
ISPRA
Ministero dell'Ambiente
Regione Sardegna
Agenzia di distretto idrografic
Flash Flood and Pluvial Flooding
Why Sardinia?
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Dott Giovanni Tilocca, RAS direzione scientifica
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DHI Italia
HYDRODATA
art
With collaboration of
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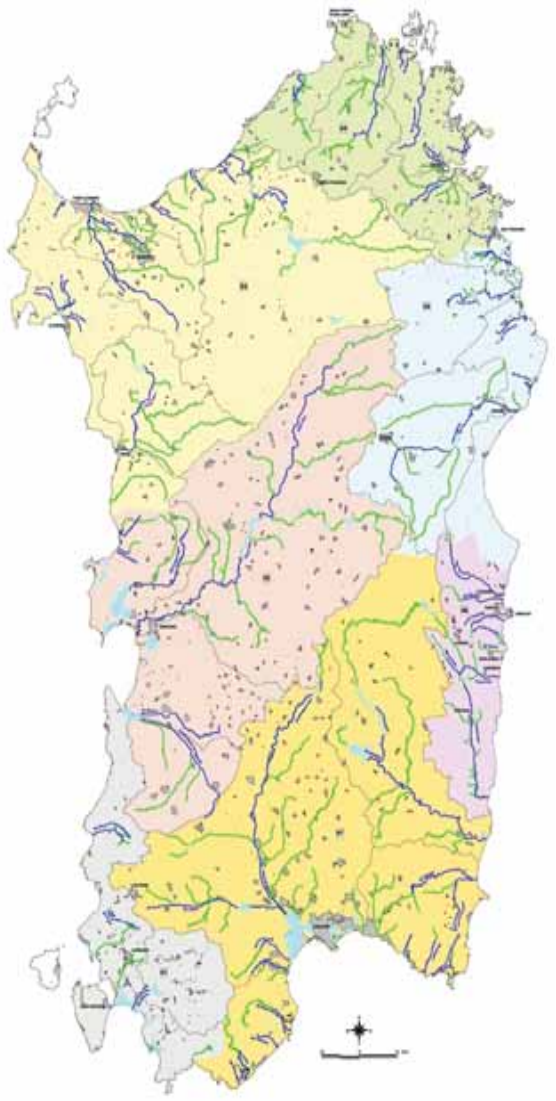
Ing R. Malcotti, ART.srl
Cagliari 26-27 Maggio 2010

Italian Mediterranean basin and flash Flood: the Sardinia example



Recipe for an effective dangerous flash flood

1) High rainfall intensity, variability & small basin concentration time

2) High variability in discharge regime

3) High solid transport phenomena

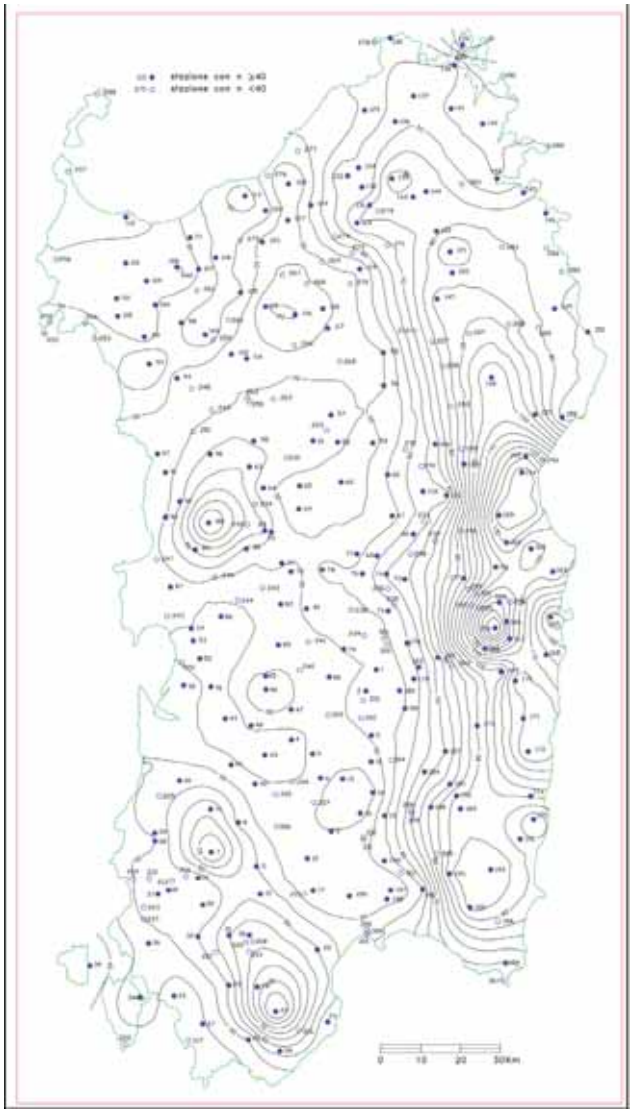
4) Low perception of river presence

5) High Photosynthetic Active Radiation and fluvial vegetation development

) Low maintenance of river sections

High rainfall variability

Isoiete di pioggia media da VAPI

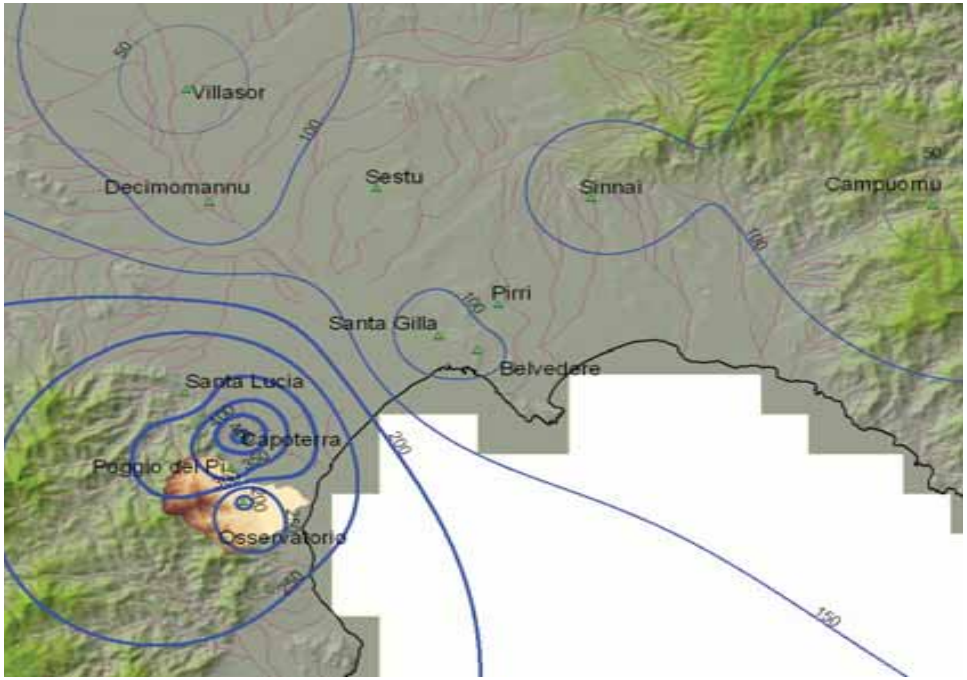


Evento 2008 (RAS)

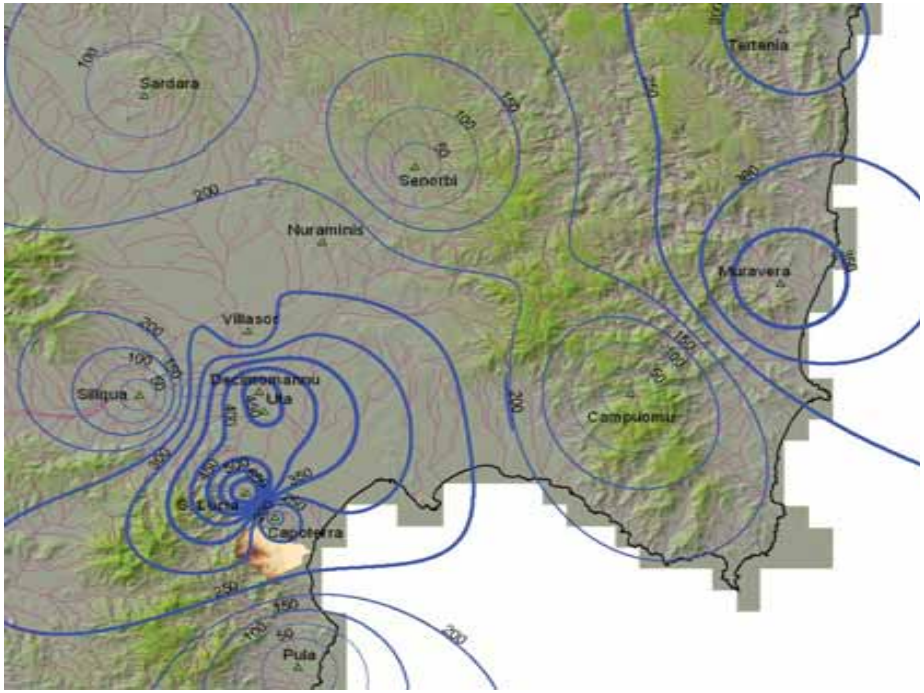
High rainfall variability

Contour lines for cumulative rainfall for the 1999 and 2008 flash flood events

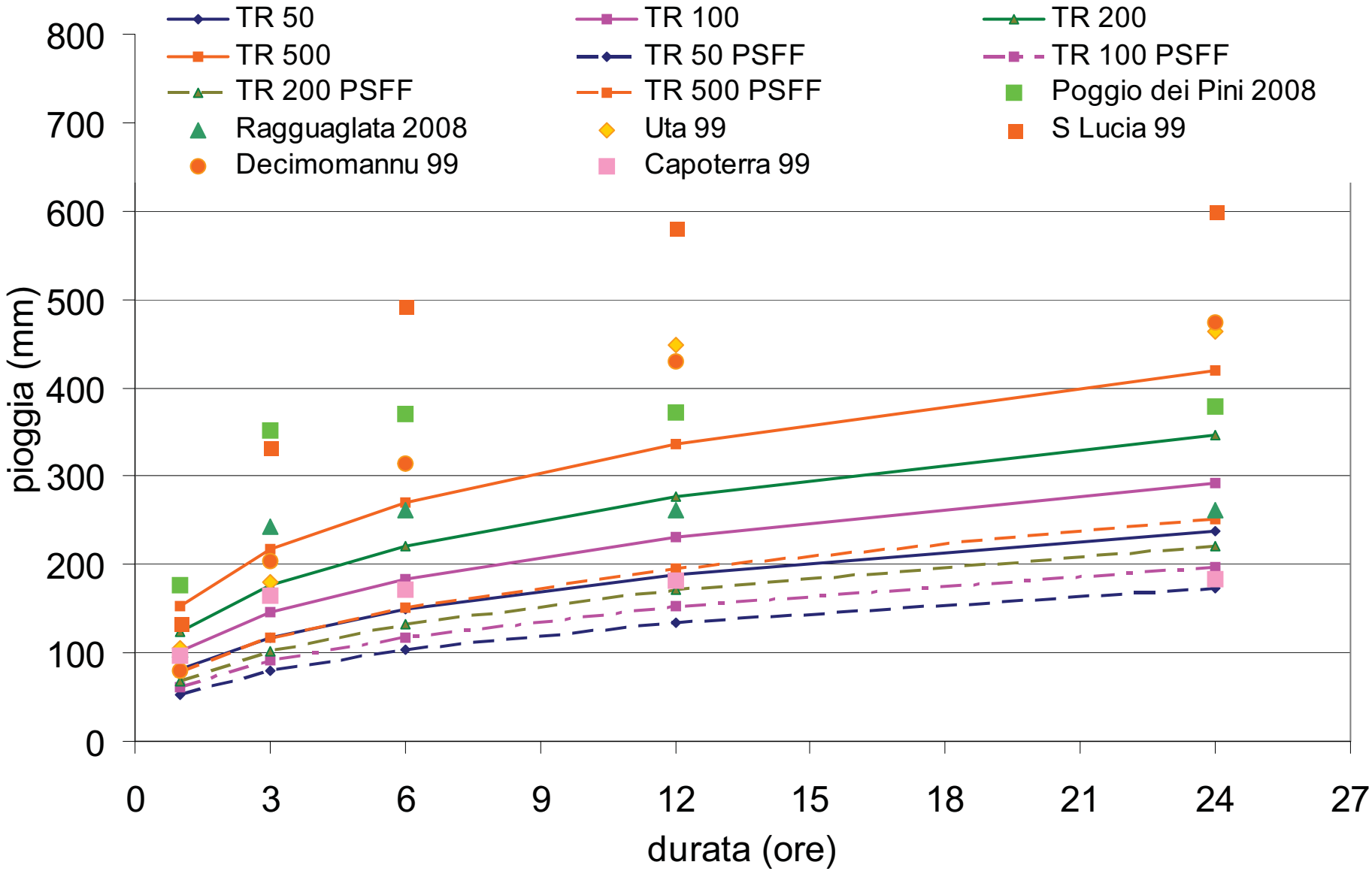
Evento October 2008



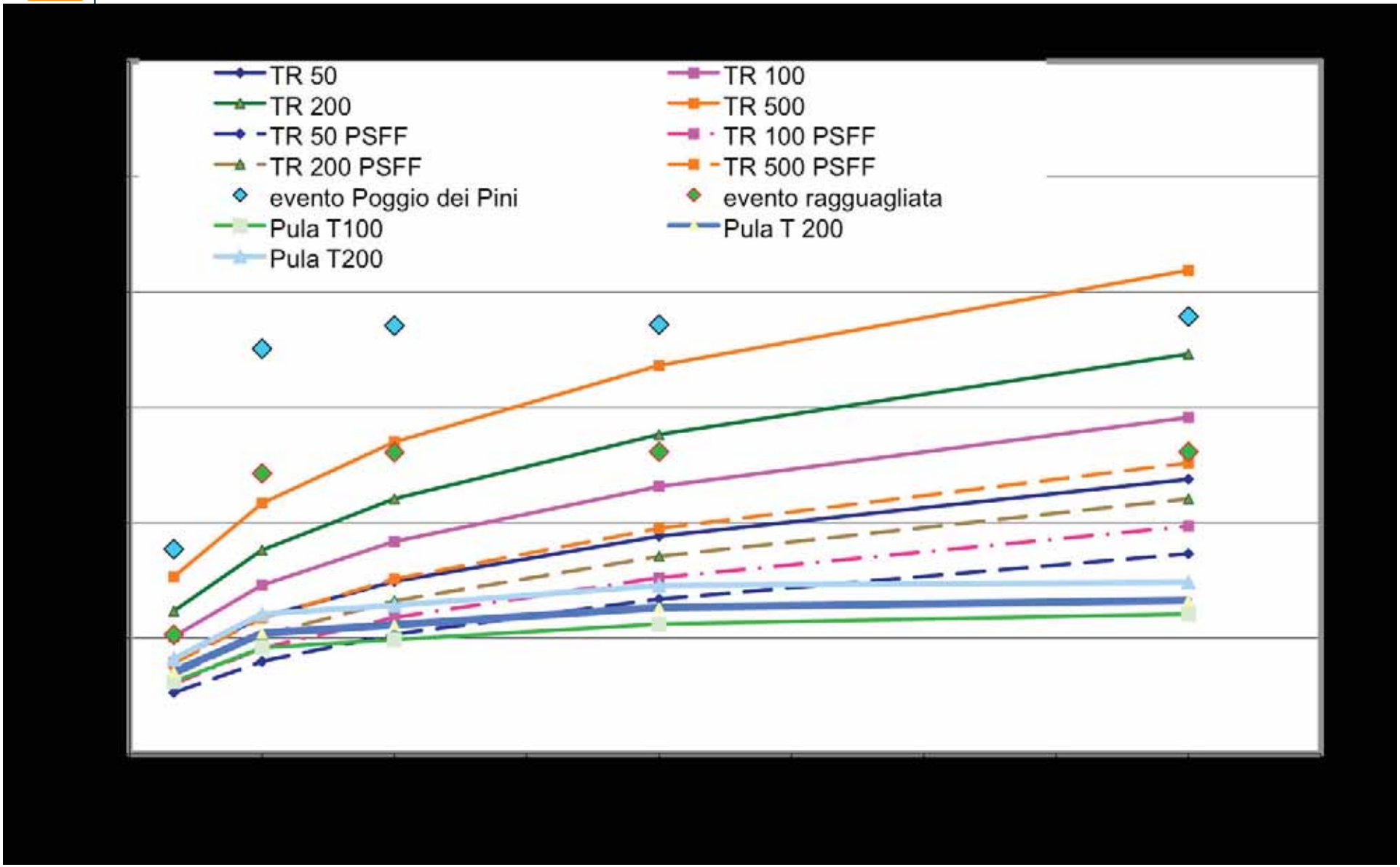
Evento November1999



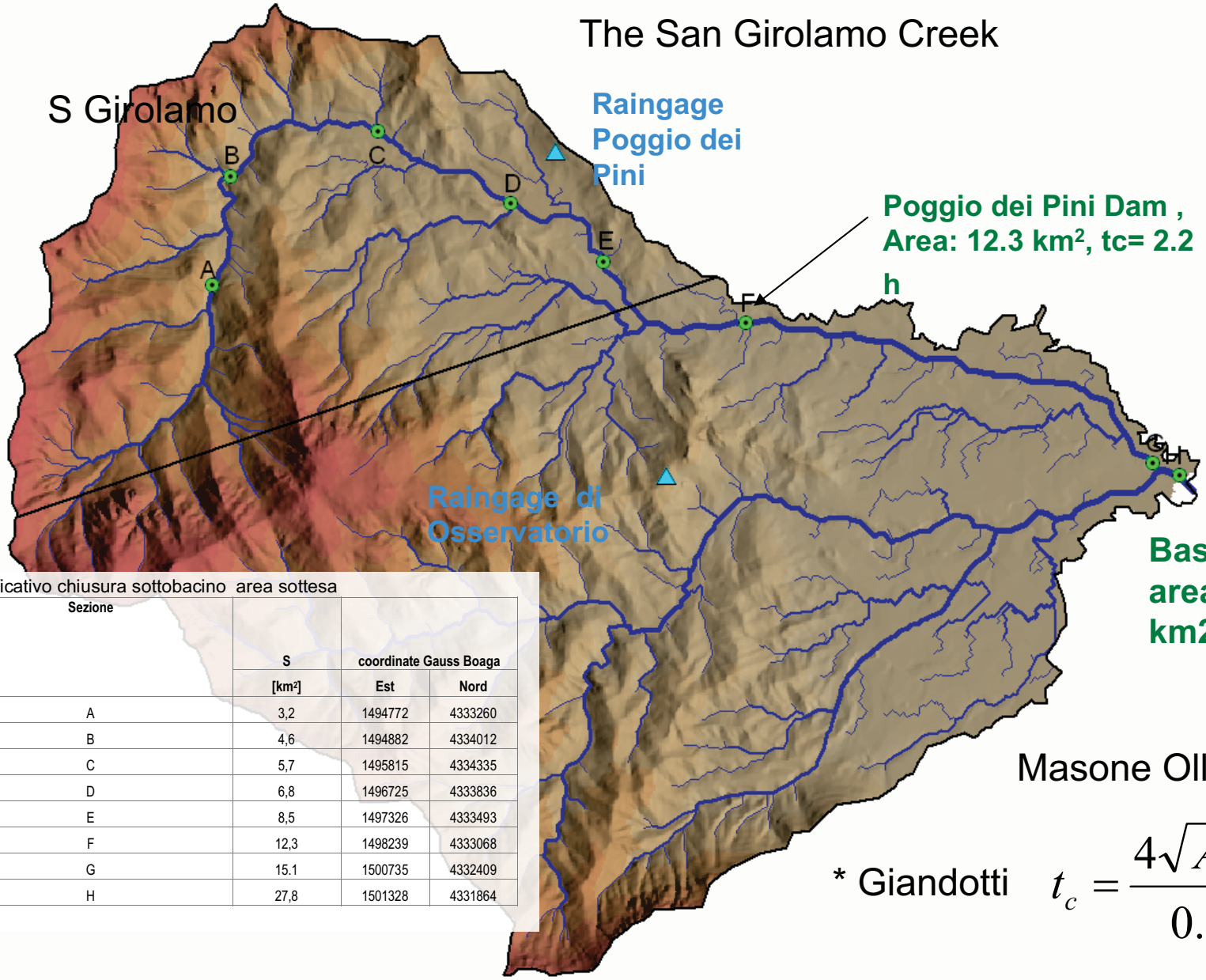
Depth duration frequency curve: events November 99 & October 2008



Local effect of Capoterra topography respect to the regional rainfall analysis



The San Girolamo flash flood case study

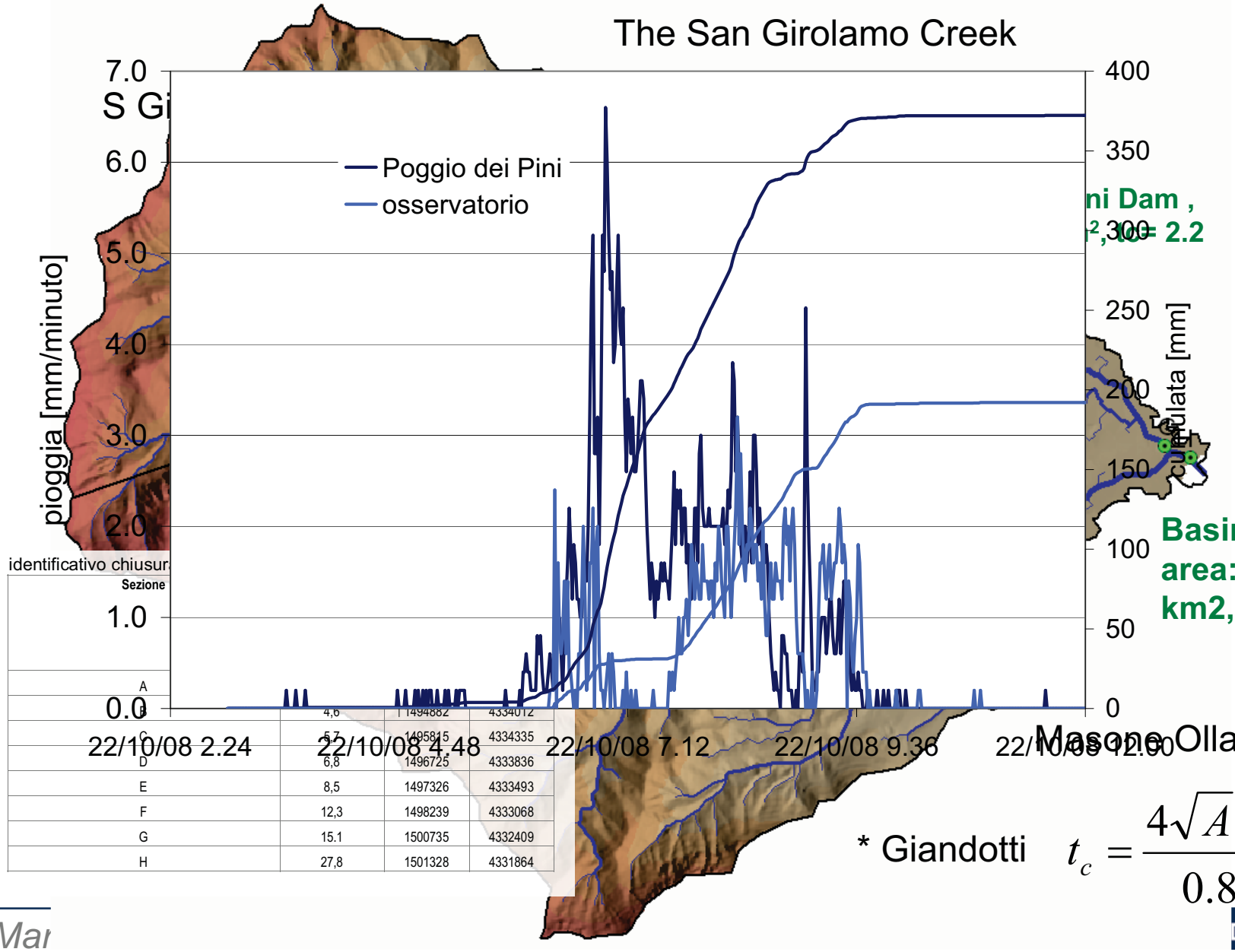


identificativo chiusura sottobacino area sottesa

Sezione	S	coordinate Gauss Boaga	
	[km²]	Est	Nord
A	3,2	1494772	4333260
B	4,6	1494882	4334012
C	5,7	1495815	4334335
D	6,8	1496725	4333836
E	8,5	1497326	4333493
F	12,3	1498239	4333068
G	15.1	1500735	4332409
H	27,8	1501328	4331864

* Giandotti $t_c = \frac{4\sqrt{A} + 1.5L}{0.8\sqrt{z_m}}$

The San Girolamo flash flood case study



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Poggio dei Pini Dam, Dam overtopping due to failure of dam spillway

Fllod peak and solid transport during the event

Principali cause di insufficienza idraulica

The San Girolamo flash flood case study: estimation of the peak discharge at dam

Portata al colmo alla diga

L = lunghezza del coronamento = m 86.0

Dati da Pulighedu

t = altezza media del paramento di monte = m 4.0

he = carico efficace = m 1.85

Formula di Rehbock

$$Q = \mu_s * L * h_e \sqrt{(2gh_e)} \text{ con } \mu_s = 0{,}402 + 0{,}054 * (h_e / t)$$

Q = 396 m^3/s

Stramazzo a larga soglia

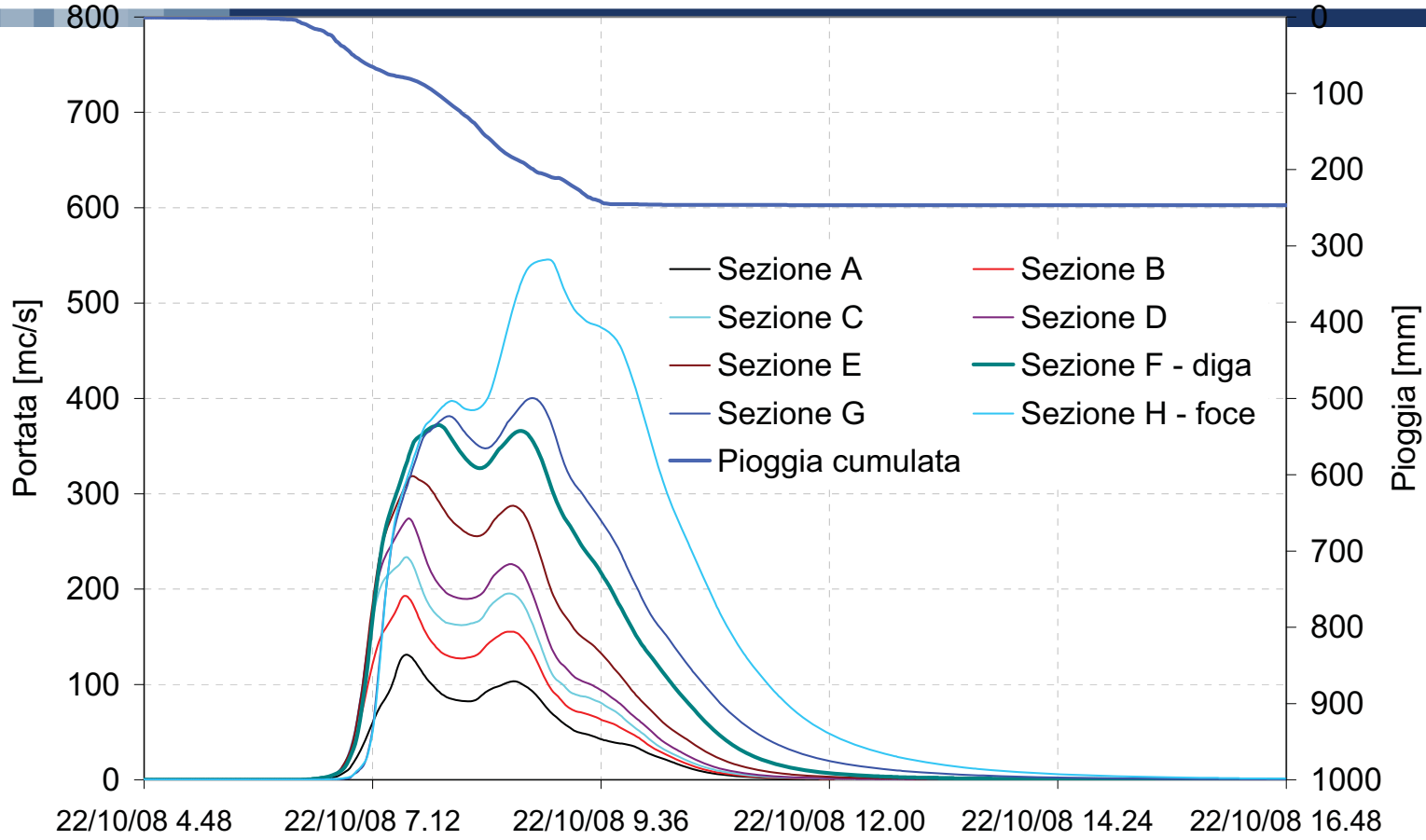
$$Q = \mu_s * L * h_e \sqrt{(2gh_e)} \text{ con } \mu_s = 0.385$$

Q = 357 m^3/s

Analisi idraulica

Q = 370 - 460 m^3/s

The San Girolamo case study: Model calibration using FEST distributed model

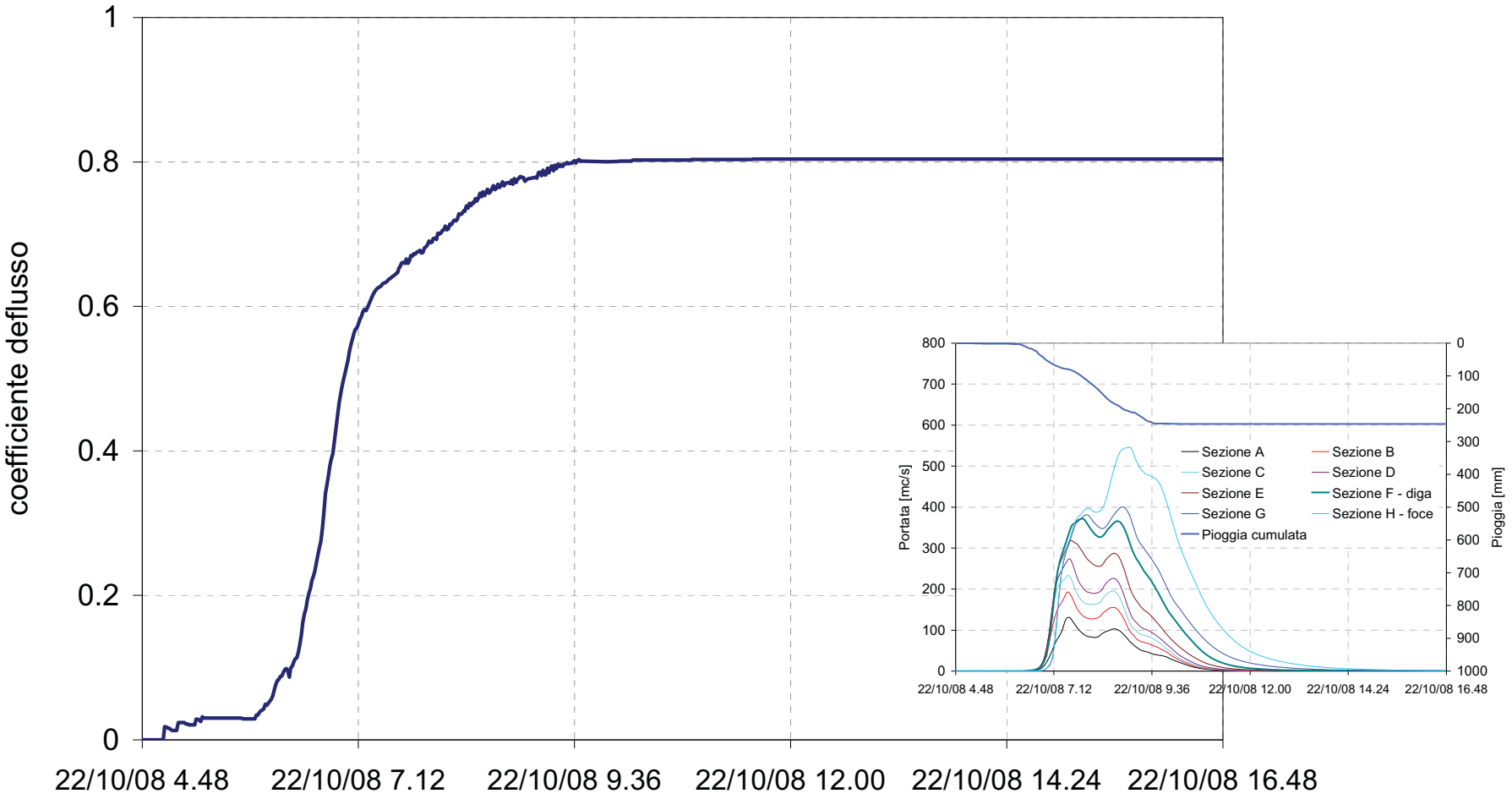


Portata massima sezione Diga = 372 m^3/s alle ore 7:54

Portata massima sezione Foce = 545 m^3/s alle ore 9:03

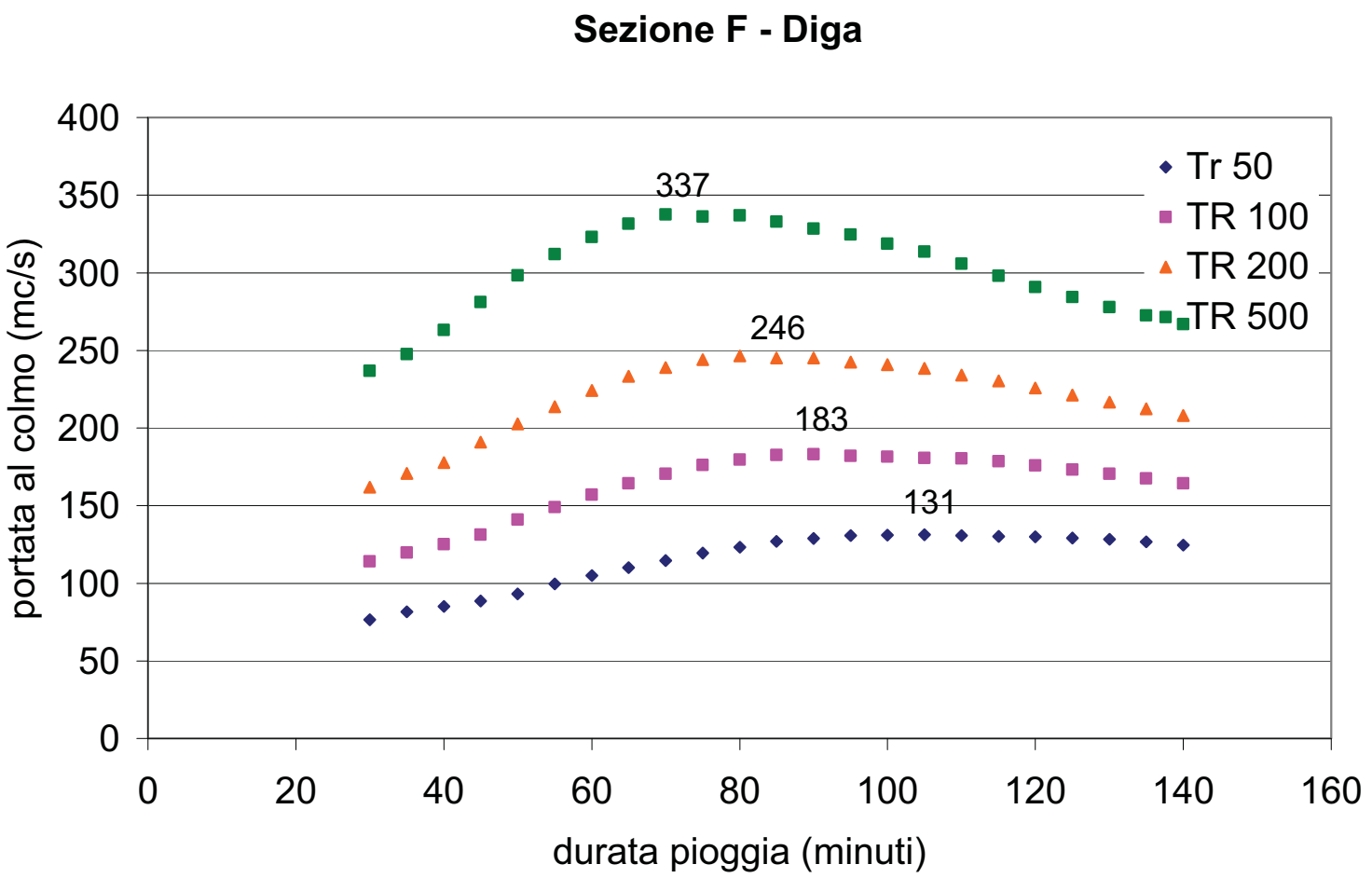
The San Girolamo case study: temporal behavior of coefficient of runoff.

Coefficiente di deflusso dell'evento

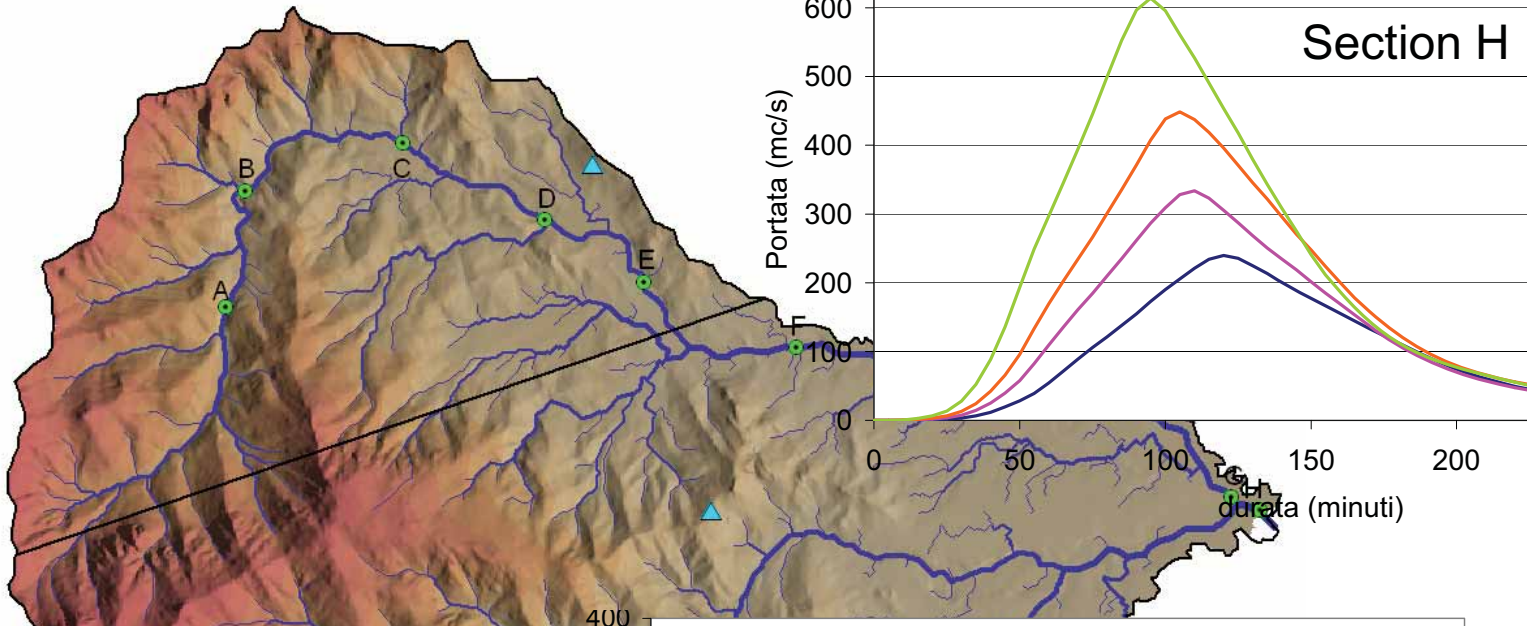


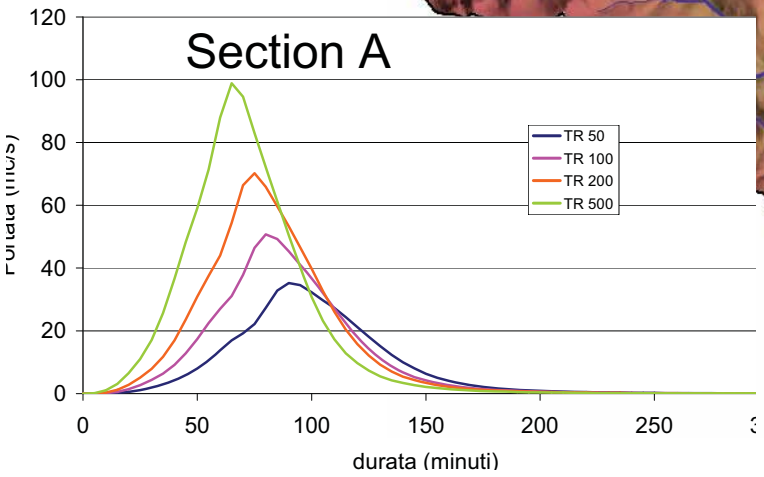
Portata per assegnato tempo di ritorno: evento critico

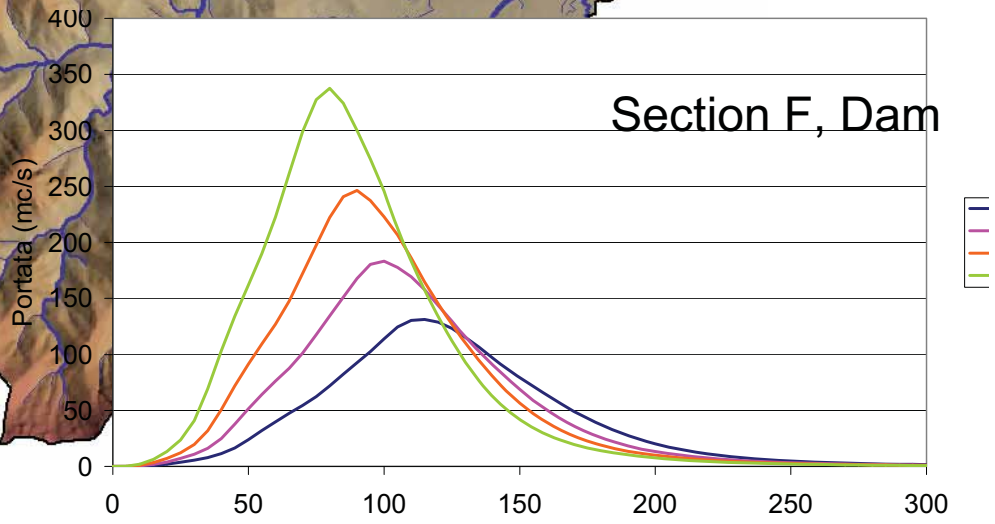
LSPP aggiornate



The S. Girolamo case study: simulated design hydrographs



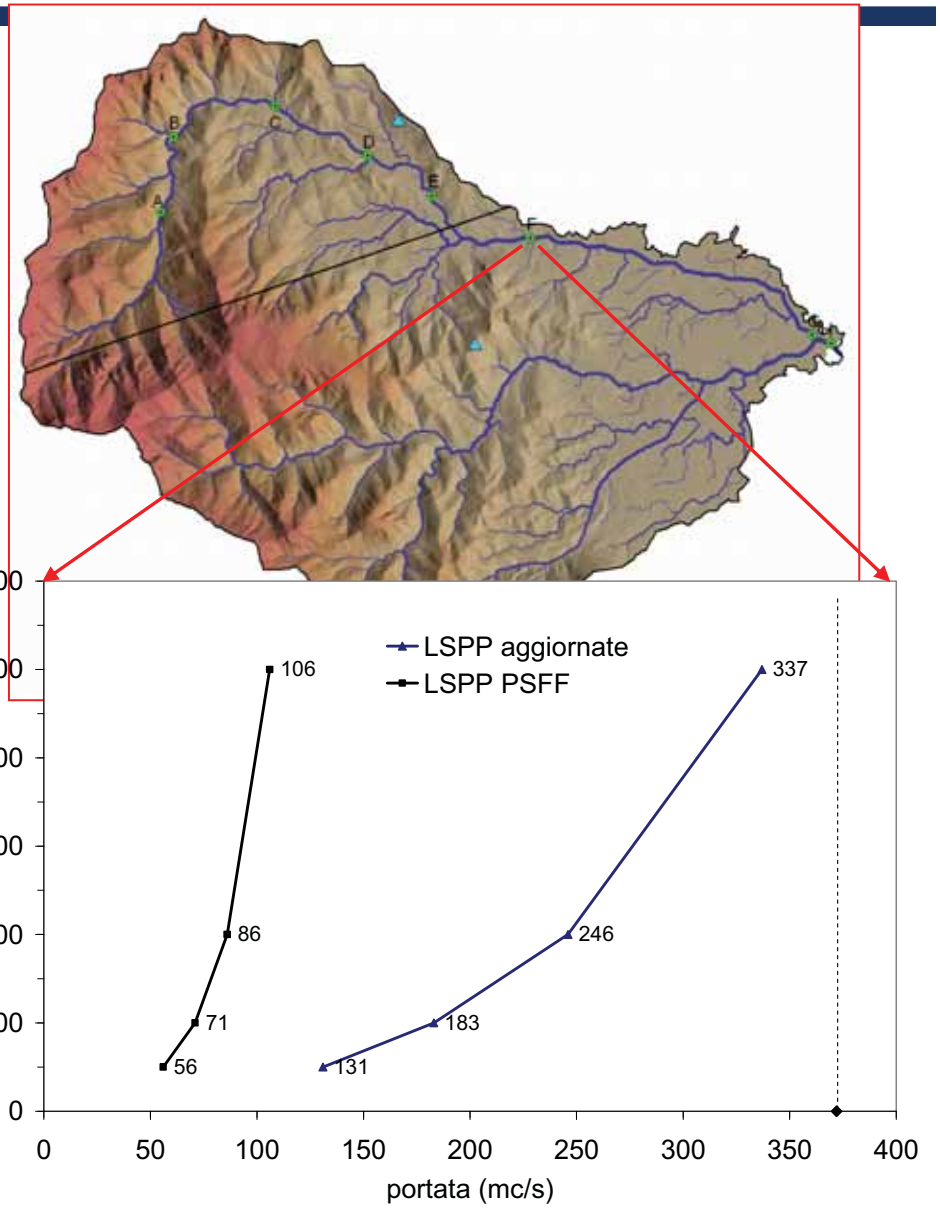




Effect of Capoterra rainfall station on IDF and peak discharge estimation

Sezione	Area kmq	TR 50	TR 100	TR 200	TR 500
A	3.2	14	18	22	28
B	4.6	21	28	34	42
C	5.7	27	34	42	53
D	6.8	31	39	48	61
E	8.5	38	48	58	73
F	**12.3**	**57**	**71**	**86**	**106**
G	15.1	65	81	98	122
H	27.8	104	130	157	194

Sezione	Area kmq	TR 50	TR 100	TR 200	TR 500
A	3.2	35	51	70	99
B	4.6	53	75	103	143
C	5.7	65	93	126	175
D	**6.8**	**76**	**107**	**146**	**201**
E	8.5	90	128	173	239
F	**12.3**	**131**	**183**	**246**	**337**
G	15.1	150	208	278	381
H	**27.8**	**240**	**334**	**449**	**614**



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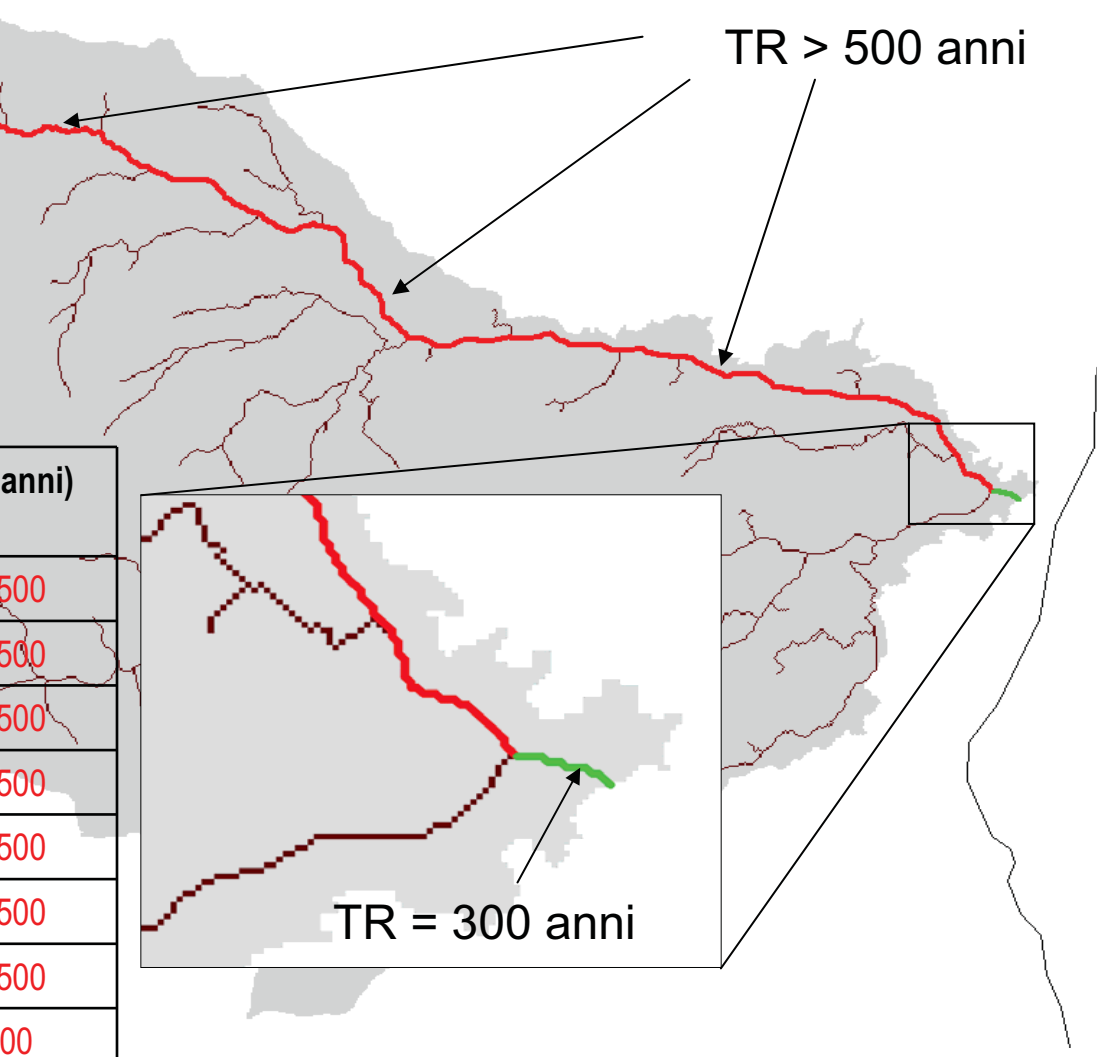
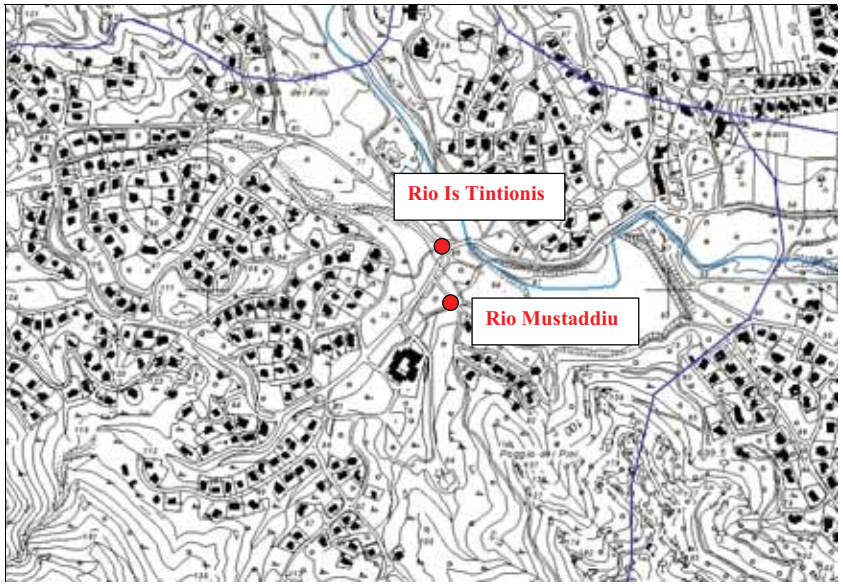
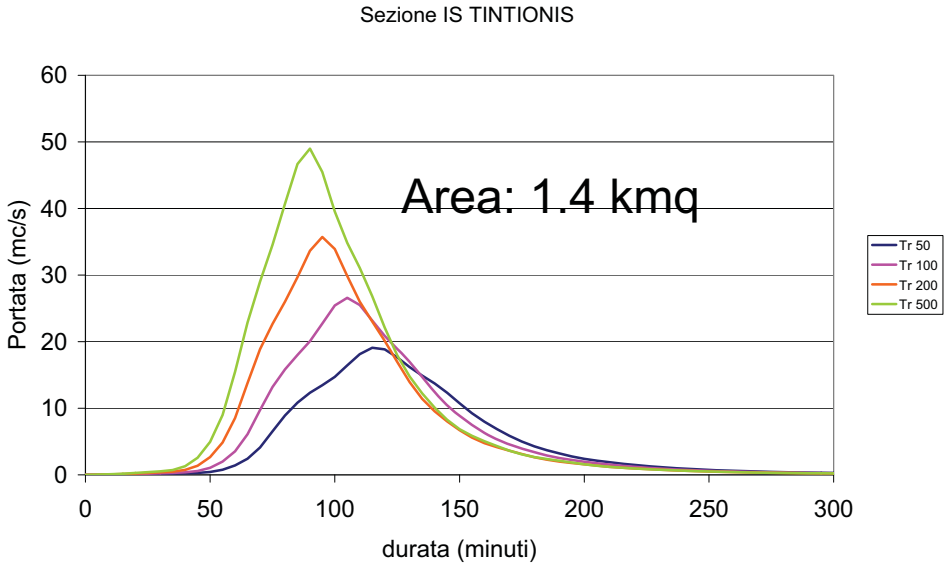
Event return period of peak discarge along the river network

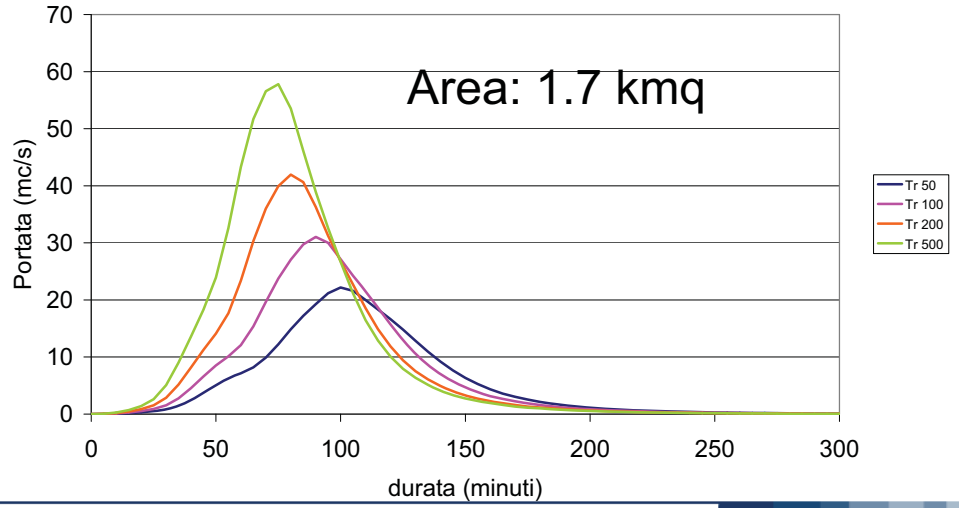
Sezione	Area kmq	Qmax (mc/s)	TR (anni)
A	3.2	131	> 500
B	4.6	193	> 500
C	5.7	234	> 500
D	6.8	274	> 500
E	8.5	319	> 500
F	12.3	372	> 500
G	15.1	400	> 500
H	27.8	546	300



Idrogrammi di progetto dei rii minori







Structural defense works: SOLUZIONE 1 : risagomatura con difesa della golena

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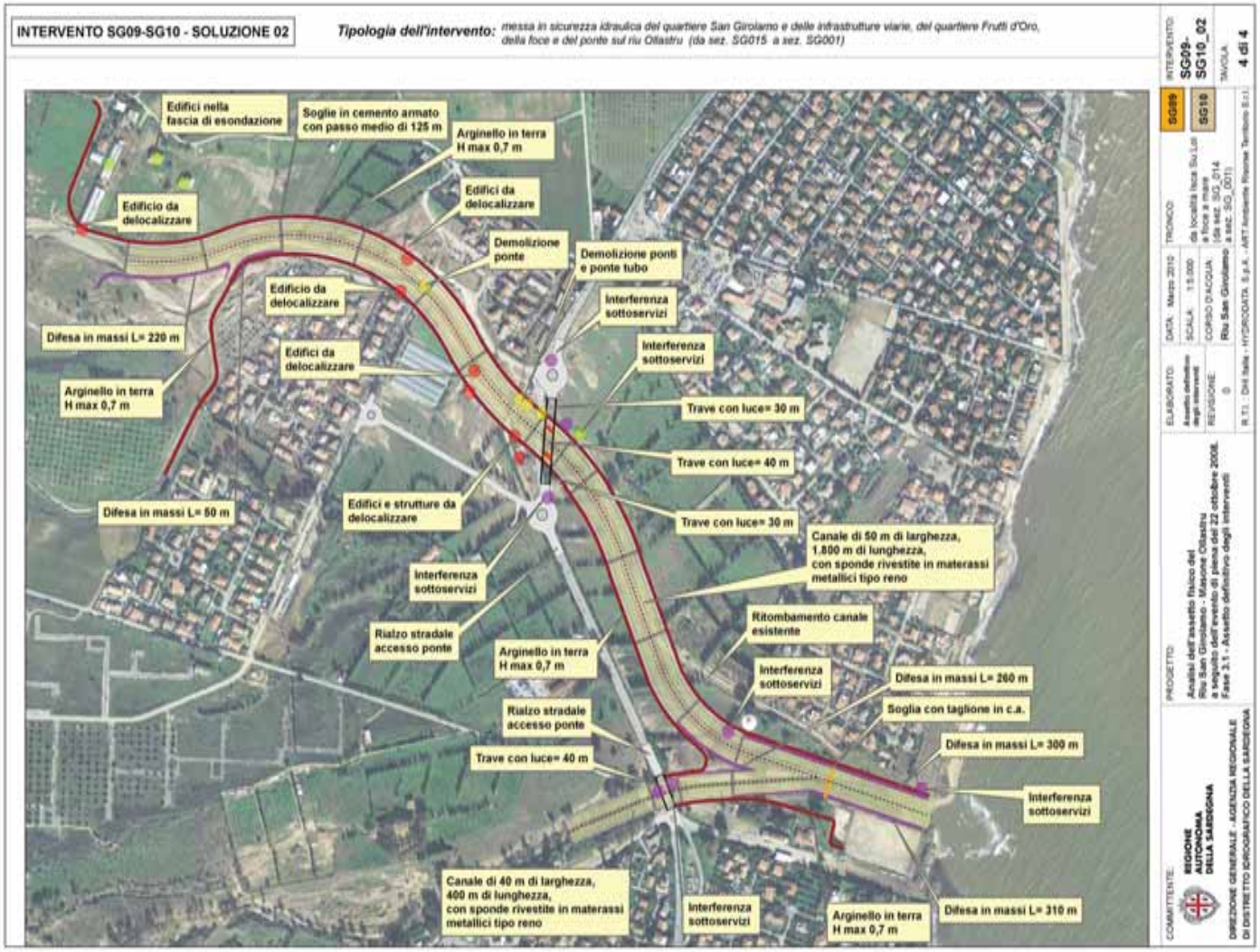
POLITECNICO DI MILANO

Design of Structural defense SOLUZIONE 2: Canalizzazione



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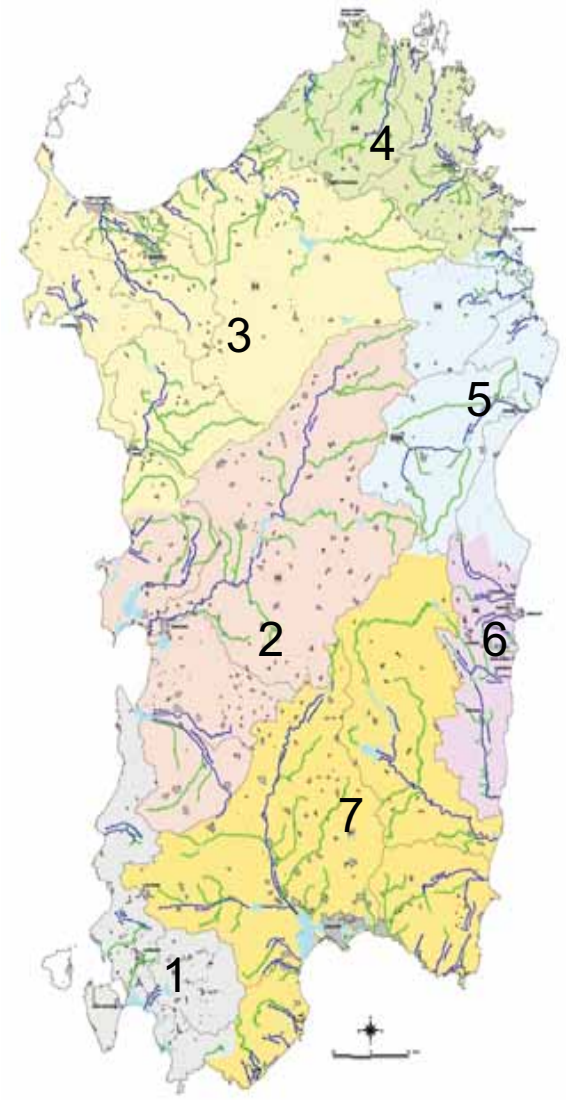
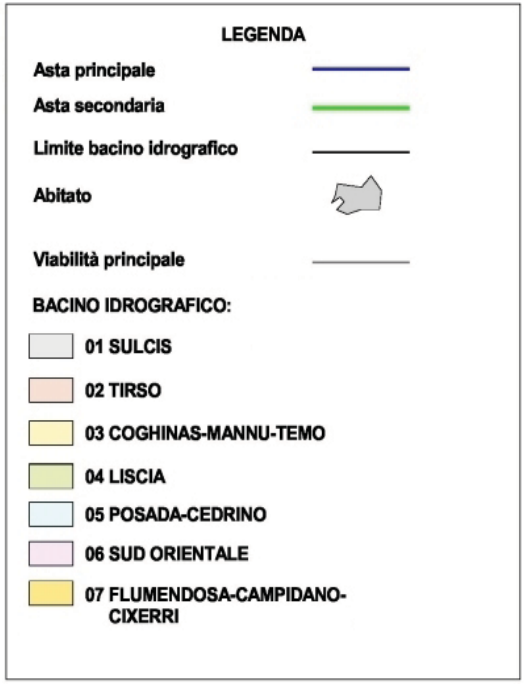
Design of Structural defense SOLUZIONE 3: Canalizzazione con difesa della golena

What Sardinia has done: Sistematic mapping of river hazard areas (PSFF)



Piano Stralcio Fasce Fluviali (PSFF)

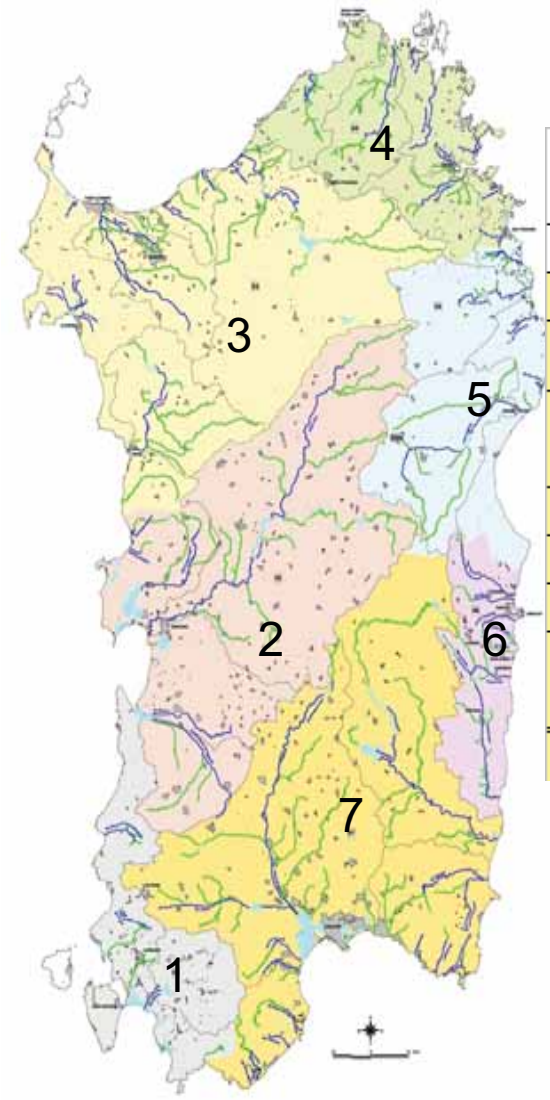


7 SUB BACINI IDROGRAFICI

58 CORSI D'ACQUA PRINCIPALI (1.120 Km di tratti fasciati)

226 CORSI D'ACQUA SECONDARI (2.030 Km di tratti fasciati)

What Sardinia has done: Sistematic mapping of river hazard areas (PSFF)



Piano Stralcio Fasce Fluviali (PSFF)

LEGENDA	FASCE FLUVIALI				
Macrobacino	Fascia A_2	Fascia A_50	Fascia B_100	Fascia B_200	Fascia C
	[ha]	[ha]	[ha]	[ha]	[ha]
1 Sulcis	122	440	716	169	560
2- Tirso	3418	15042	684	513	3002
3 Coghinas-Mannu di Porto Torres-Temo	1164	3252	389	371	186
4 Liscia	1018	1346	79	683	1459
5-Posada -Cedrino	972	2350	573	749	538
6- Sud orientale	832	1978	270	912	2695
7 Flumendosa-Campidano-Cixerri	7162	7476	2145	3270	39367
TOTAL	14687	31884	4856	6667	47808

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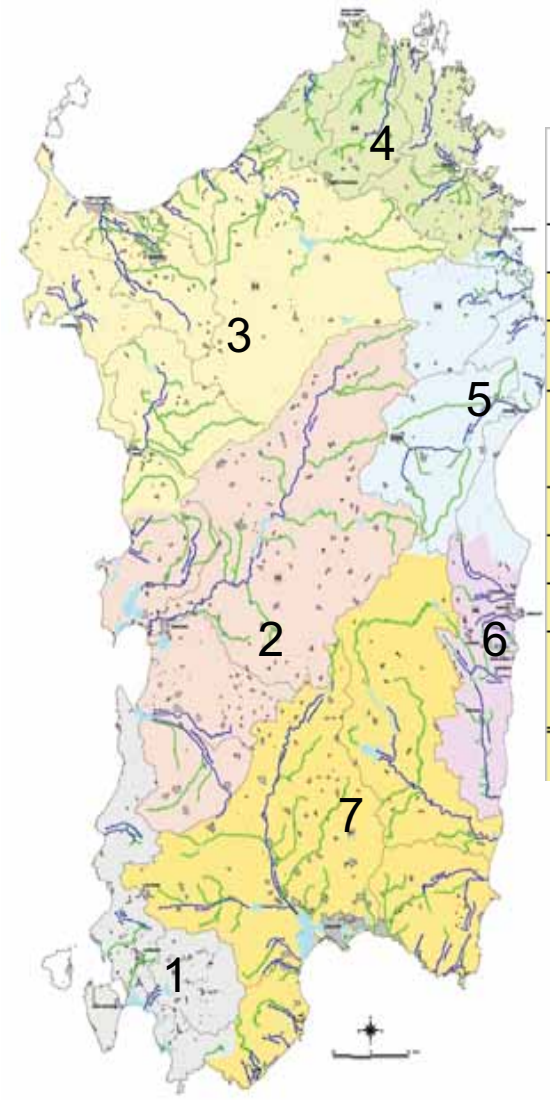

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7 Flum					39367
TOTAL					47808

PONTI ANALIZZATI	PONTI INADEGUATI PER PROFILO TR50 (FRANCO<1m)
407	266

7 S

58 (

226 CORSI D'ACQUA SECONDARI (2.030 Km di tratti fasciati)

Criteria used to asses the Piano Stralcio Fasce Fluviali (PSFF)

General

Flood hazard inundated area are: defined according to technical regulation of PAI and EU flood directive. GIS based, reproducible & updatable tool.

Basin Hydrology

- Peak discharge estimation with regional analysis either direct or indirect methods;
- Peak discharge computed at river cross sections with drainage area increment < 15%
- Peak discharge attenuation down stream reservoirs using reservoire routing

Fluvial Hydraulic

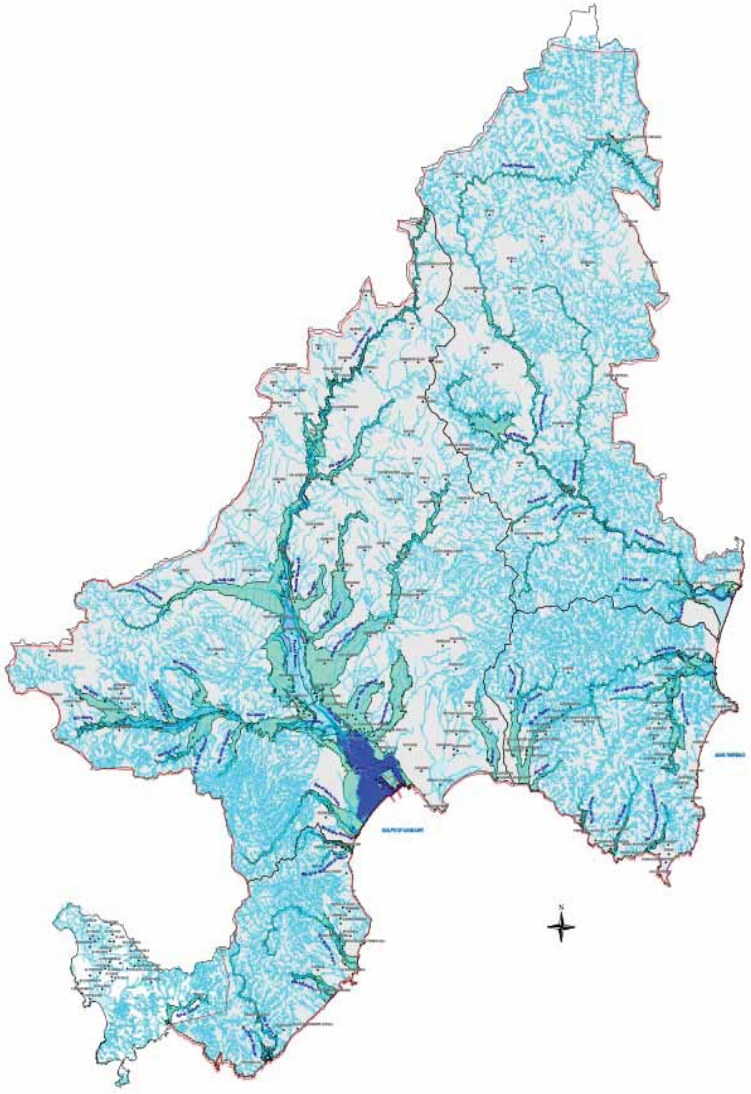
- Steady state analysis
- One-dimensional routing for extended river cross sections;
- Roughness coefficient computed according to flexible and rigid fluvial vegetation in a ordinary maintenance condition
- Stream Velocity profile in each section for each Discharge return period

Mapping criteria:

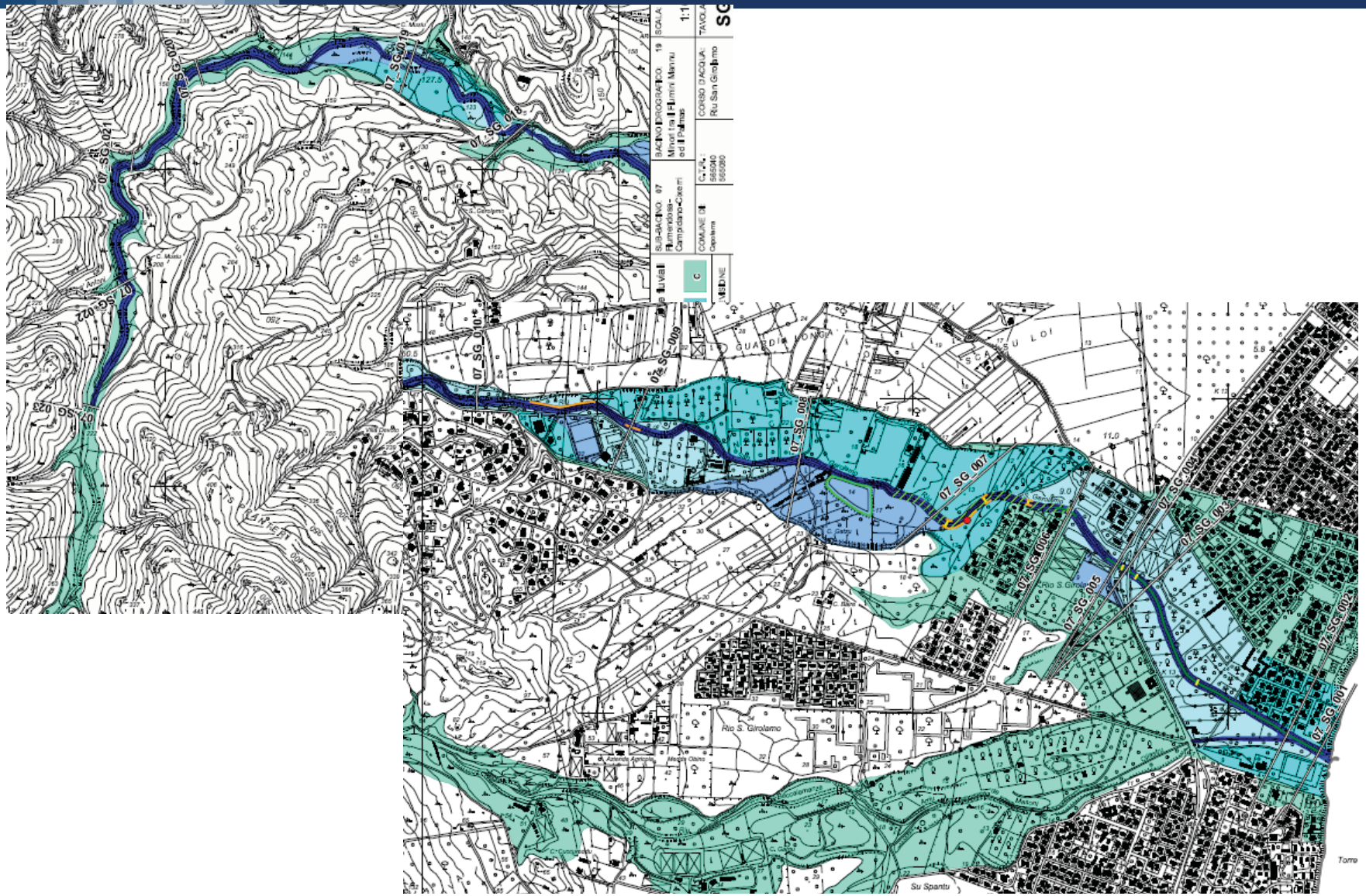
- Hydraulic Level extension
- Geomorphologic analysis for return period discharge >T 200 years

Example of: Piano Stralcio Fasce Fluviali (PSFF)

07 FLUMENDOSA-CAMPIDANO-CIXERRI

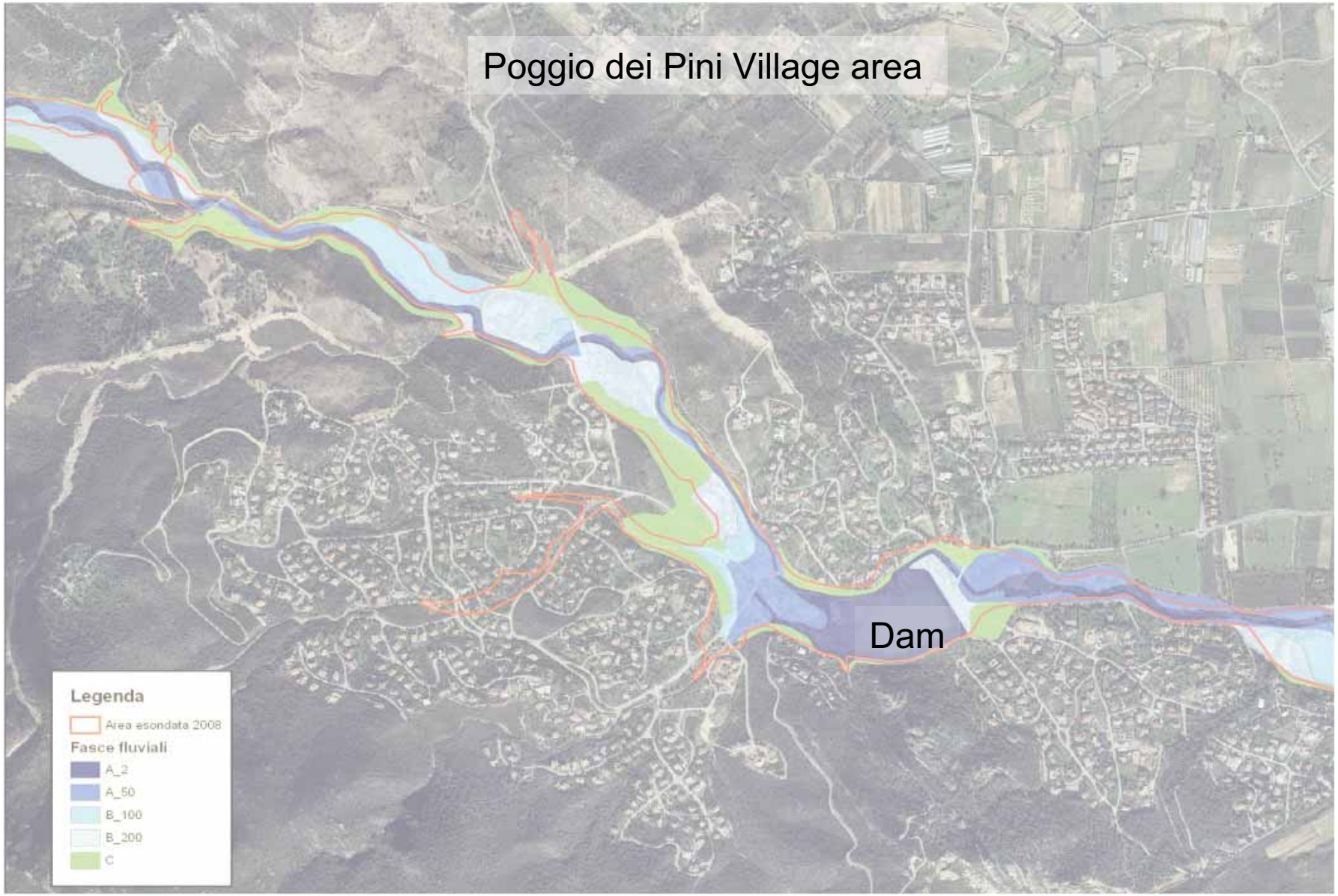


PSFF Hazard areas for the San Girolamo Creek before the 2009 flood event



Criteri PSFF : The role of the geomorphologic behavior events T>200 anni rografico

Comparison between flood traces and fluvial hazard areas



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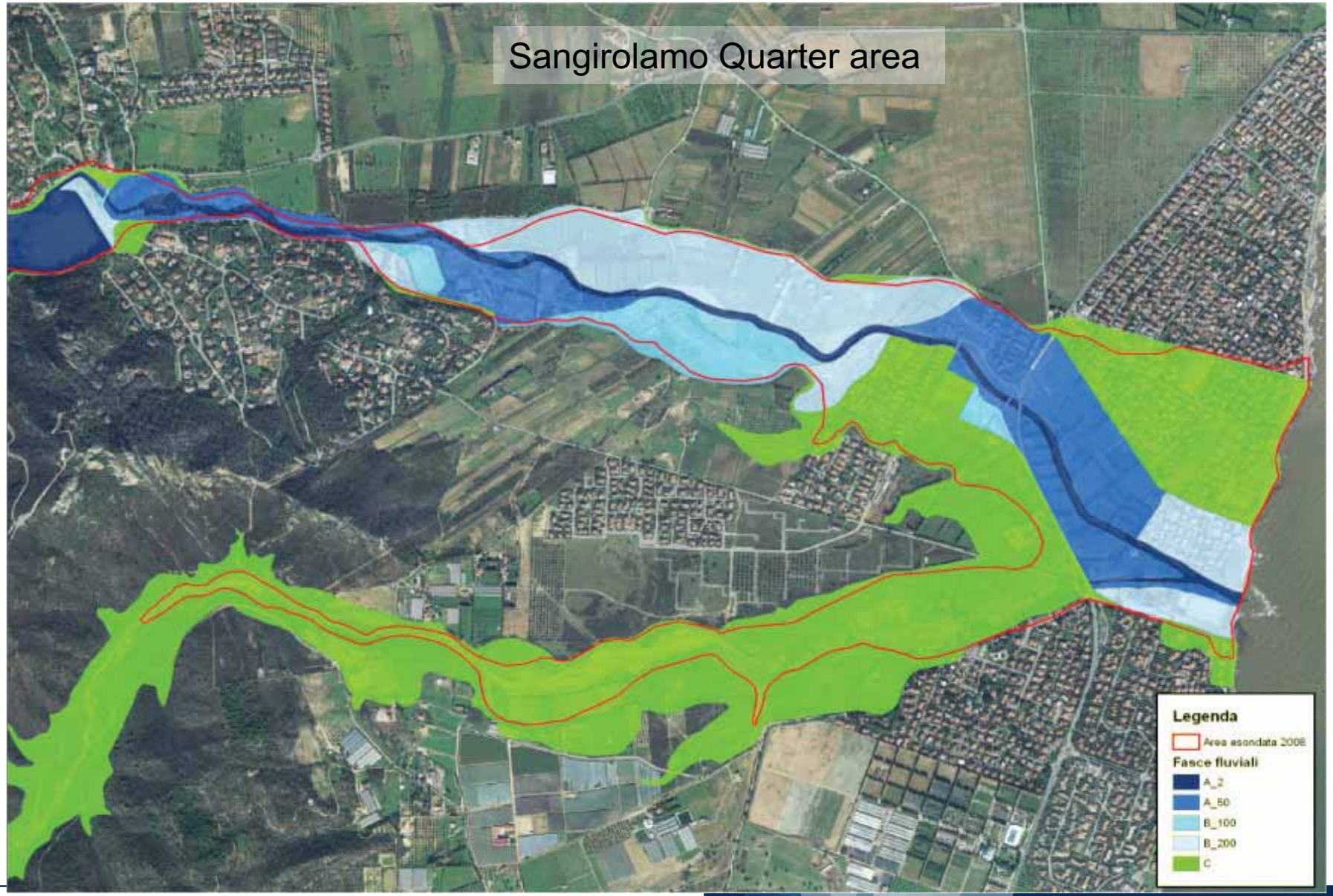
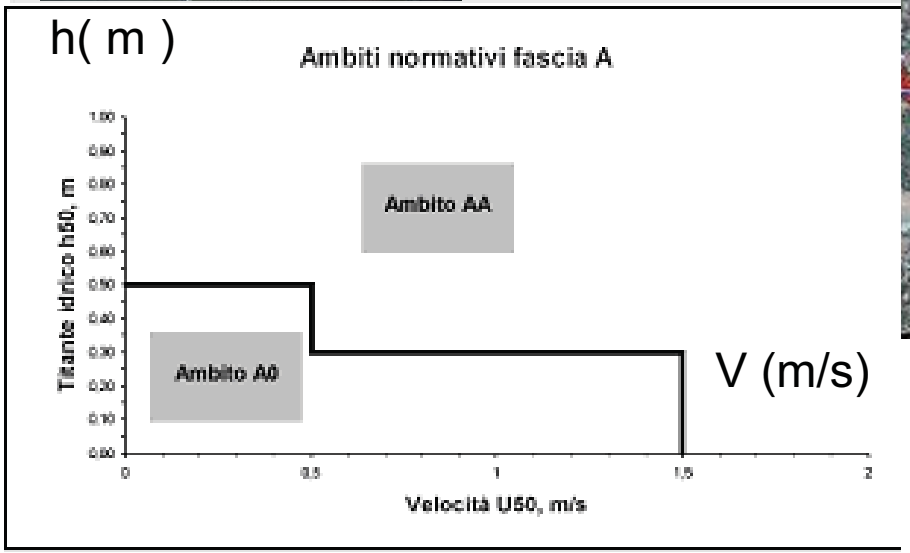


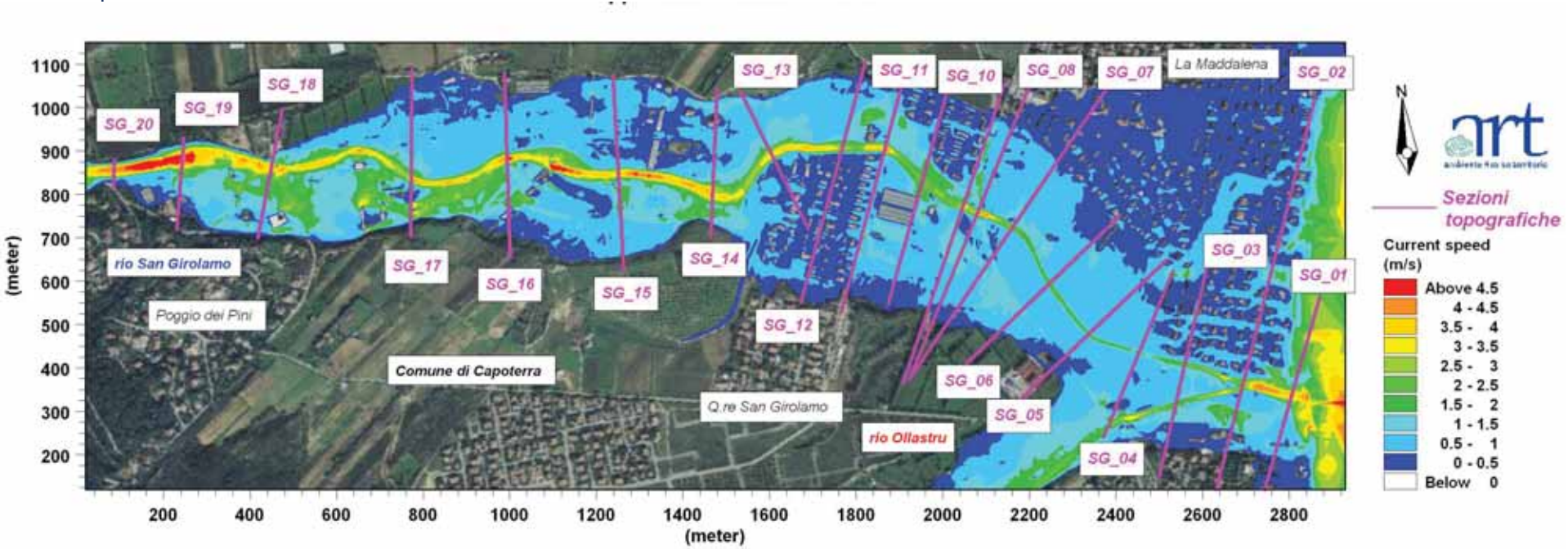
Hazard from combined hydrology and hydraulics of flood plain

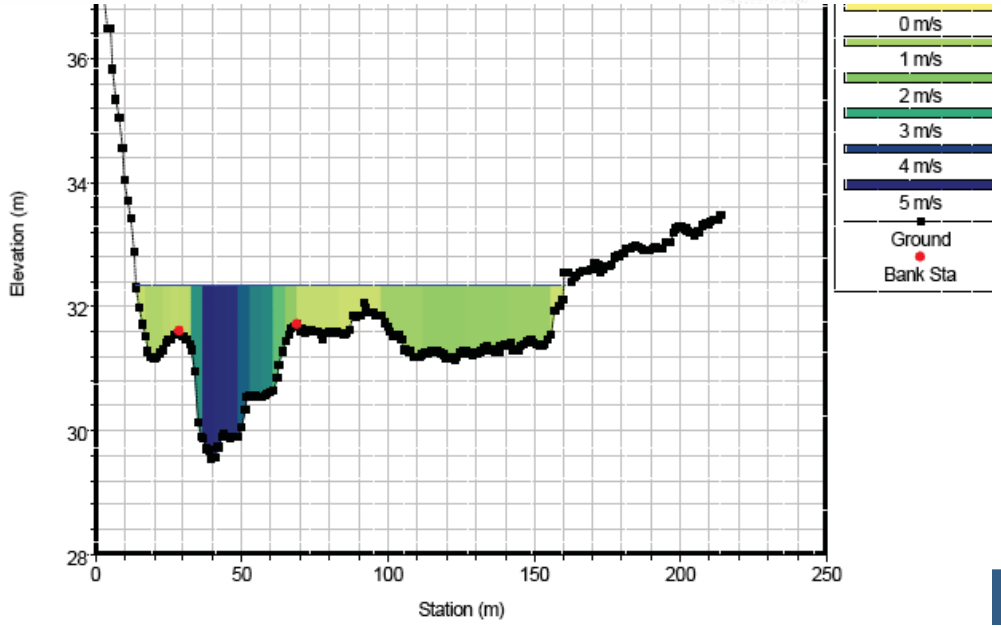
The role of steam velocity in defining hazard area



A case study for the Liguria River Basin Authority
Ravazzani & Mancini, Urban Water 2009

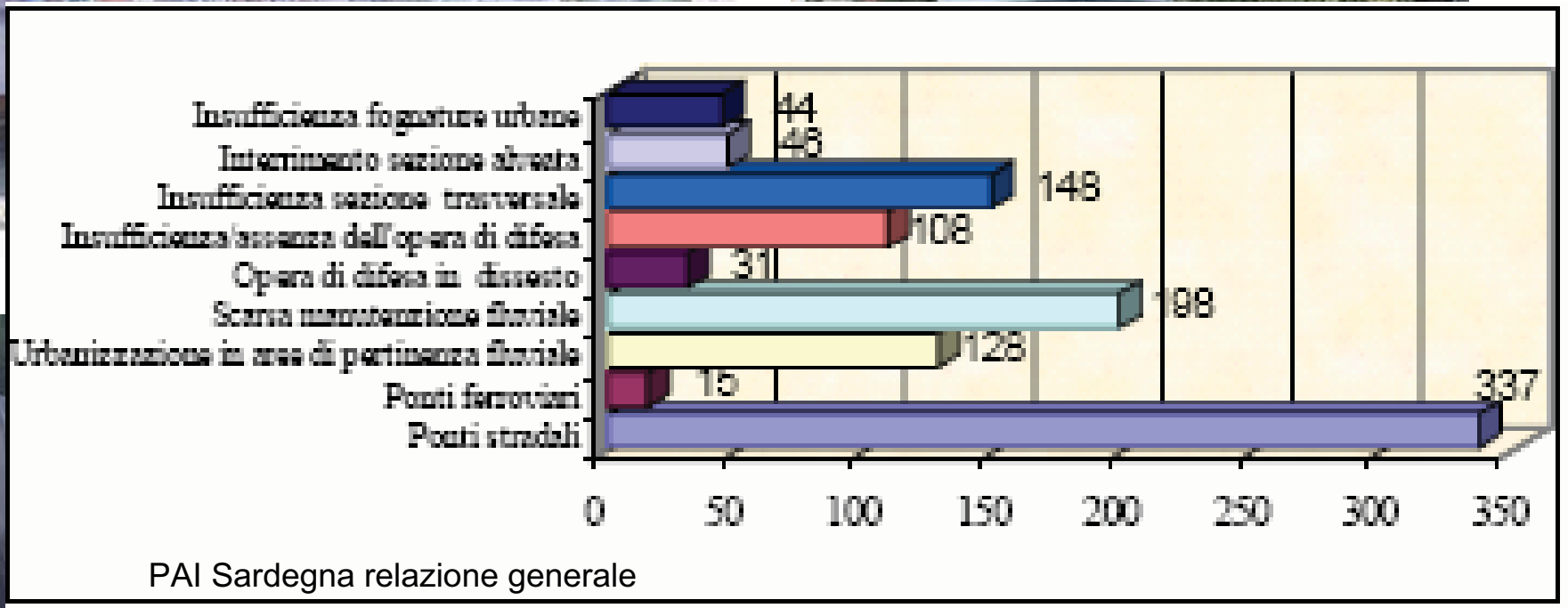
The role of the velocity: Steady State or unsteady state analysis





Low perception of river presence

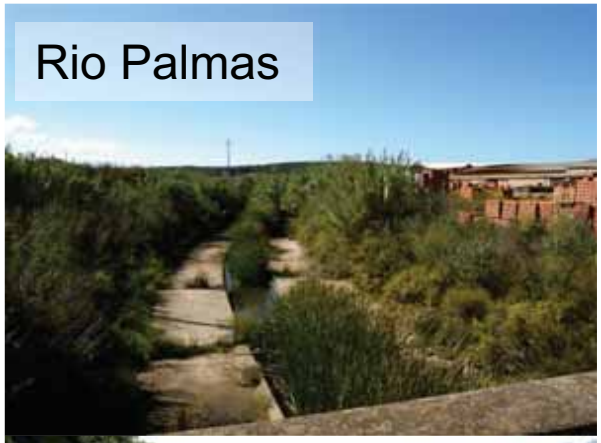
Principali cause d'insufficienza idraulica: il Caso di studio della Sardegna



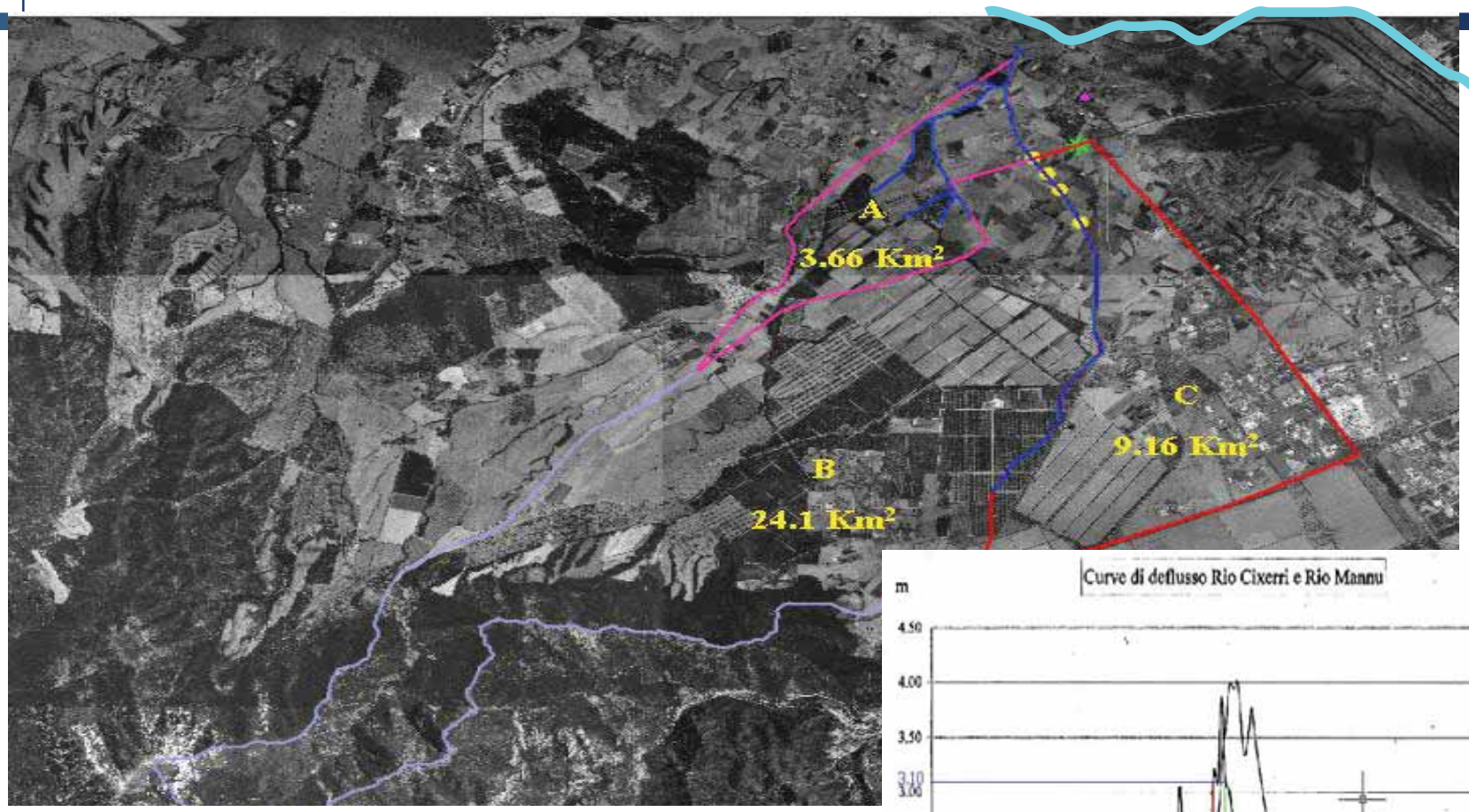
PAI Sardegna relazione generale

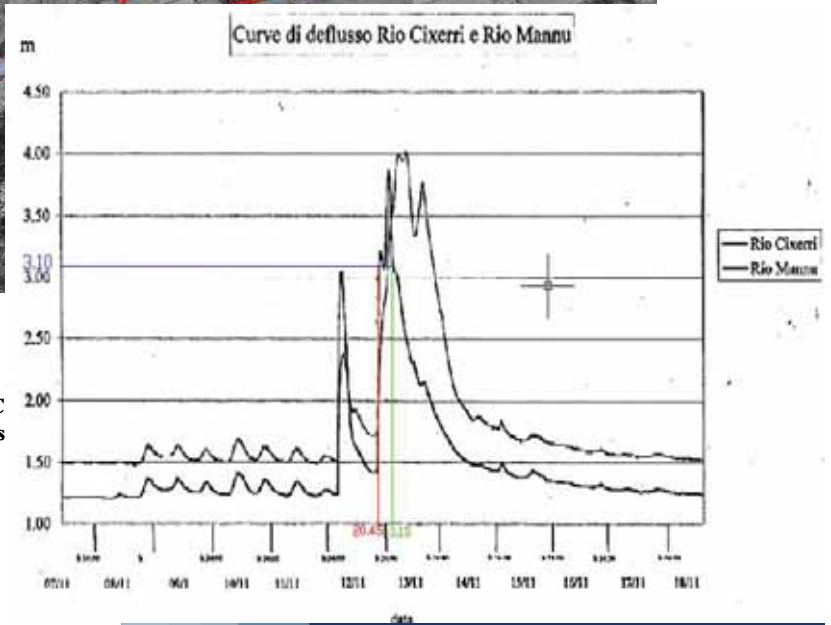
Figura 1. Principali cause di insufficienza idraulica nel Bacino Unico

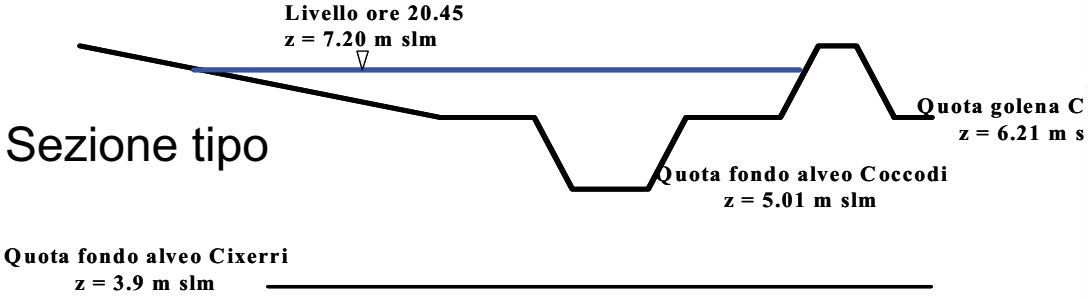
Vegetation and maintenance of river cross sections



Effetto di rilevati stradali sulla pericolosità delle aree di esondazione







Sezione tipo

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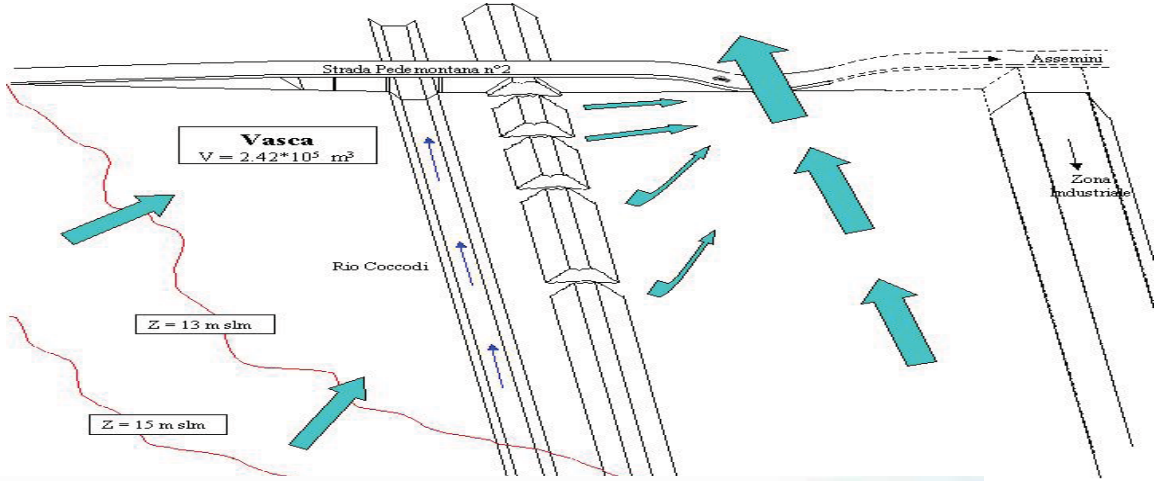
Il reticolo artificiale e rilevati stradali durante eventi alluvionali



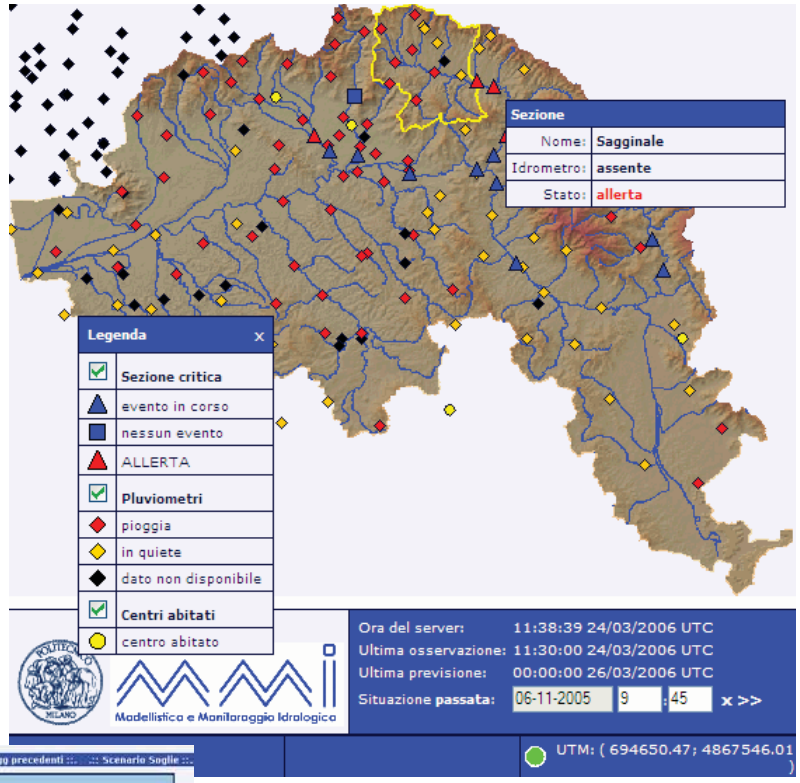
What Sardinia should do

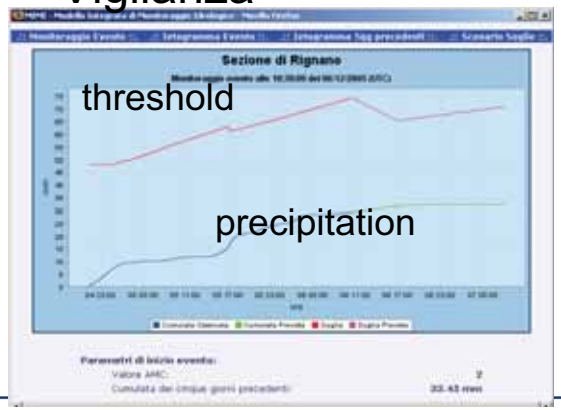
Hazard Mitigation measures: Operative Real time warning system on rainfall thresholds

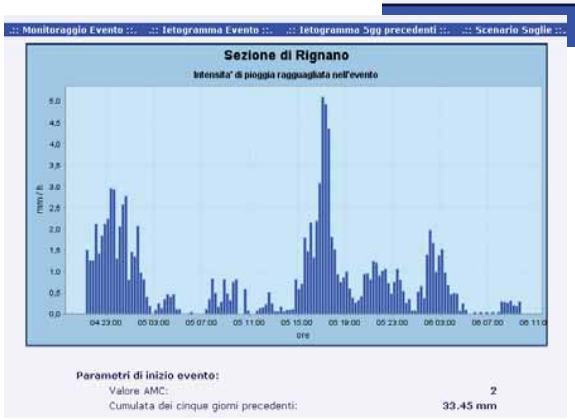
Centro Funzionale Regione Toscana

15 critical cross sections

Sinergia tra soglie pluviometriche e soglie di Vigilanza

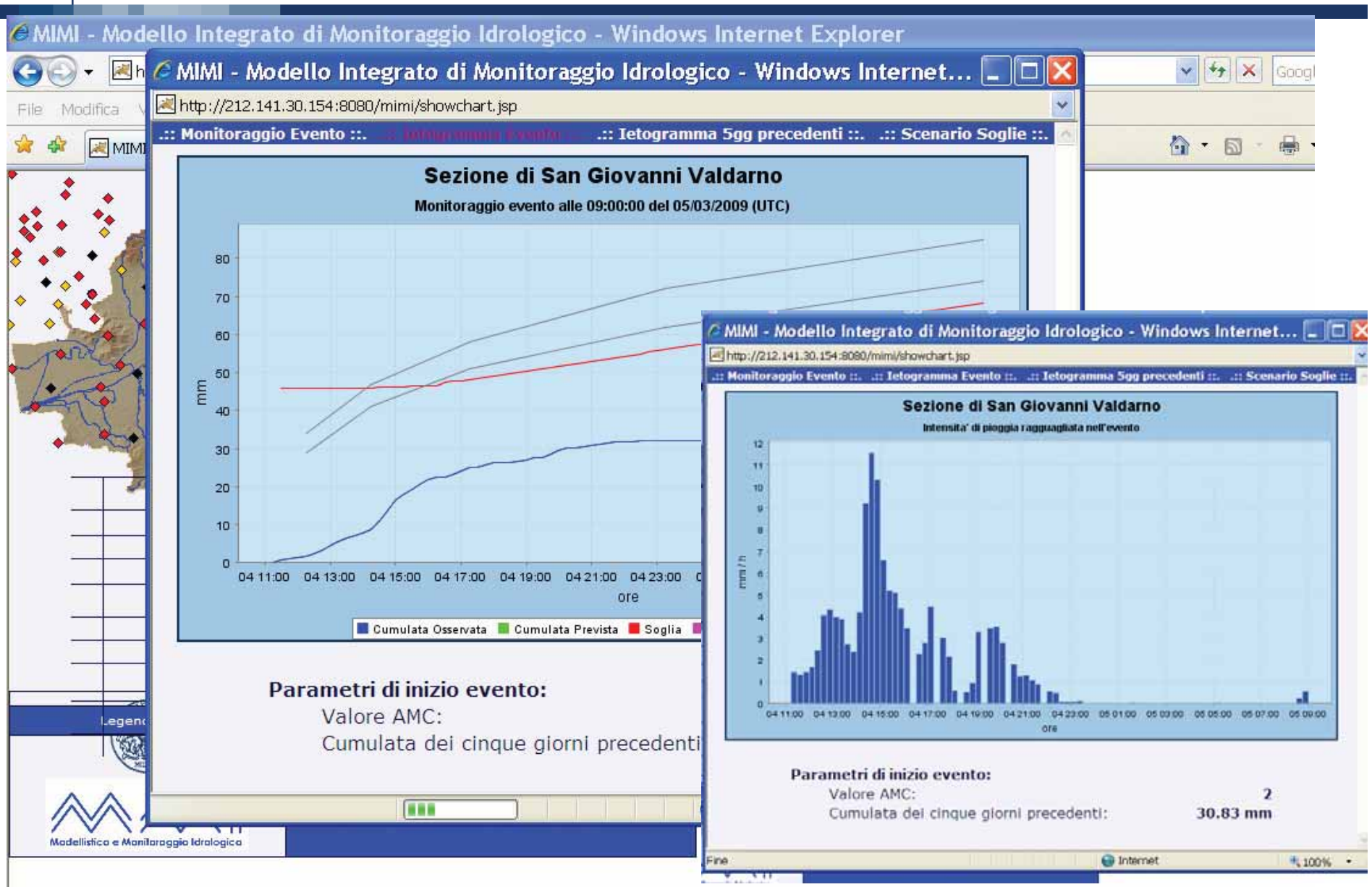






M.I.M.I.
Modello Integrato Meteo Idrologico

What Sardinia should do



Monitoraggio Fiume Arno: Evento 6 Marzo 09

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Conclusion: Why Sardinia?.....

Sardinia is a very peculiar example for flash flood events.

The hazard mapping implemented by Regione Sardinia is consistent with the EU Flood Directive , not only for the technical methodology, but also for the participation procedure (EU Directive) for flood Risk Mitigation works;

A need for:

a) increase people sensibility to cope with flood;
b)more attention to hydrologic analysis for hydraulic design;
c)manutention of river reaches;
d)robust flood forecast system based,

Sardinia has places that can be terrible during a flash flood, but terrific during the no rainfall period !!!!

Evento 22 ottobre 2008: modello 2D