FLASH FLOODS AND PLUVIAL FLOODING

ISPRA

REGIONE AUTONOMA DELLA SARDEGNA

MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE

Working Group F Thematic Workshop

EUROPEAN DIRECTIVE "FLOODS" 2007/60/EC AND RIVER BASIN PLANNING

Ing. Giorgio Cesari
General Secretary of Tevere river basin Authority

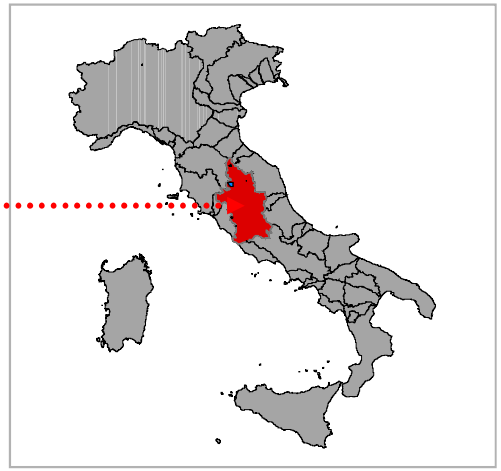
26th-28th May 2010, Cagliari, Italy

TEVERE RIVER BASIN IN THE NATIONAL CONTEXT

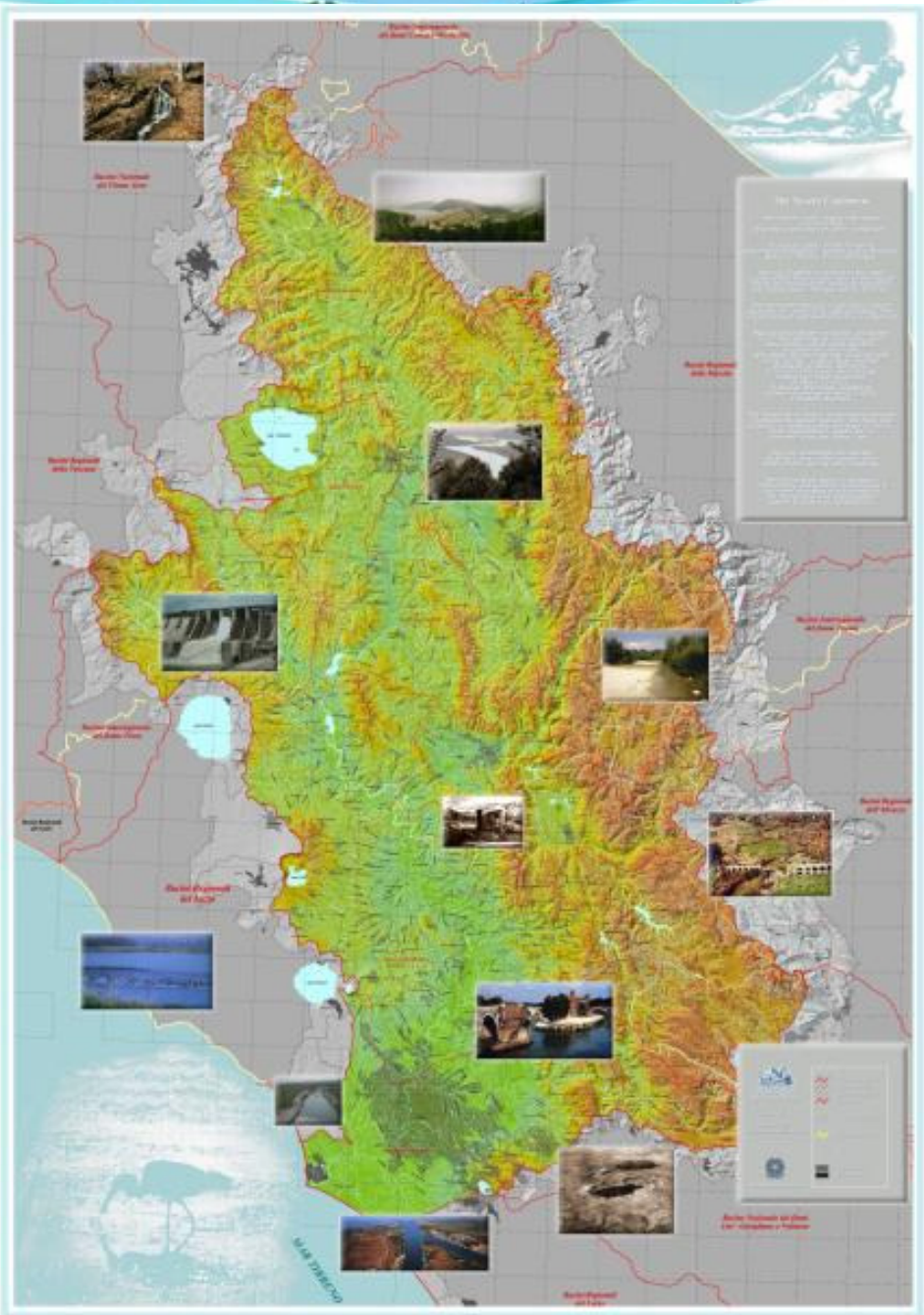
Working Group F Thematic Workshop

FLASH FLOODS AND PLUVIAL FLOODING

National River Basin Authorities



Tevere River Basin Authority



TEVERE RIVER BASIN: PHISICAL AND ADMINISTRATIVE FRAMEWORK

TEVERE RIVER BASIN:

6 Regions 14 Provinces e 357 Municipalities

Involved population :

4.344.197 inhabitants

Total surface of the river basin:

Kmq 17.375

Floodplain and river delta:

15% of the territory

Hill and mountain areas:

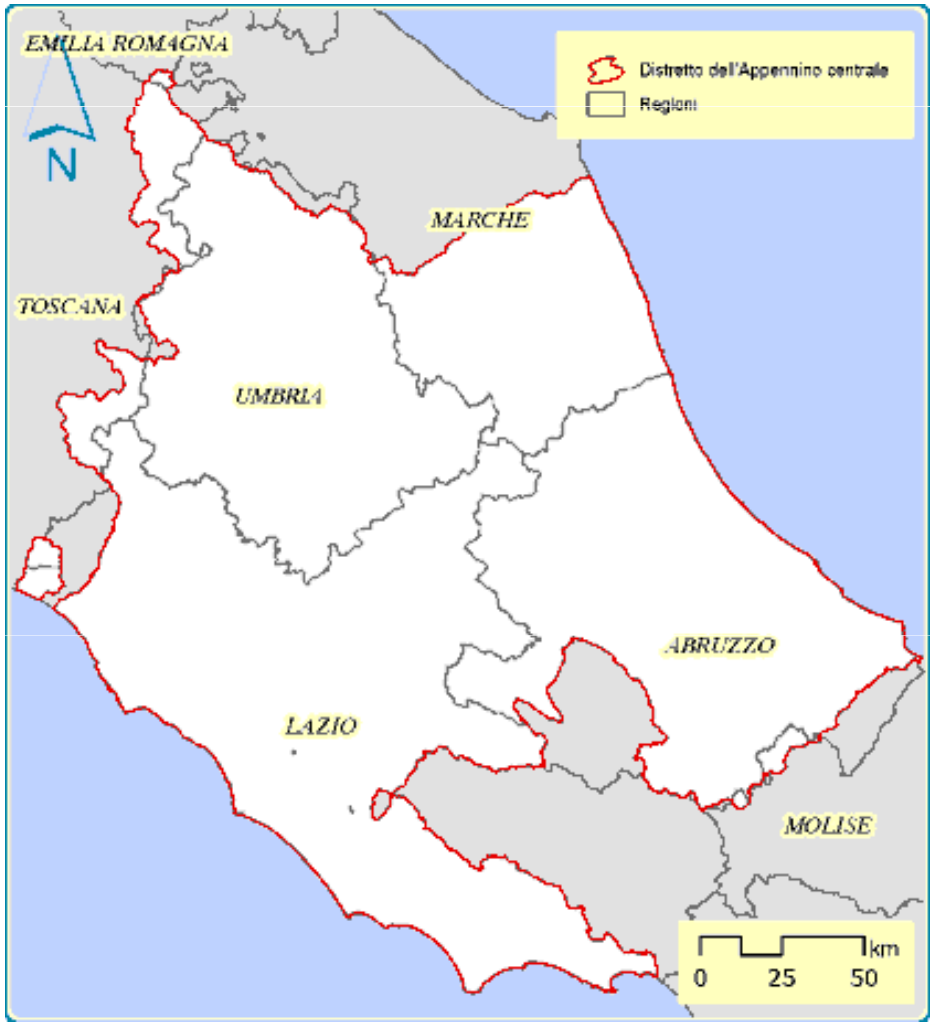
85% of the territory

Population living in main cities:

90%

Working Group F Thematic Workshop

FLASH FLOODS AND PLUVIAL FLOODING



Central Appennines District Authority (DLgs 152/2006)
RBMP (Directive 2000/60/EC)

SURFACE: about **35.800 kmq** (including the following river basins):

1 – **Tevere** - national basin

2 – **Tronto** – inter-regional basin

3 – **Sangro** – inter-regional basin

4 – **River basins in Abruzzo Region**– regional basins

5 – **River basins in Lazio Region** – regional basins

6 – **Potenza, Chienti, Tenna, ecc., Aso, Menocchia, Tesino e smaller basins in Marche Region** – regional basins

PROJECTS AND INTERNATIONAL ACTIVITIES WHERE TEVERE RIVER BASIN AUTHORITY (TRBA) WAS OR IS PRESENT

EUROPEAN COMMON IMPLEMENTATION STRATEGY FOR 2000/60/EC DIRECTIVE
TRBA was involved as a pilot river basin in the testing activity promoted by the European Commission within the Common Implementation Strategy (CIS) for the implementation of the Water Framework Directive 2000/60/EC. The outcome of the Directive implementation was "The Article 5 Report"

EXCIMAP European exchange circle on flood mapping
The Tevere river basin Authority - was one of the member of circle representing Italy in the exchange circle on flood mapping. The aim of the circle is to gather all existing experience and know – how in Europe and to improve flood mapping practices. The work of Excimap started before the "Directive on the assessment and management of flood risks" 2007/60/EC endorsement (18 september 2007).
As a practical outcome Excimap established a guide called "Handbook on good practices for flood mapping in Europe" and an "Atlas of Flood maps". These documents were endorsed by the Water Directors of the European Union in 11/2007.

R.I.O.B.- Reseau International des Organismes de Bassin; chaired in 2008 by the Tevere River Basin Authority General Secretary.

IMRA PROJECT –" Integrative flood risk governance approach for improvement of risk awareness and increased public participation" – under 2nd call for research CRUE- ERA net

WORLD WATER ASSESSMENT PROGRAM –" Case Study for the World Water Development Report n. 4 (Managing Water under Risk and Assessment) – (Oct. 2009 – Jan. 2011)

In April 2010 was released legislative Decree february 23, 2010 - No 49 transposing into italian law the Directive 2007/60/EC on the assessment and management of flood risk: the Decree came into force on April 17, 2010

WHAT DOES THE DIRECTIVE PROVIDE?

2011

In the river basin district:
For potential flood risk areas - subset of the river basin district:
Preliminary flood risk assessment

2013

In the potential flood risk areas

Hazard maps: delineating geographic areas affected by possible floods

a) To be given the following probabilities:
- Extreme Events
- Medium probability (Tr> = 100 years)
- High probability (Tr 20-50)

b) The flood event must be characterized by the following festures:
- Flood extent
- Water depth / water level
- Flow velocity

In the potential flood risk areas

Risk maps: showing the potential negative consequences coming from flood hazard maps

a) To be considered the following types of exposed assets:
- Inhabitants potentially affected
- Type of economic activities of the area potentially affected
- Other information eg. Accidental pollution in case of flooding, large amounts of solid materials transported and debris flow

2015

RISK MANAGEMENT PLAN

2010

TANSITIONAL MEASURES
Member states …

Member States may decide not to undertake the preliminary flood risk assessment for those river basins, sub-basins or coastal areas where they have either:
already undertaken a risk assessment to conclude, before 22 December 2010, that a potential significant flood risk exists or might be considered likely to occur leading to the identification of the area among those potentially risk affected (article 5) or decided, before 22 December 2010, to prepare flood hazard maps and flood risk maps and to establish flood risk management plans in accordance with the relevant provisions of this Directive.

Member States may decide to make use of flood hazard maps and flood risk maps finalised before 22 December 2010, if such maps provide a level of information equivalent to the requirements of the directive (article 6)

Member States may decide to make use of flood risk management plans finalised before 22 december 2010, provided the content of these plans is equivalent to the requirements set out in the directive (article 7)

….MEANWHILE ITALIAN RIVER BASIN AUTHORITIES HAVE ALREADY…

REGARDING RISK MANAGEMENT

- ✓ Developed hazard maps
- ✓ Developed risk maps
- ✓ Approved hydrological setting plans
- ✓ Programmed actions for the safety of areas prone to risk

REGARDING THE IMPLEMENTATION OF DIRECTIVE 2007/60 EC

- ✓ Participated in European projects for the implementation of Directive 2007/60/EC on the assessment and management of flood risks

REGARDING RISK MANAGEMENT….

RISK MAPS
INPUT DATA AND RESULT

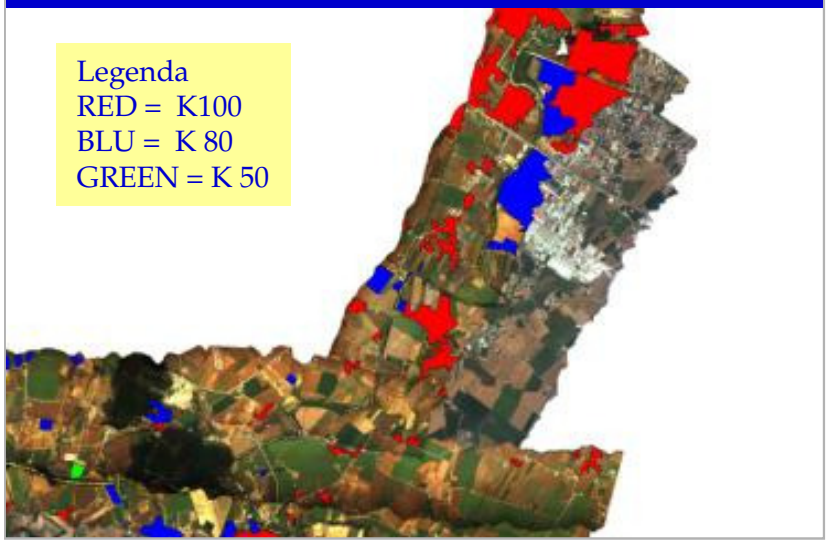
Working Group F Thematic Workshop

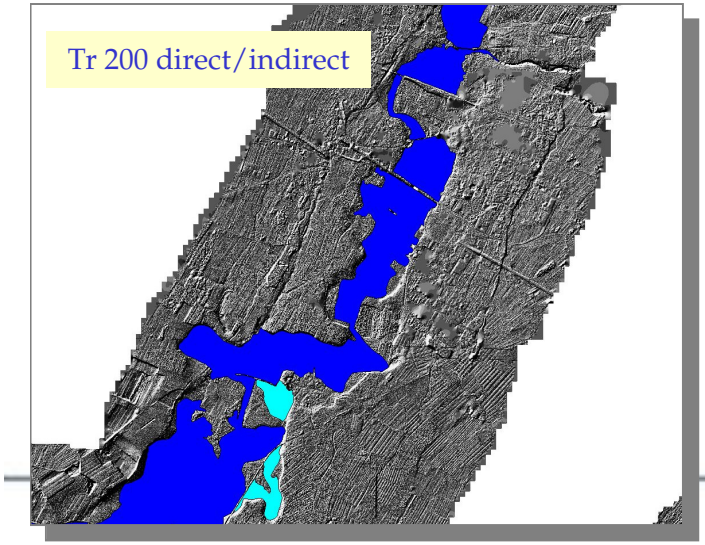
PLUVIAL FLOODING

EXPOSED ASSET	K
Continuous building	100
Discontinuous building	100
Hospitals	100
Schools	100
Military barracks	100
Industrial commercial handicrafts buildings	80
Airports	80
Train stations	80
Deposit and storage areas	80
Civil defence	80
Sports facilities	80
Treatment plants	50
Dumps/landfills	50
Power plants	50

We give a value (k) to all kinds of exposed asset based on the possibility of loss of human lives in relation to the asset's use in case of occurrence of event

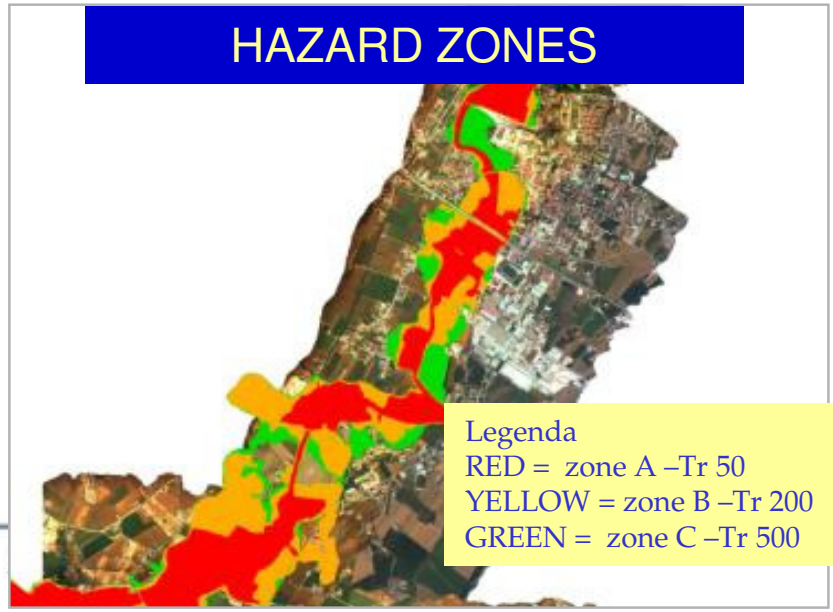
VULNERABILITY OF EXPOSED ASSETS





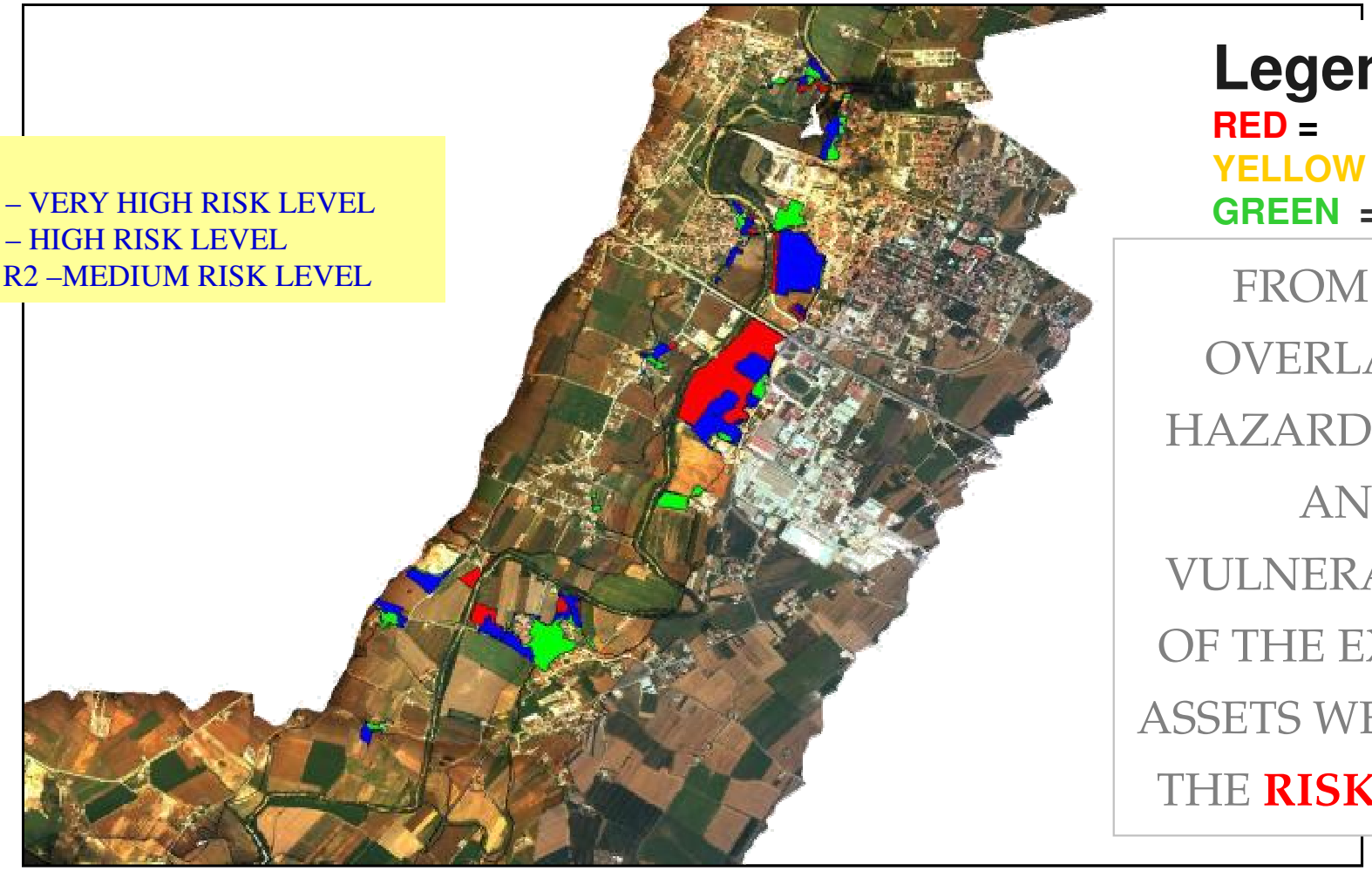
Hydraulic models for simulation of flood extent with different return times provide the hydraulic hazard zones - basis for the identification of risk areas

HAZARD ZONES



FLOOD RISK MAPS: DELIMITATION R4, R3,R2 ZONES

Legenda
RED = R4 – VERY HIGH RISK LEVEL
BLU = R3 – HIGH RISK LEVEL
GREEN = R2 –MEDIUM RISK LEVEL



Legenda
RED = R4
YELLOW = R3
GREEN = R2

FROM THE OVERLAY OF HAZARD ZONES AND VULNERABILITY OF THE EXPOSED ASSETS WE DERIVE THE **RISK AREAS**

REGARDING IMPLEMENTATION OF DIRECTIVE 2007/60/ EC

Progetto IMRA
Improvement **R**isk **A**wareness

Working Group F Thematic Workshop

FLASH FLOODS AND PLUVIAL FLOODING

ISPRA

REGIONE AUTONOMA DELLA SARDEGNA

MINISTERO DELL'AMBIENTE

IMRA

The European Directive 2007/60 EC puts to the center of every initiative of flood risk government the participation of local communities in decision-making.

The Tevere river basin Authority, together with other European partners – thanks to ISPRA funding - is piloting through **IMRA project**, new methods of communication / participation to improve risk awareness

AUTORITA'DI BACINO DEL FIUME TEVERE

T-6

CNR-IRPPS

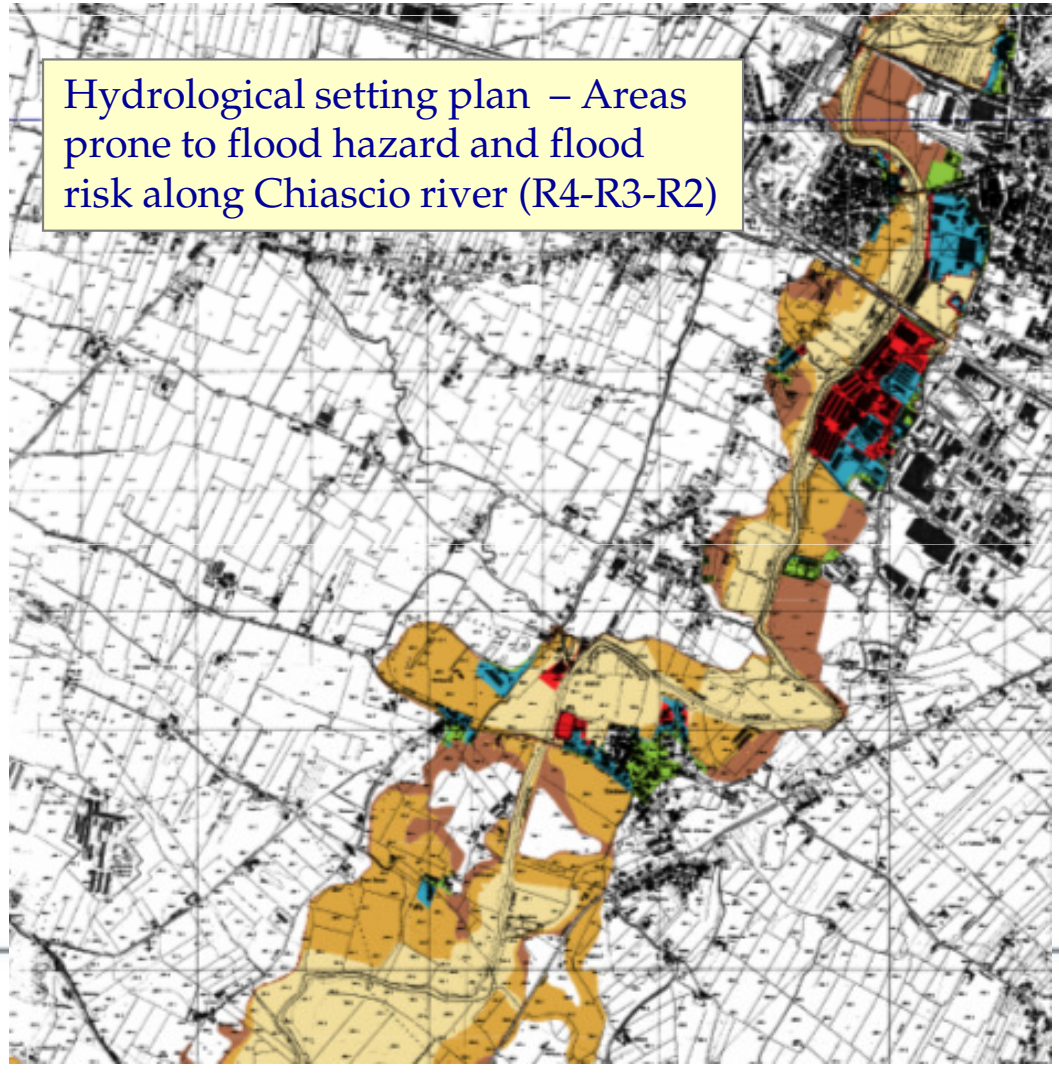
CRUE FLOODING ERA-NET

Integrate, Consolidate and Disseminate
European Flood Risk Management Research

2nd ERA-Net CRUE Funding Initiative for Research in Flood Risk Management

WHY DID WE CHOOSE CHIASCIO RIVER BASIN AS CASE STUDY?

Each project partner experiences the IMRA methodology on a river basin chosen in their country as case study.
The Italian case study is the basin of the Chiascio river, left tributary of the river Tevere



Hydrological setting plan – Areas prone to flood hazard and flood risk along Chiascio river (R4-R3-R2)

- There is considerable interference between the floods areas and land use
- In the basin are present different kinds of land use: industrial areas, areas for agriculture, and urban agglomerates
- The area is characterized by active local communities which are open and available for public participation

MAIN GOALS OF IMRA PROJECT

- ✓Influencing and changing the real decision-making by actively involving institutional stakeholders and the public.

- ✓Testing the concept of governance in different environments.

- ✓Producing examples of good practices that could serve as a reference for other authorities dealing with flood risk management plans in Europe.

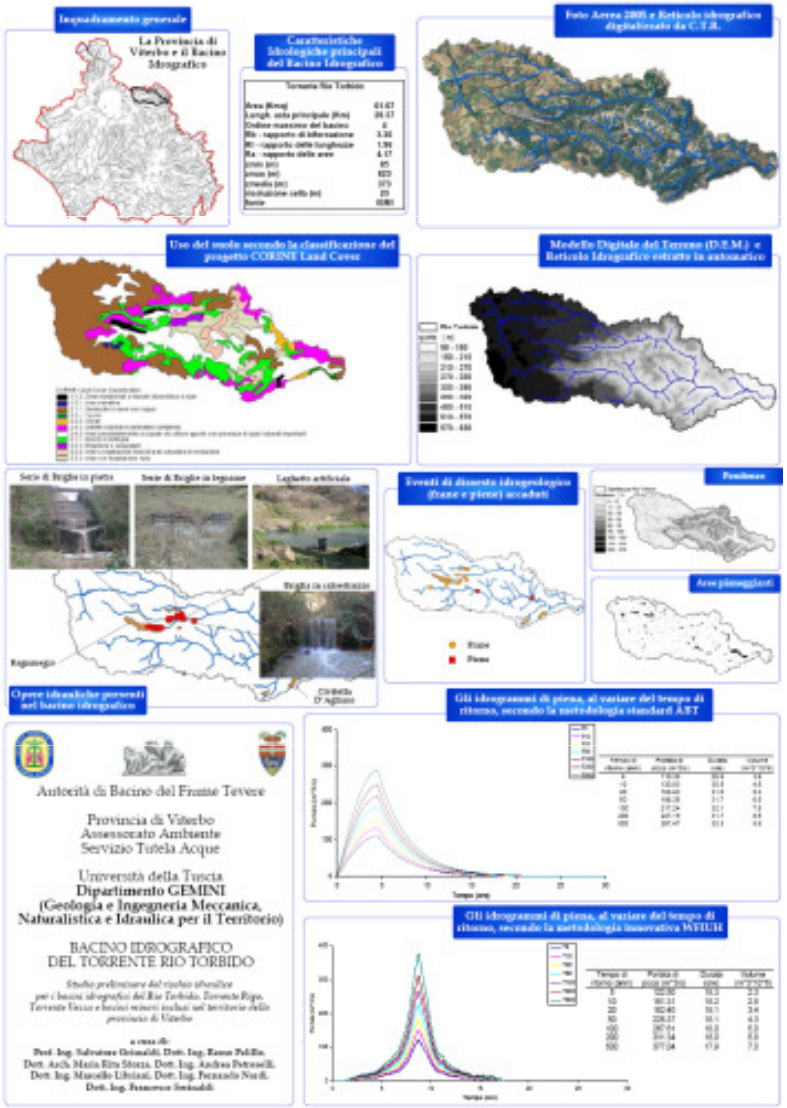
- ✓Making a practical manual that contains the main lessons learned from case studies in IMRA project

ABOUT RISK MAPPING : WORK IN PROGRESS

Agreement between:

- TEVERE RIVER BASIN AUTHORITY
- VITERBO PROVINCE
- UNIVERSITY OF TUSCIA - GEMINI Department - Water Engineering Section :

"the preliminary assessment of flood risk for ungauged catchment areas in the Viterbo province"



AN ALTERNATIVE METHODOLOGY …

- ☺ The hydrological setting plan [AbT, 2002] identifies flood risk areas - for the main hydraulic network – and in some cases, for the secondary one.
- ☹ For the remaining part of the basin there are no appropriate basic information and therefore are proposed simplified procedures for the assessment of the situation for preliminary characterization of hydraulic risk .
- ☺ New technologies of spatial data acquisition remotely (eg. Reliefs from LIDAR aircraft systems and Earth observation by satellite as Cosmo SkyMed the ASI, Aster NASA etc.) make available basic information in higher resolution and for affordable purchase
- ☺ The current activity provides an alternative methodology to the traditional procedure of flood risk mapping – (quickly procedure), using existing resources with particular regard to potential new generation of spatial data

AN ALTERNATIVE METHODOLOGY TO THE TRADITIONAL ONE

…suitable for small basin poorly monitored such as Rio Torbido, Rigo and Vezza basins and other smaller ones falling in the territory of Viterbo province…

WHAT DOES WE MEAN FOR "SMALL NOT INSTRUMENTED RIVER BASIN"?

SMALL RIVER BASIN →

- ABSENCE OF FLOW MEASURES
- SURFACE < 150 Kmq
- UNPREDICTABLE FLOOD RISK
- SEMILINEAR CONDITIONS
- STRATEGIC IMPORTANCE IN ANALYZING WIDE RIVER BASIN

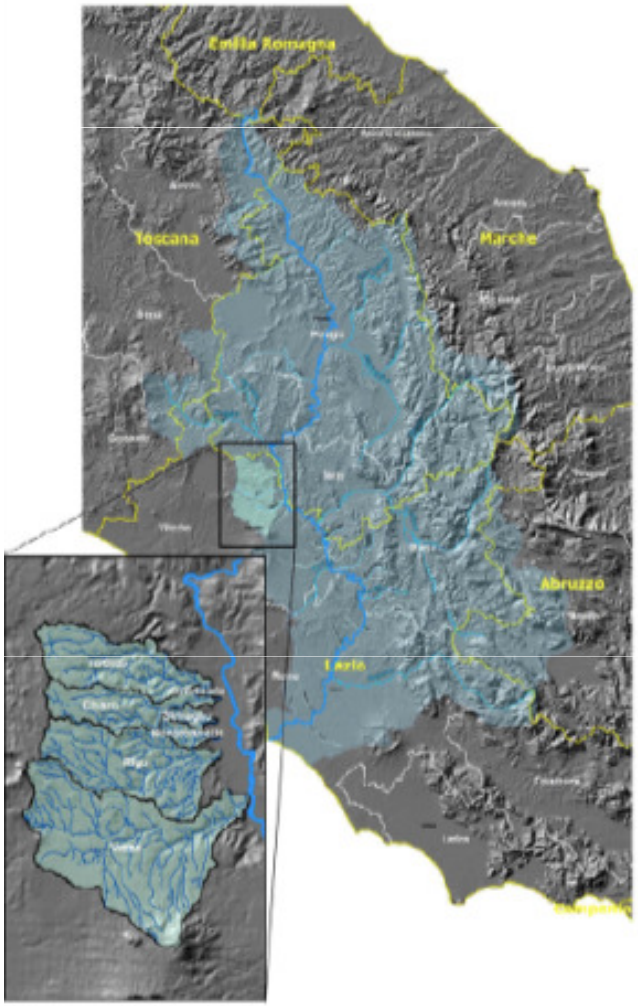
UNGAUGED RIVER BASIN →

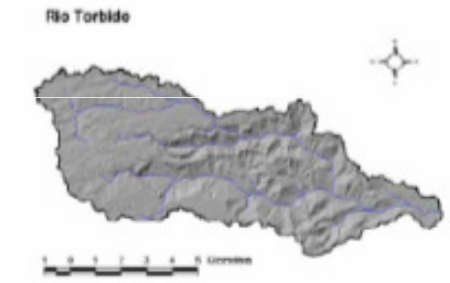
- ABSENCE OF FLOW MEASURES
- AVAILABILITY OF RAINFALL DATA IN DIFFERENT RESOLUTION
- AVAILABILITY OF DIGITAL ELEVATION MODEL (DEM)
- AVAILABILITY OF LAND USE MAPS

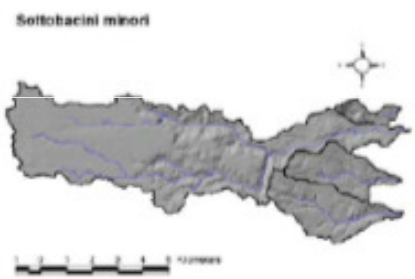
MAIN GOALS

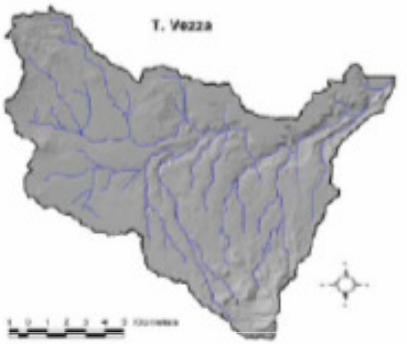
- ✓ Definition of hydrological scenario for project
- ✓ Prior identification of flooded areas using, as main information, digital elevation model and rainfall data

ANALYZED RIVER BASINS









Bacino	Area [km²]	Coordinate Centroide (ED50 UTM 33) Est [m]	Nord [m]	Dislivello altimetrico [m]	Quota minima [m]	Quota massima [m]	Lunghezza asta princ. (km)
Torbido	61.67	264795	4723584	540	85	625	20.37
Rigo	84.25	265505	4714094	480	70	550	19.84
Vezza	167.88	265975	4706734	990	62	1052	29.71
Chiaro	37.72	265705	4719664	520	80	600	18.75
Montecalvello	7.36	270675	4717394	268	74	342	5.07
Ombricolo	1.40	271965	4721064	133	78	211	1.8
Serraglio	5.18	270955	4718734	253	79	332	3.71

PRELIMINARY RISK CHARACTERIZATION
- FLOODPLAIN model -

Working Group F Thematic Workshop

FLASH FLOODS AND PLUVIAL FLOODING

✓Experimental GIS method to preliminay identify river flood prone areas frequently subject to saturation; the method is based on geomorphological analysis.

✓The method aims to divide the territory in:

- areas that probably will not be subject to any risk
- areas that could, instead, be prone to flood under certain conditions, eg level of risk / return time [Nardi et al. WRR 2006]*.

Simplified flow chart with the main stages of the *floodplain* model

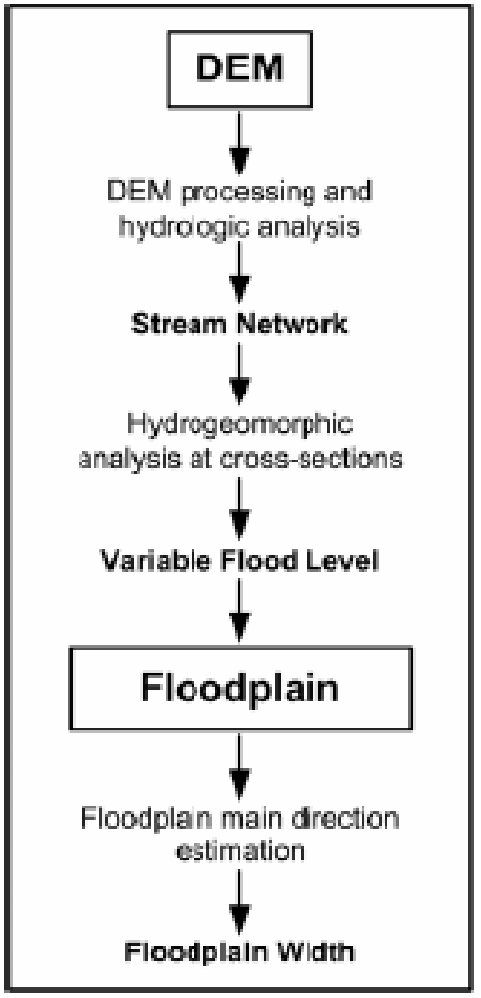
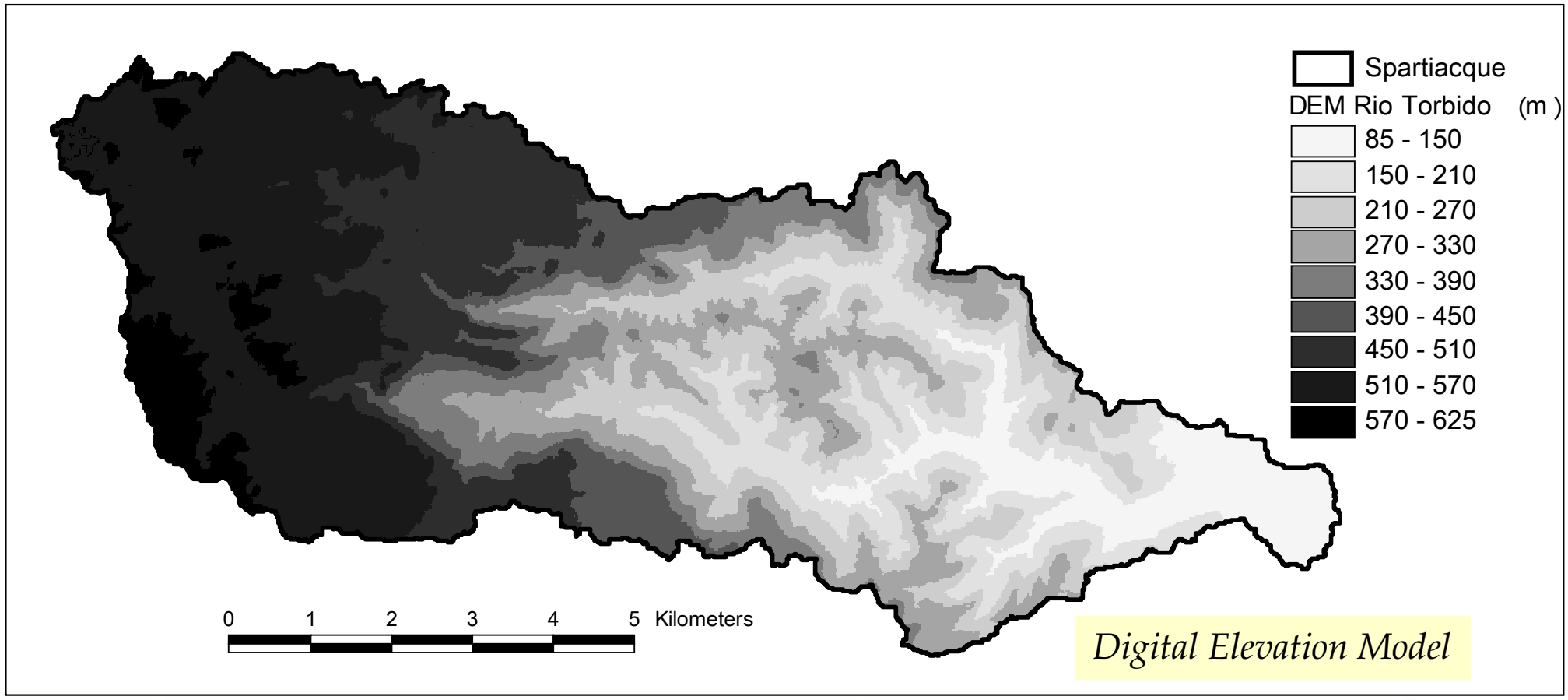


Figura 120. Esempi di conformazioni territoriali che mettono in evidenza i differenti ecosiste differenti conformazioni morfologiche tra floodplain e versante.

* Nardi F., Vivoni E.R., Grimaldi S., (2006) Testing Floodplain Width Scaling Using a Hydrogeomorphic Delineation Method, *Water Resources Research*, 42, W09409, doi: 10.1029/2005WR004155

Floodplain model needs a Digital Elevetion Model with appropriate resolution and the design- hydrograph to the closing section



A NEW PROCEDURE TO DEFINE WAVE PROJECT

Standard approach of Tevere RB Authority

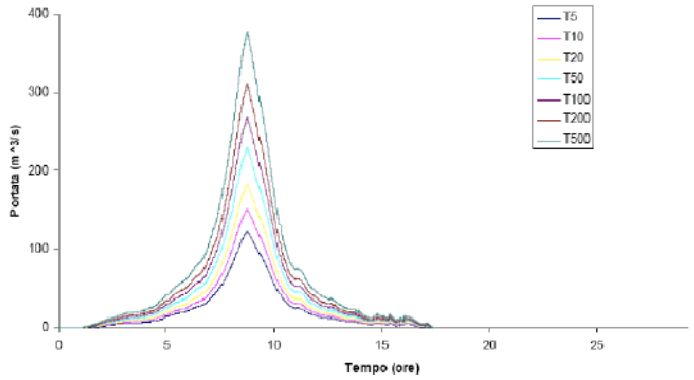
1) Estimate concentration time from DEM
2) Estimate peak flow through the rational formula
3) Estimate flood hydrographs with ABT methodology

WFIUH Methodology

Overcoming the limits of standard procedure

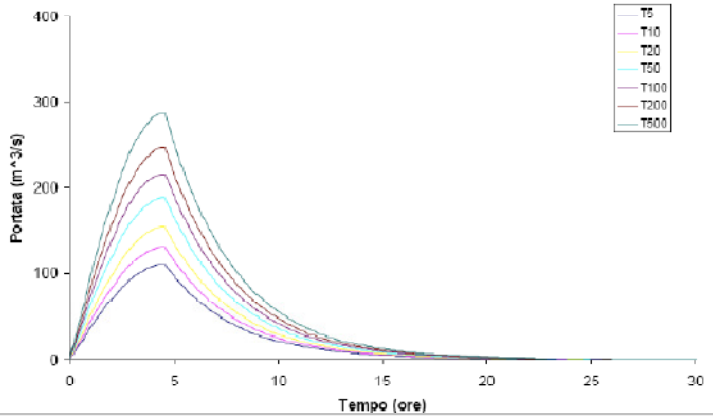
1) The approximate calculation of the design hydrograp may *frustrate* modelling activity downstream
2) Scientific literature suggests good alternatives
3) Technological innovation provides useful data on topography

RISULTATI DELL'APPLICAZIONE DELLA PROCEDURA SUL BACINO DEL RIO TORBIDO



Tempo di ritorno (anni)	Portata di picco (m^3/s)	Durata (ore)	Volume (m^3*10^6)
5	122.50	18.3	2.3
10	151.31	18.2	2.8
20	182.40	18.1	3.4
50	228.37	18.1	4.3
100	267.61	18.0	5.0
200	311.34	18.0	5.8
500	377.04	17.9	7.0

The flood hydrographs - according to the variation of return time (WFIUH methodology)



Tempo di ritorno (anni)	Portata di picco (m^3/s)	Durata (ore)	Volume (m^3*10^6)
5	110.39	29.8	3.8
10	130.83	30.5	4.5
20	153.63	31.0	5.3
50	188.35	31.7	6.5
100	217.24	32.1	7.5
200	247.19	31.7	8.5
500	287.47	32.3	9.9

The flood hydrographs- according to the variation of return time (Tevere RB Authority methodology)

PROCEDURE FOR AUTOMATIC CALCULATION OF "flooded areas"

Automatic extraction of the hydrographic network starting from DEM

- Elimination of spurious hydrological zones from DEM (local depressions and areas with no slope)
- Calculation of flow directions
- Delineation of the watershed basin
- Calculation of the contribution of drainage area for each cell
- Identification of cells making up the hydrographic network

Estimation of variable level of water in riverbed

- Estraction of the river sections from DEM and estimation of water level
- Calculation of parameters of Leopold
- Assigning a value for each water level variable for each cell according to Leopold law: $h = a\,A^b$

Delineation of Floodplain on GIS basis

THE DRAINAGE NETWORK AUTOMATICALLY EXTRACTED WITH METHODOLOGY PHYSICALLY BASED (PEM4PIT)

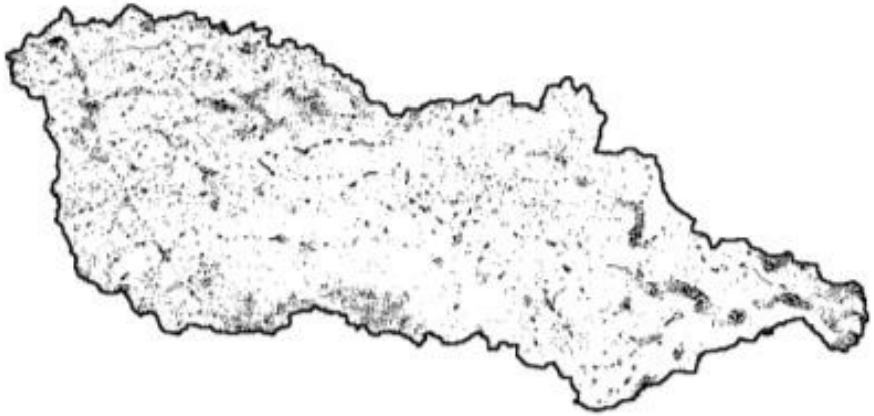
Working Group F Thematic Workshop

FLASH FLOODS AND PLUVIAL FLOODI

ISPRA

REGIONE AUTONOMA DELLA SARDEGNA

MINISTERO DELL'AMBIENTE



Slope zero areas (black) before (top) and after (bottom) removal of spurious hydrological zones (local depressions or pits)

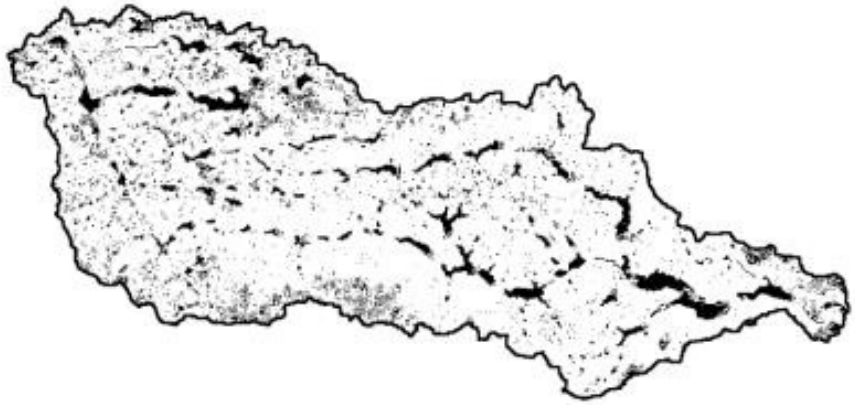
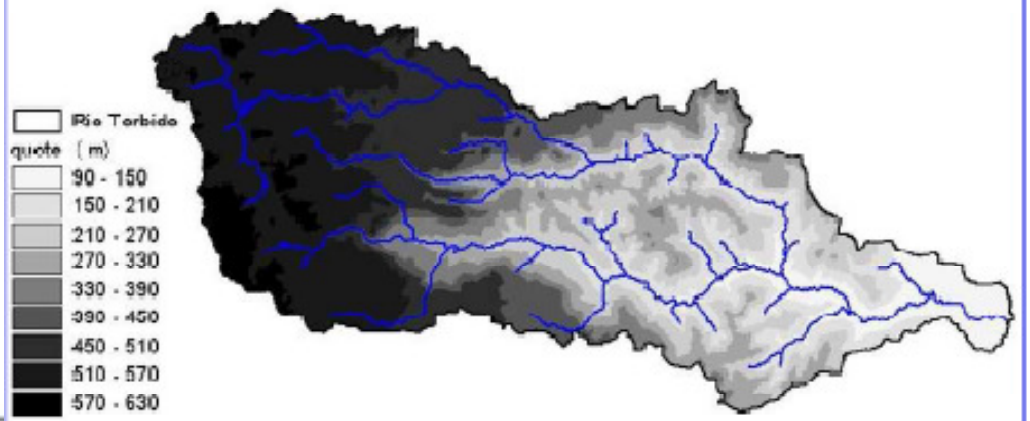


Foto Aerea 2005 e Reticolo idrografico digitalizzato da C.T.R.

Modello Digitale del Terreno (D.E.M.) e Reticolo Idrografico estratto in automatico



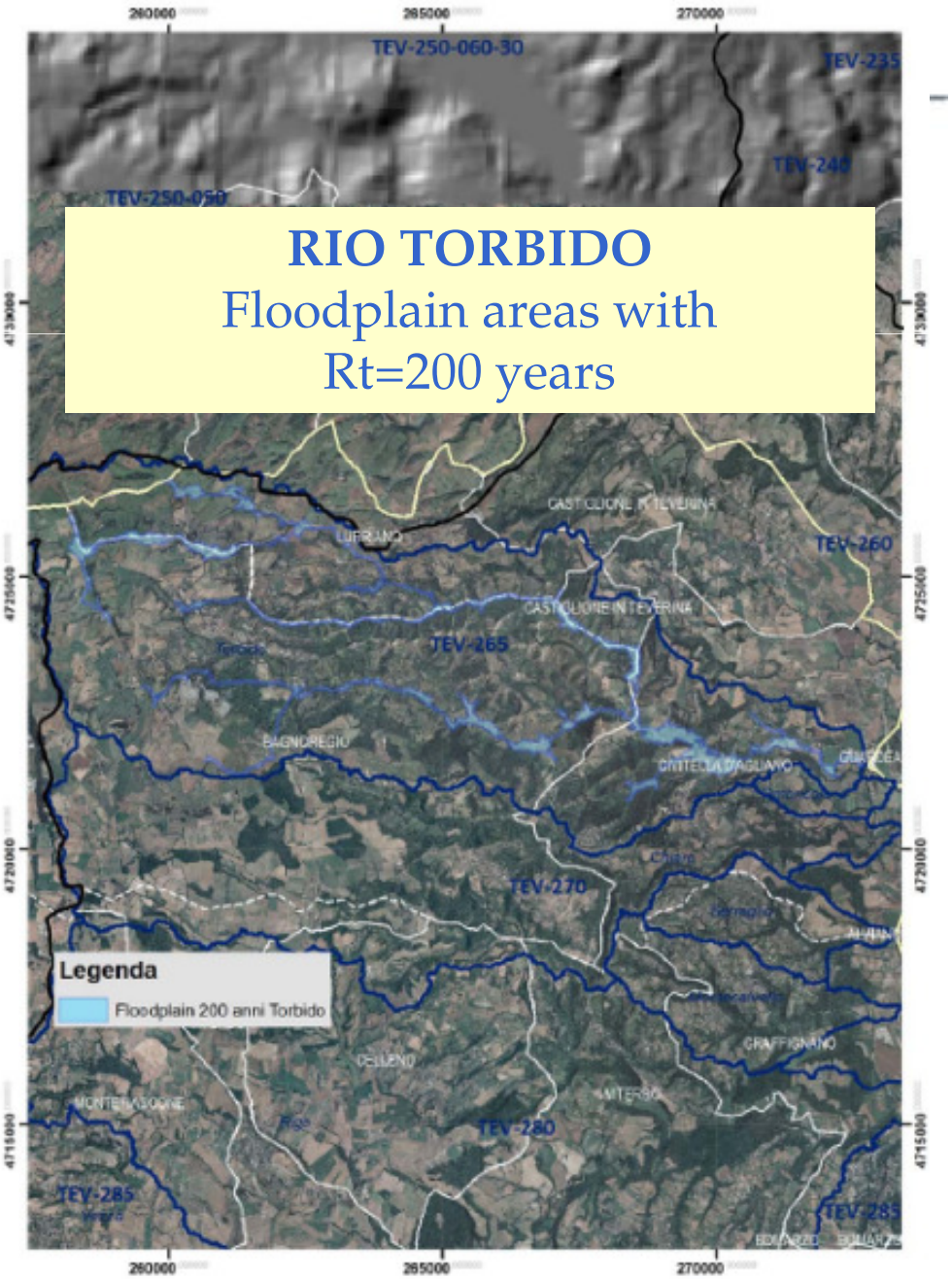
"FLOODPLAIN MODEL" RESULTS

Working Group F Thematic Workshop

FLASH FLOODS AND PLUVIAL FLOODIN

Bacino	Area [km²]	Area floodplain Tr 200 anni [km²]	area a rischio %	Lunghezza asta princ. (km)	Impatto economico Migliaia di€
Torbido	61.67	3.4	5.6	20.37	~119
Rigo	04.25	6.2	7.4	19.04	~130
Vezza	167.88	11.2	6.6	29.71	~204
Chiaro	37.72	2.1	5.6	18.75	~104
Montecalvello	7.36	0.5	7.0	5.07	~27
Ombricolo	1.40	0.2	9.2	1.8	~10
Serraglio	5.18	0.3	6.6	3.71	~20
Somma/Media	~365	~24	~6-7%	~100	~616

Tabella 31. Sommario dei risultati dell'applicazione del modello floodplain ai bacini di studio



igura 122. Identificazione della floodplain per il bacino del Torbido: tempo di ritorno di 200 anni

ANALYSIS OF RESULTS

- The application of the procedure allows to assess potential hydrological scenarios optimizing the available information and in particular the DTM.

- Are estimated accurately extreme hydrological scenarios (according to return time) analyzing in detail the distribution of peak, volume and time of flood hydrograph .

- The preliminary hydraulic risk characterization model identifies the maximum extent of flooded areas. The result should be used to predefine the limits of application of traditional models of hydraulic propagation suitable for detailed mapping of flooded areas.

- We have to consider the importance, under the hydrological point of view, of the small basins for the announcement of flood in the watercourse of the Tevere River at the confluence of all seven small river basins

- Recent studies [Natale and Savi, 2004; Natale and Savi, 2007, Calvo and Savi, 2009] have highlighted the importance of the overlapping effect in the whole Tevere river basin, where these basins fall, in the characterization of the flood dynamics with particular regard to the runoff generation, flood inizialization and propagation towards Rome

Thank you for the kind attention

Ing. Giorgio Cesari
General Secretary of Tevere river basin Authority