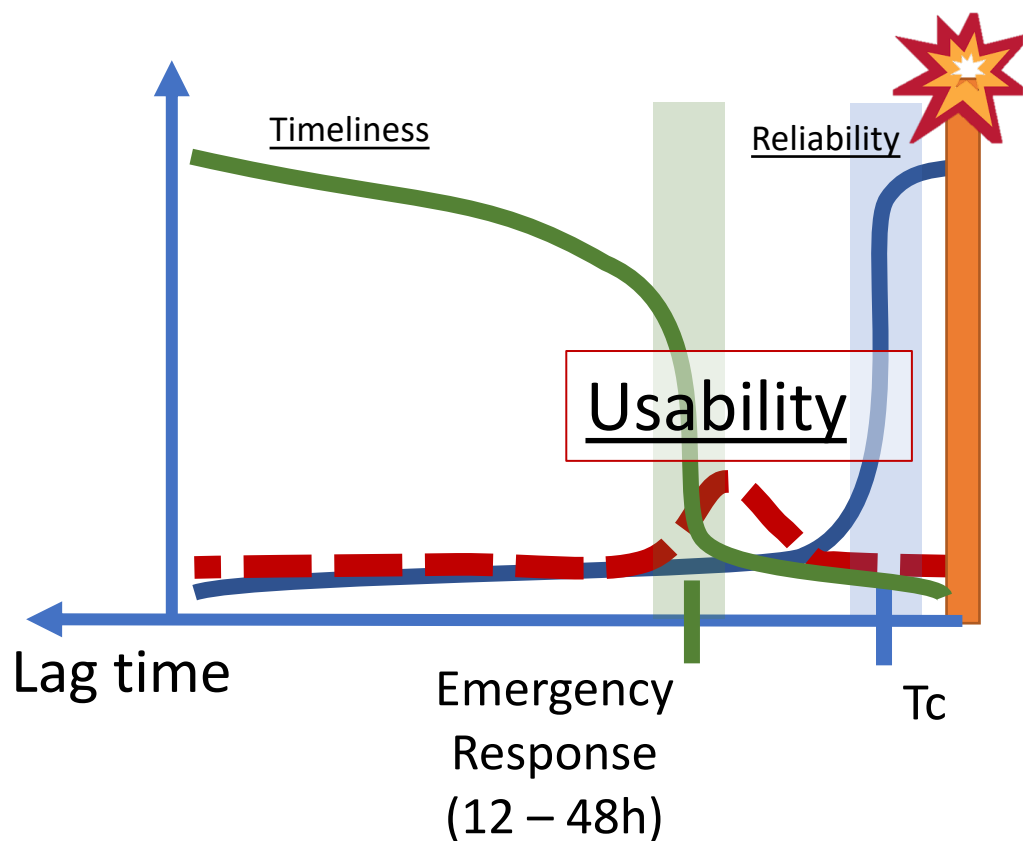
Large continental basins (e.g. Danube, Po, ...)



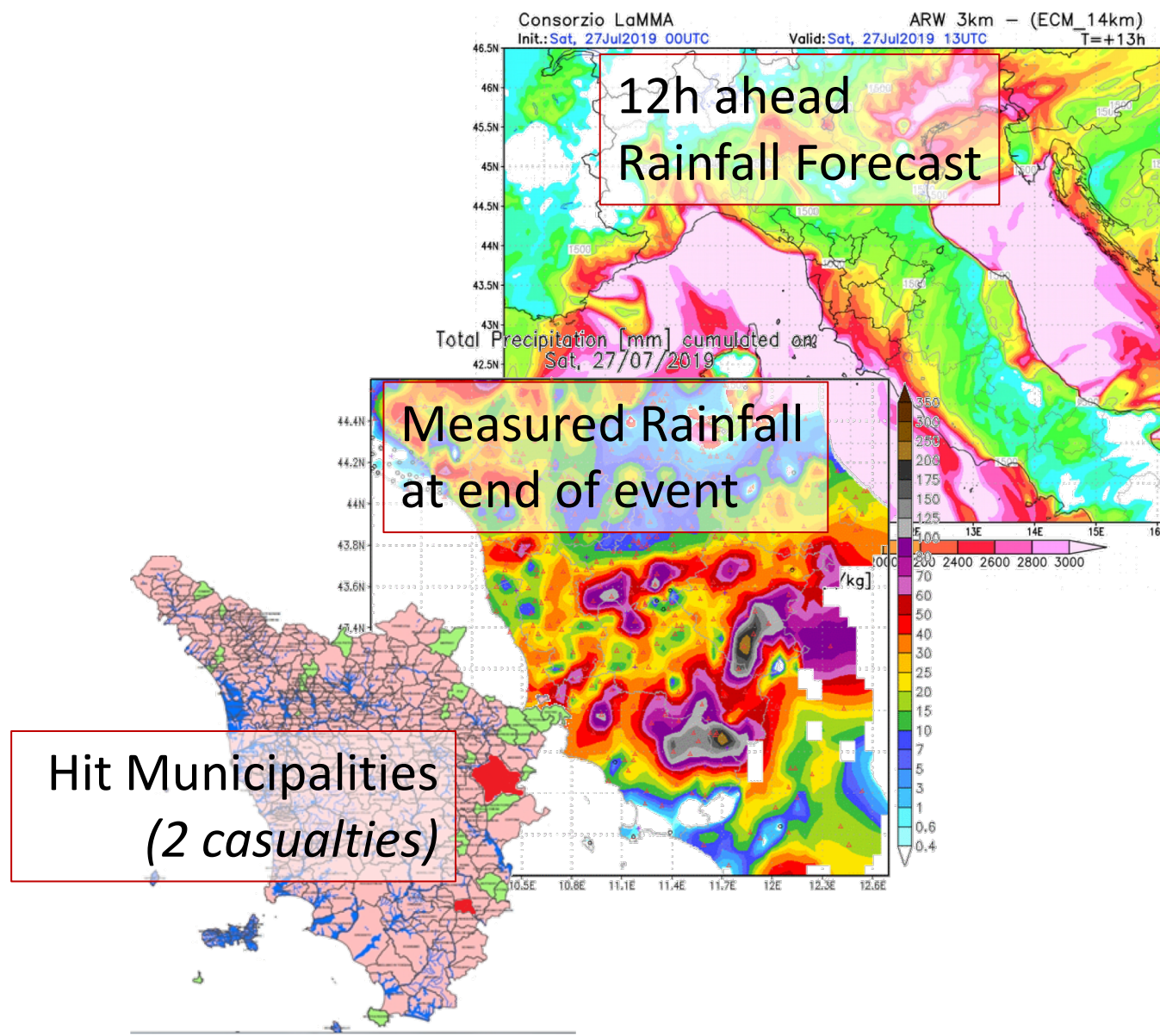
Mid-size mediterranean (e.g. Arno in Florence ...)



Small creeks, urban drainage (flash-floods)



Recent disastrous flash-flood in Tuscany,
July 27th, 2019





Further confirmation evidences

Condition	Flood fatalities		Landslide fatalities	
	#	%	#	%
On foot	137	37.8	121	39.3
By car	203	56.1	95	30.8
By road bike	2	0.5	2	0.6
By van	4	1.1	2	0.6
By tractor	2	0.5		
By truck	4	1.1	3	1.0
By excavator	2	0.5	11	3.6
By bus	1	0.3	2	0.6
By train			65	21.1
By boat	7	1.9		
Climbing			7	2.3
Total	362		308	

Place	Flood fatalities		Landslide fatalities	
	#	%	#	%
Public/private building	122	24.7	354	55.0
Proximity of house	13	2.6	10	1.6
Road/highway	188	38.1	137	21.3
Railway			65	10.1
Campsite	21	4.3		
Countryside	20	4.1	13	2.0
Mountains			47	7.3
Beach			16	2.5
Bridge	64	13.0	2	0.3
Riverbed	5	1.0		
River bank	38	7.7		
Underpass	2	0.4		
Ford	20	4.1		
Total	493			

Salvati *et al.*, 2018,
Sci. Total Env., 610, 867-879.

A few conclusions

Evidences on the historic roots of flood risk may guide better understanding of feasible options for structural and non-structural remedies.

Residual risk management remains high priority due to:

- Increasing exposure while decreasing hazard
- Non-transferable risk for human life, artistic values
- Flash-flooding low predictability



Thank you for your attention!

*...and remember to spot
flood water marks while
touring downtown ...*



December 22nd, 2019