

IMPRINTS



Bringing science to decision-making: example of flash flood management

Prof. Daniel Sempere Torres

**Centre de Recerca Aplicada en Hidrometeorologia
Universitat Politècnica de Catalunya. Barcelona (Spain)**



The problem

FLOODS

The major Natural Hazard in Europe

1998-2004: 100 major events, 700 deaths, 25 109 € of insured economic losses



FLASH FLOODS

**Floods that happen very quick
(the most devastating of all floods)**

The most difficult problem facing the hydrological and meteorological forecasters at present

WMO, 2006 (Info note # 19)

Mountainous areas and Mediterranean region the most affected in Europe (but they can occur almost everywhere)

AGGRAVATING FACTORS

- Localized events
- STEEP SLOPES (Short time responses)
- SPATIAL AND TEMPORAL EXTREME VARIABILITY
- HEAVY RAIN INTENSITIES
- HIGHLY TORRENTIAL PHENOMENA

Flash Flood

+

Sediment generation and
Debris Flow

FF & DF happen usually together



EU Research

**Sustained support to research on Floods since the 80's
(> 30 years of R+D projects)**

Riverine Floods:

Significant advancements in **improving forecasts**,
management of **structural defences** and procedures to
increase **public preparedness**





EU Research

**How to transfer the scientific
advancements to society?**

Flash Floods:

Far from the advancements in riverine floods

Still a main challenge (worldwide)





EU Policy

Directive 2007/60/EC on the assessment and management of flood risks

- 2011: Preliminary Flood risk assessment
- 2013 Flood hazard maps and flood risk maps (number of inhabitants, economic activity, environmental damage potentially at risk)
- 2015 Flood risk management plans: PREVENTION, PROTECTION and PREPAREDNESS
- Steps to be reviewed every 6 years





Objective

Improve preparedness and the operational risk management of FF / DF



Produce methods and tools to be used by practitioners of the emergency agencies and utility companies.

Support the EU Flood Directive implementation.



Produce a prototype of the operational platform designed to be used around the EU



IMPRINTS



HOW?

Capitalising on the results of the previous and on going research

Filling the gap between **what we know and can be done** and **what is available in operational centres**

CONSORTIUM: Participated in 21 EU projects on Floods

EWASE (CRUE)

FLOODsite

HYDRATE

PREVIEW

and other projects:

MAP D-PHASE

COSMO

COST 731

PUB

OPERA

IMPRINTS



HOW?

Working together

RESEARCHERS



**DECISSION
MAKERS**

Development Partners

- Universitat Politècnica de Catalunya (UPC, ES)
- MeteoSchweiz (CH)
- Joint Research Center (JRC, EC)
- Lancaster University (ULANC, UK)
- Swiss Federal Institute for Forest, Snow and Landscape Research (WSL, CH)
- Wageningen University (WU, NL)
- Technological Centre of Water (CETAQUA, ES)
- University of Salerno (CUGRI, IT)
- University of Kuazulu-Natal (UKZN, South Africa)
- Meteorological Service of Catalunya (SMC, ES)
- Hydrometeorological Innovative Solutions (HYDS, ES)

Operational Partners

- Water Agency of Catalunya (ACA, ES)
- SCHAPI (FR)
- Glarus Kanton Emergency Department (GLARUS, CH)
- Autorità di Bacino in Destra Sele (AdBDxSele, IT)
- VERZASCA S. A. (CH)
- AET (CH)
- Environmental Agency of Andalusia (AMAYA, ES)

Research: Previous & Ongoing

Practitioner's expertise

Algorithms

Tools

Expertise

Operational Needs

**Interaction
& Integration**

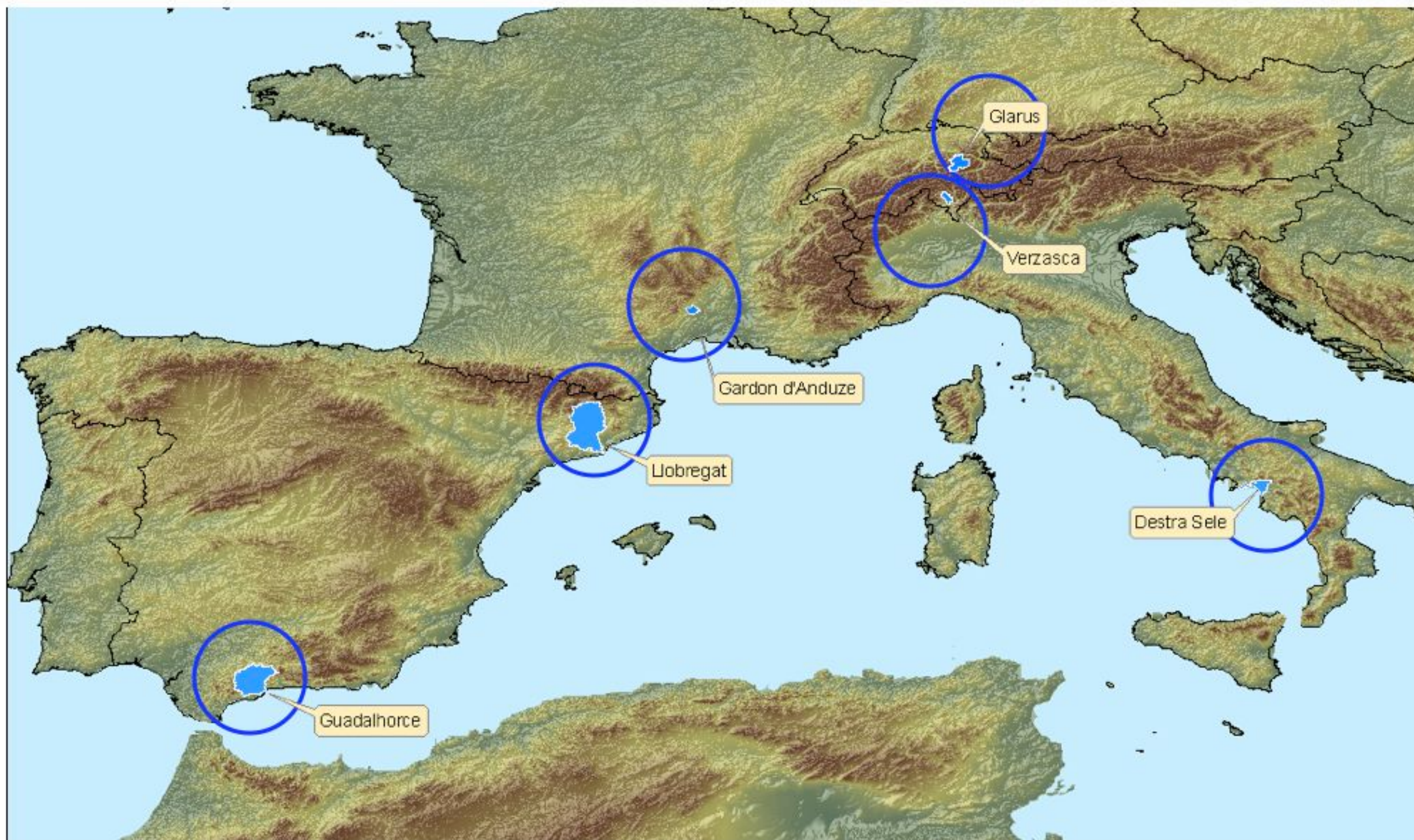
And validate them!

Forecasting and Warning Systems

Produce a prototype of the operational platform designed to be used around the EU



VERIFICATION in 6 Test-beds



Oriented to FF/DF

Advanced Rainfall Forecasting

- Lead times: 30 min -> 72 h

FF/DF Guidance for Risk Management

- Based on EFAS Forecast products
- Based on Advanced Rainfall Forecasting (+Radar)
- Adapted to 1 km² scale in fast response areas

Probabilistic Hydrologic Forecasting

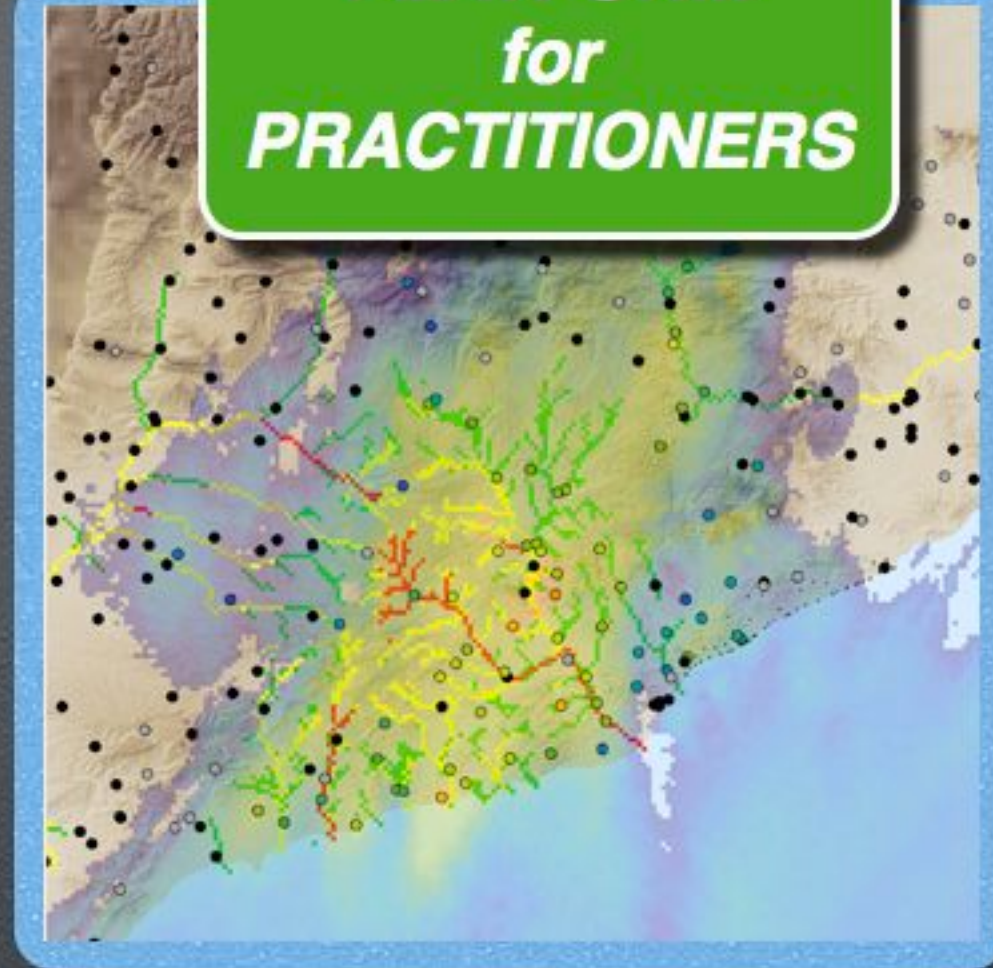
- Using adapted hydrological models

FF/DF Early Warning using a Rule-Based system for complex processes

Assessment of Impacts induced by Future Changes

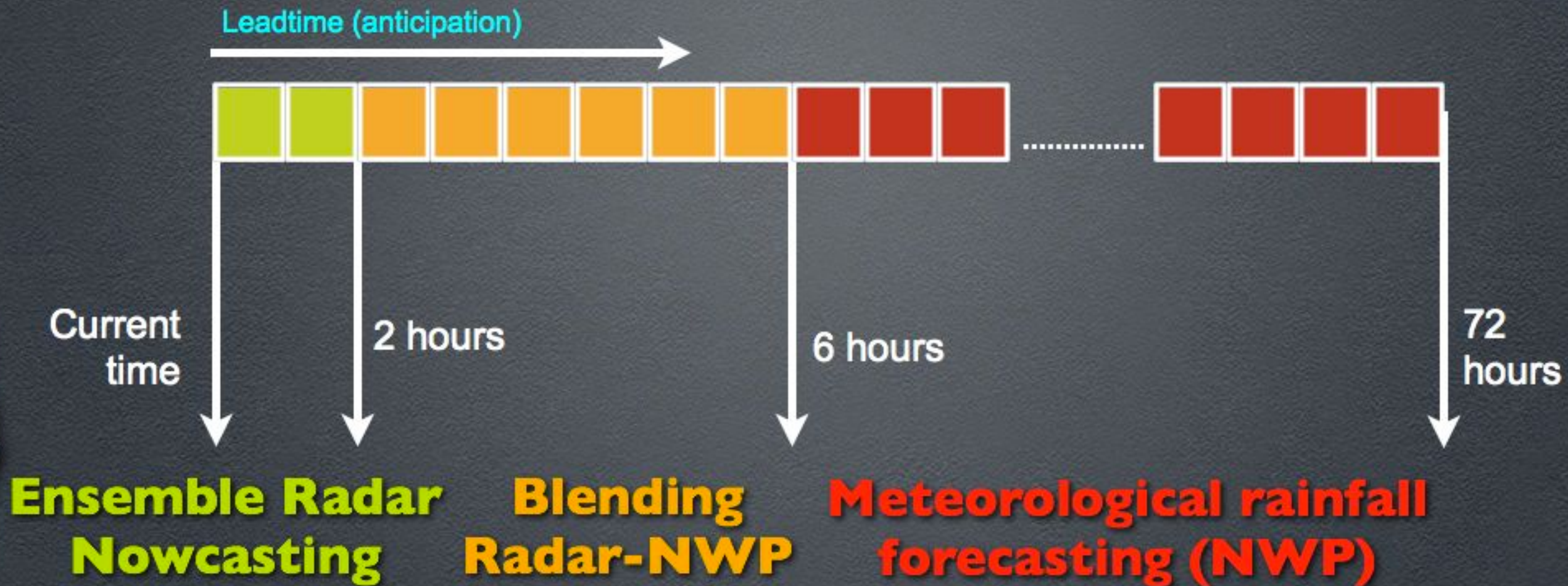
- Climate change, urban areas, land use, forest fires.

**PLATFORM
for
PRACTITIONERS**



**VERIFICATION
in 6 Test-beds**

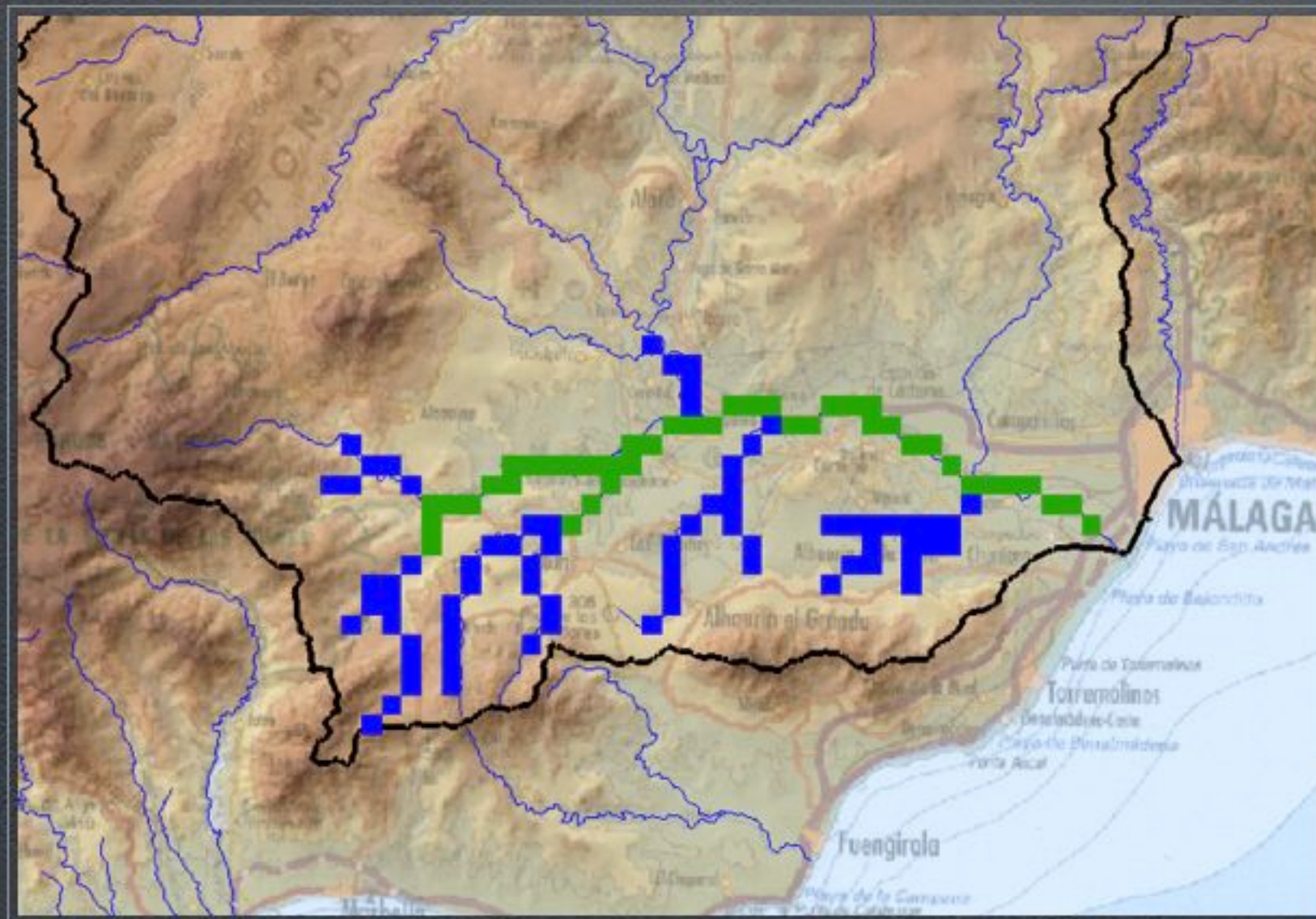
Increasing anticipation of heavy rainfalls



- **High resolution radar nowcasting probabilistic outputs** (ensembles) for FF & DF forecasting **(up to 2 h)**
- **Combining (blending) radar rainfall nowcasting with probabilistic NWP products** **(between 2h and 6h)**
- **Adapting high-resolution meteorological model forecasts** to FF & DF early warnings **(from 6h to 72 h)**

FF & DF early warning systems

- Probabilistic Early Warning System at 1 km resolution up to **6h lead time** based on **rain intensities exceedences**



**Guadalhorce
basin
(Malaga)
16/02/2010**

Example of
PFFGS 1 km
Source: CRAHI

Flood Warning

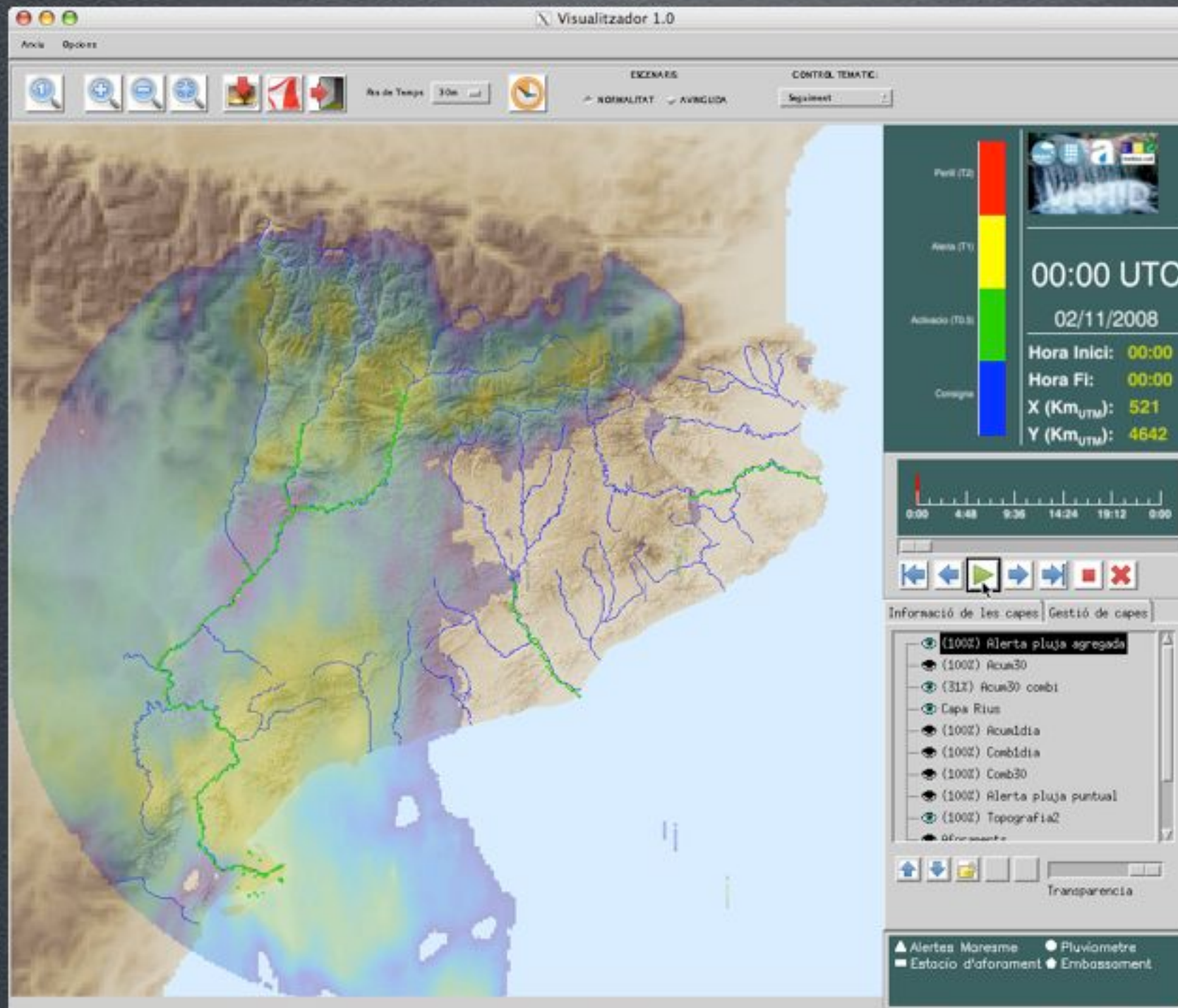


2 5 10 25 50 100 200

Exceeded Return Period T(years)

FF & DF early warning systems

- Probabilistic Early Warning System at 1km resolution up to **6h lead time** based on **rain intensities exceedences**



Example of
PFFGS 1 km
Source: CRAHI

IMPRINTS



FF & DF early warning systems

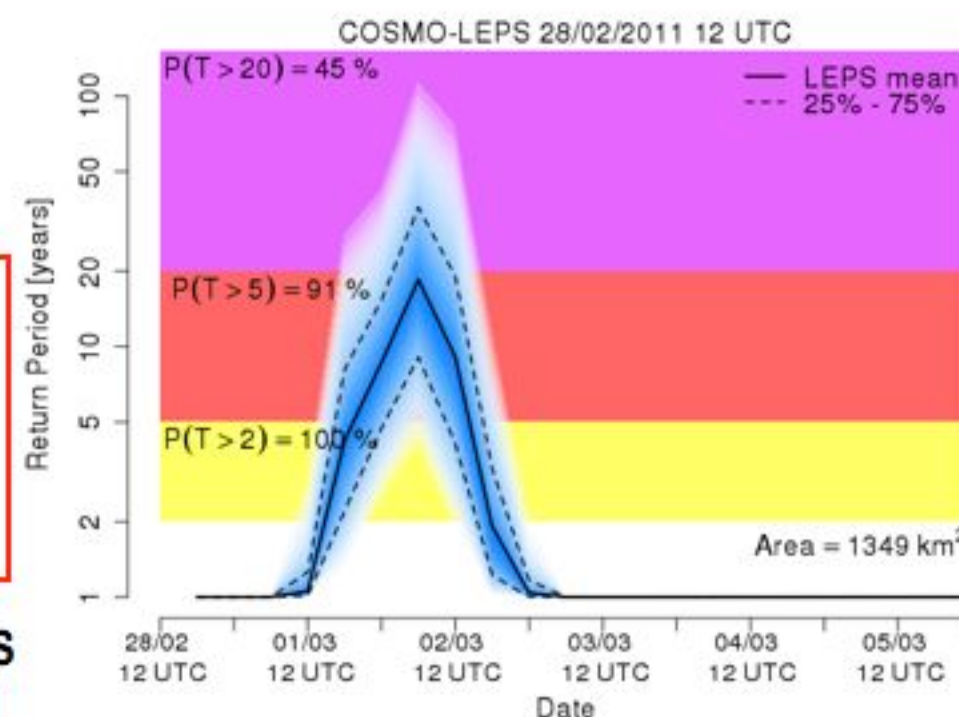
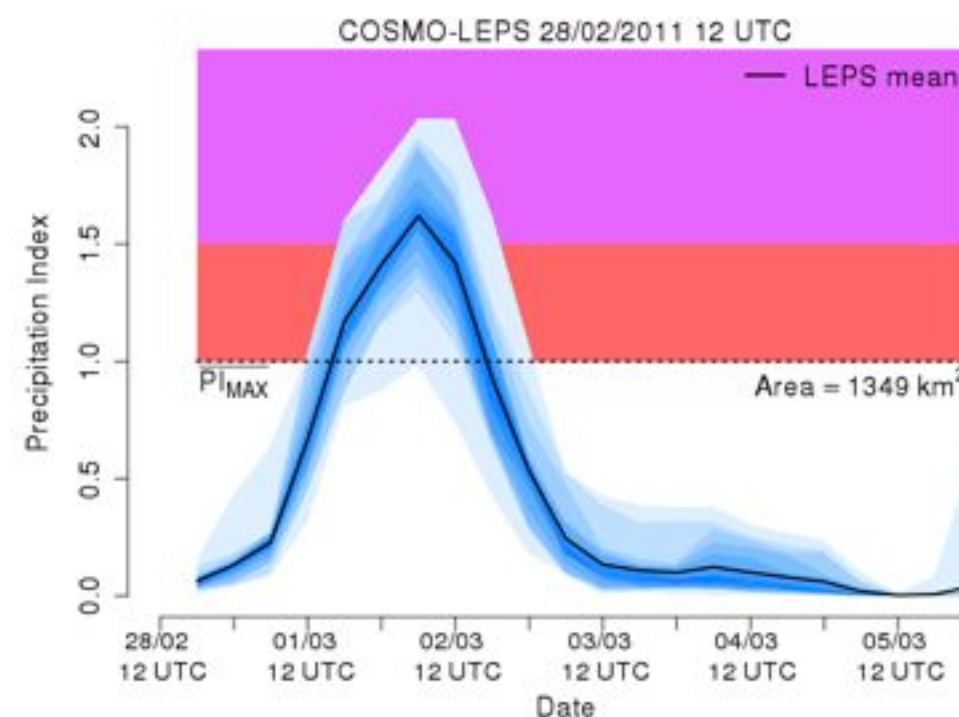
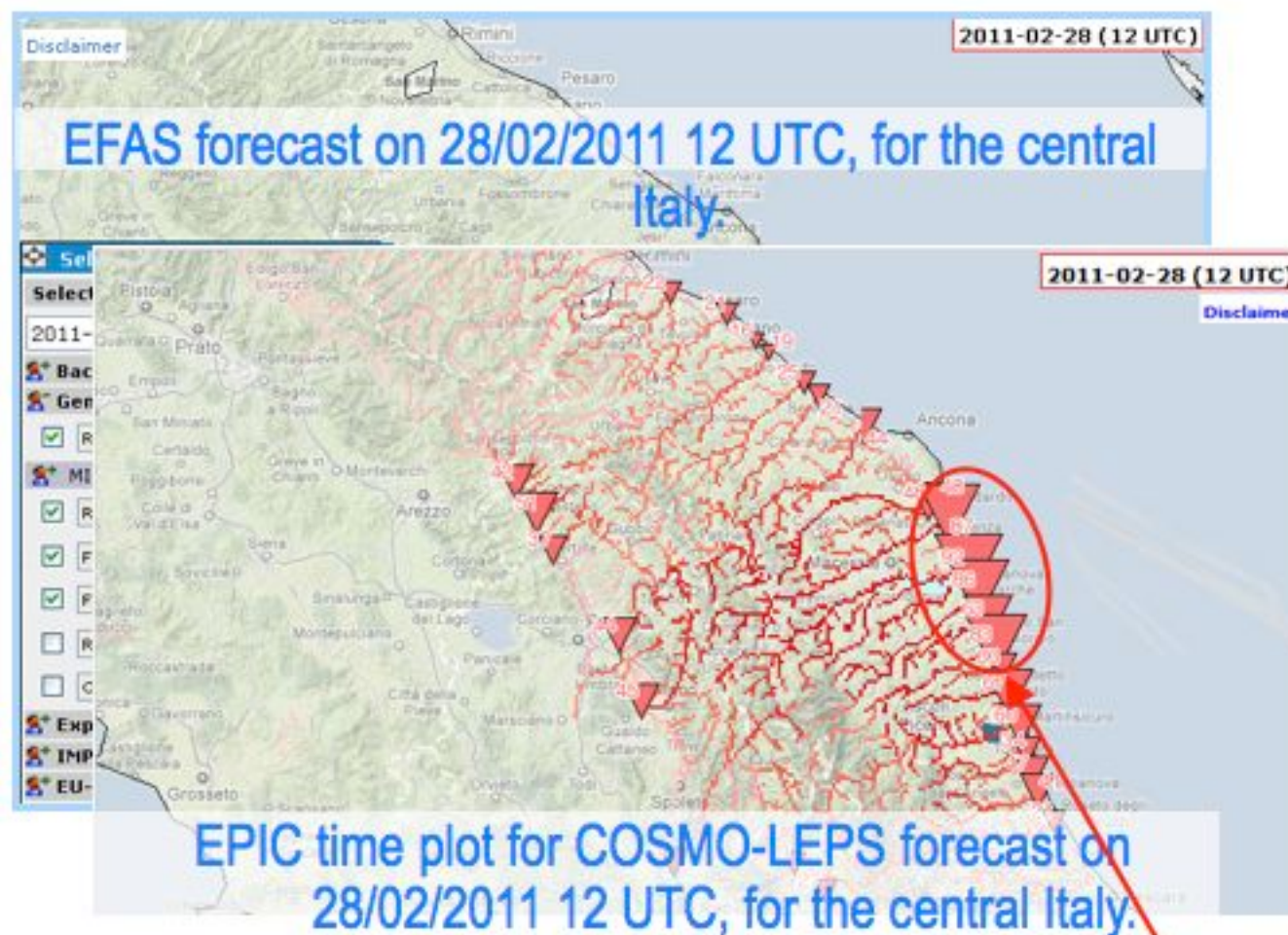
Based on the current EFAS system (European Flood Alert System) oriented to large river basins.



Develop an adapted system for FF :

EPIC (European Precipitation Index Climatology)

FF Early Warning System at 1km resolution up to **72h lead time based on probabilistic rainfall forecasts**



One killed, two missing in central Italian floods

Marche preparing state-of-emergency request

02 March, 13:48

Inviato Stampato Inviato Sottoscriviti Suggerisci

(ANSA) - Rome, March 2 - A woman is dead and two people are missing after the central Adriatic Marche region was battered by flooding in the night, prompting the regional government to prepare a request for the declaration of a state of emergency.

The dead woman is an 85-year-old who seems to have drowned after falling into a river at Venarotta near Ascoli Piceno as the region suffered gale-force winds and its most intense rainfall in 40 years.

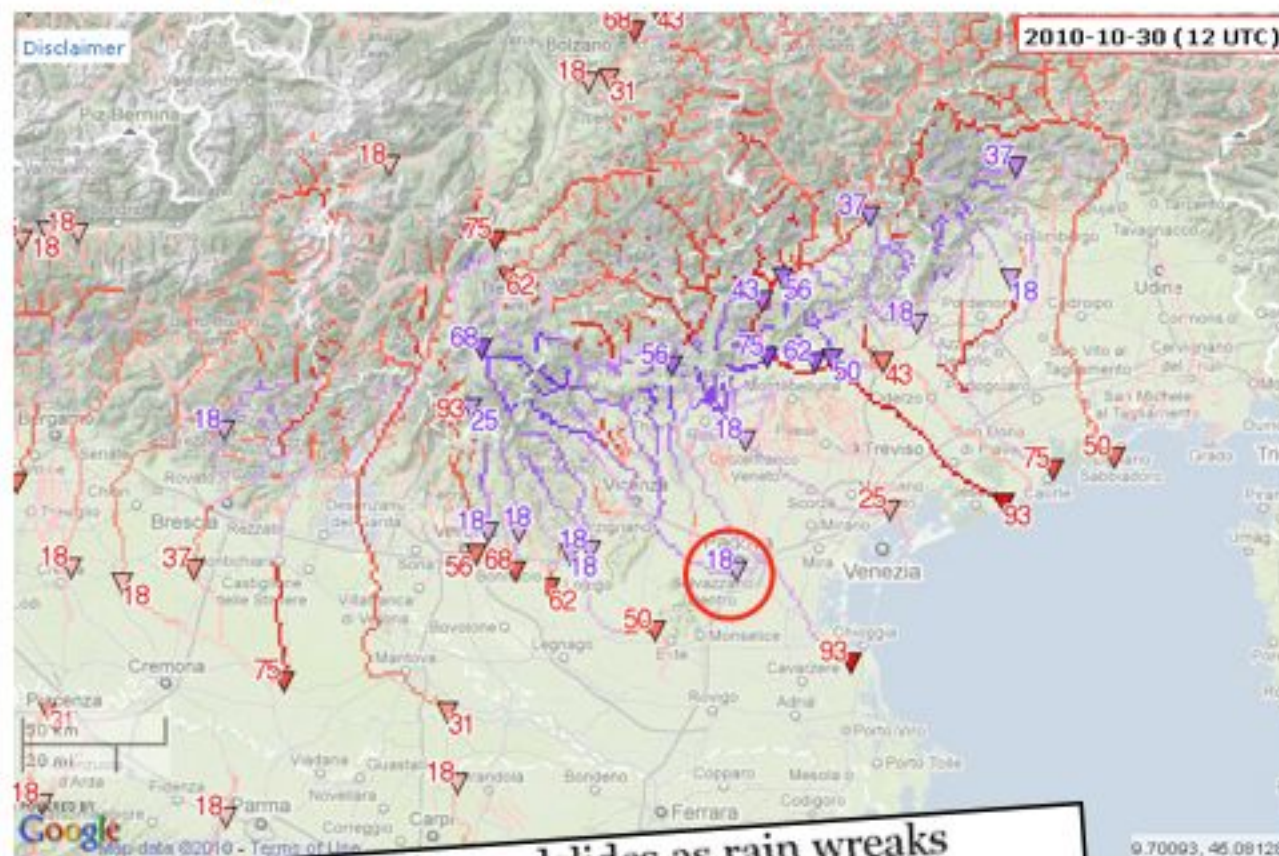
Her body was found by firefighters after her daughter raised the alarm when she failed to return from Mass on Tuesday evening.



[...] the most hit zone, between Sant'Elpidio a mare, Fermo and Ascoli Piceno [...]

[...] the region suffered its most intense rainfall in 40 years [...]

EPIC time plot for COSMO-LEPS forecast on 30/10/2010 12 UTC, for the north-western Italy.

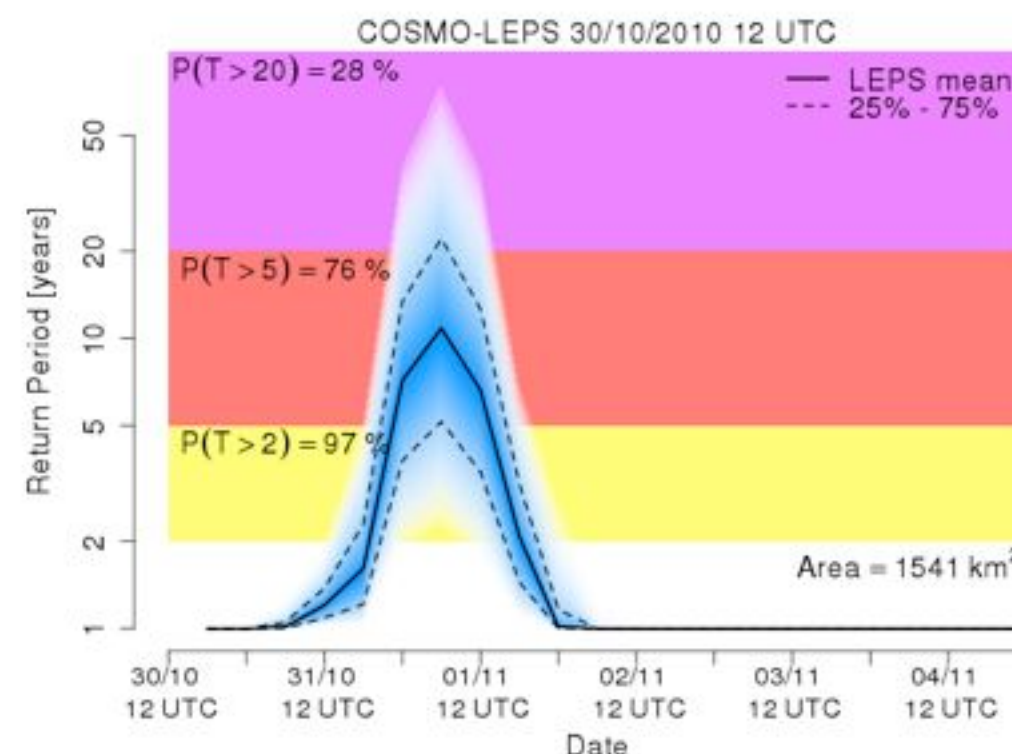
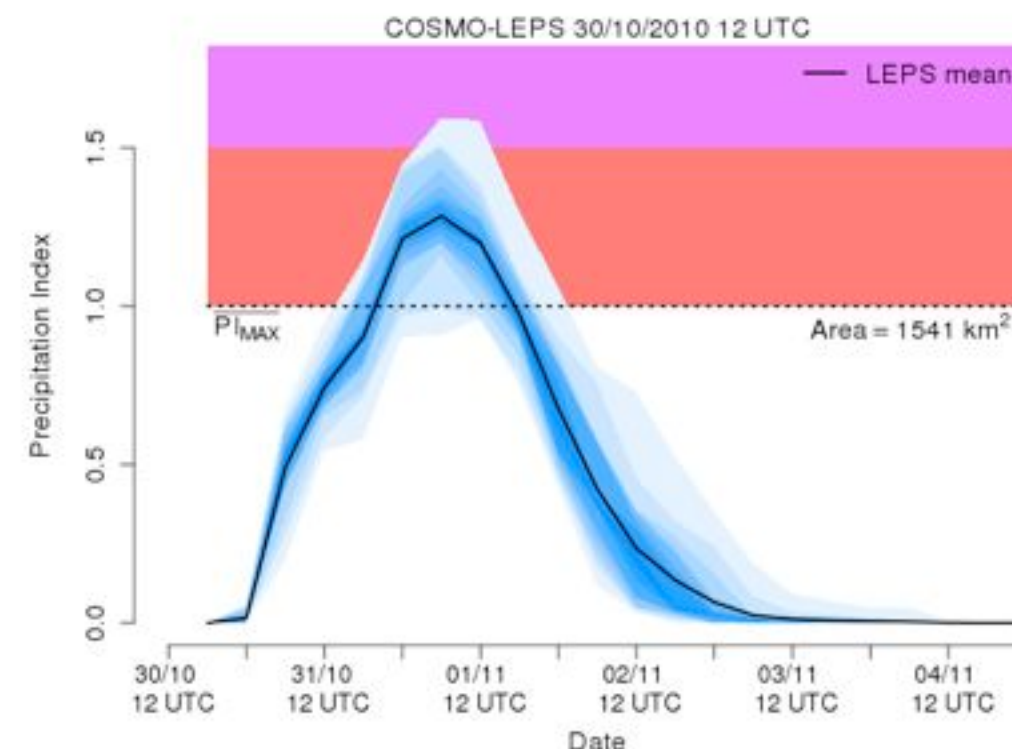


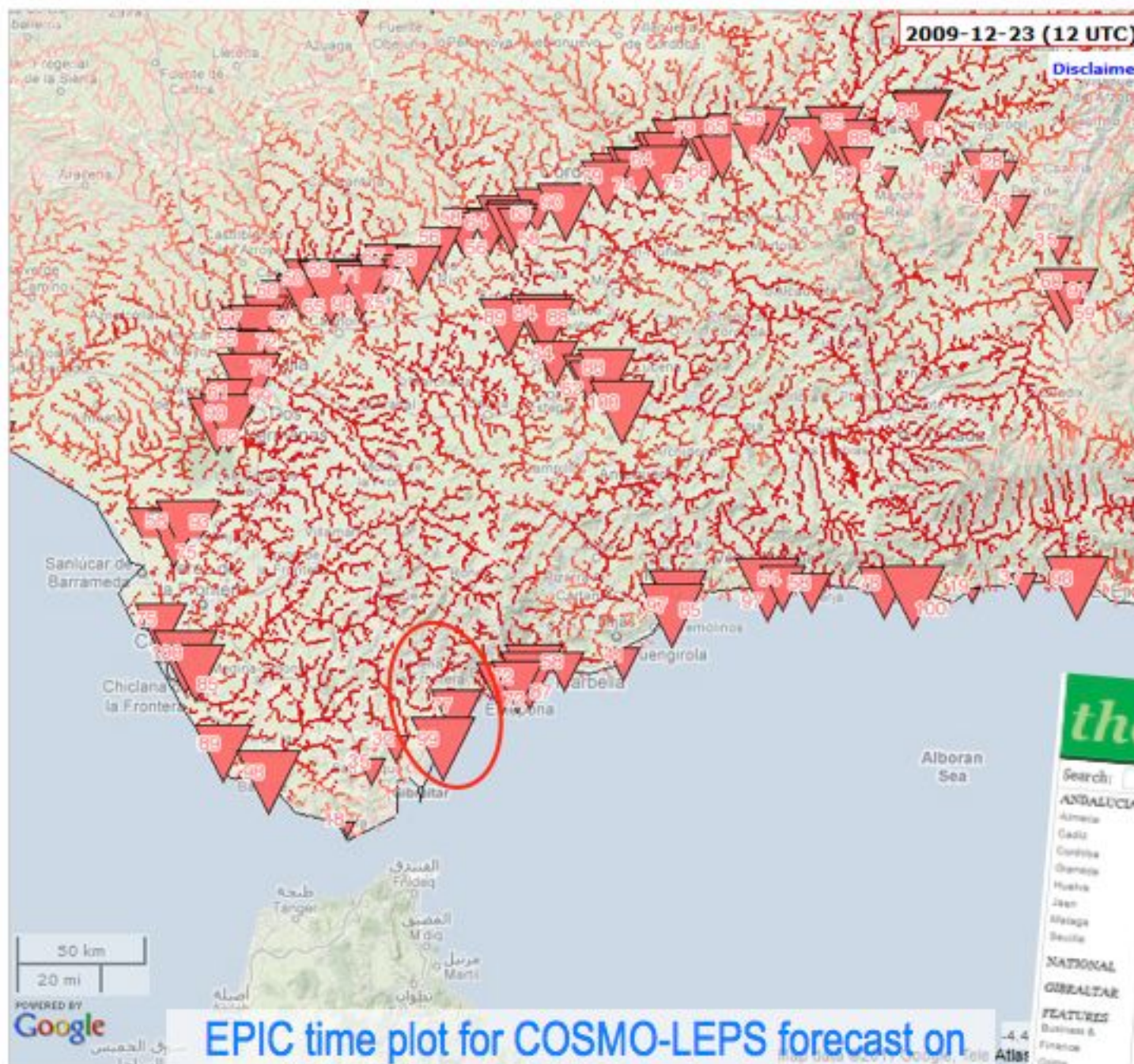
Three killed in mudslides as rain wreaks havoc

Over 10,000 people evacuated from flood-hit northern Italy

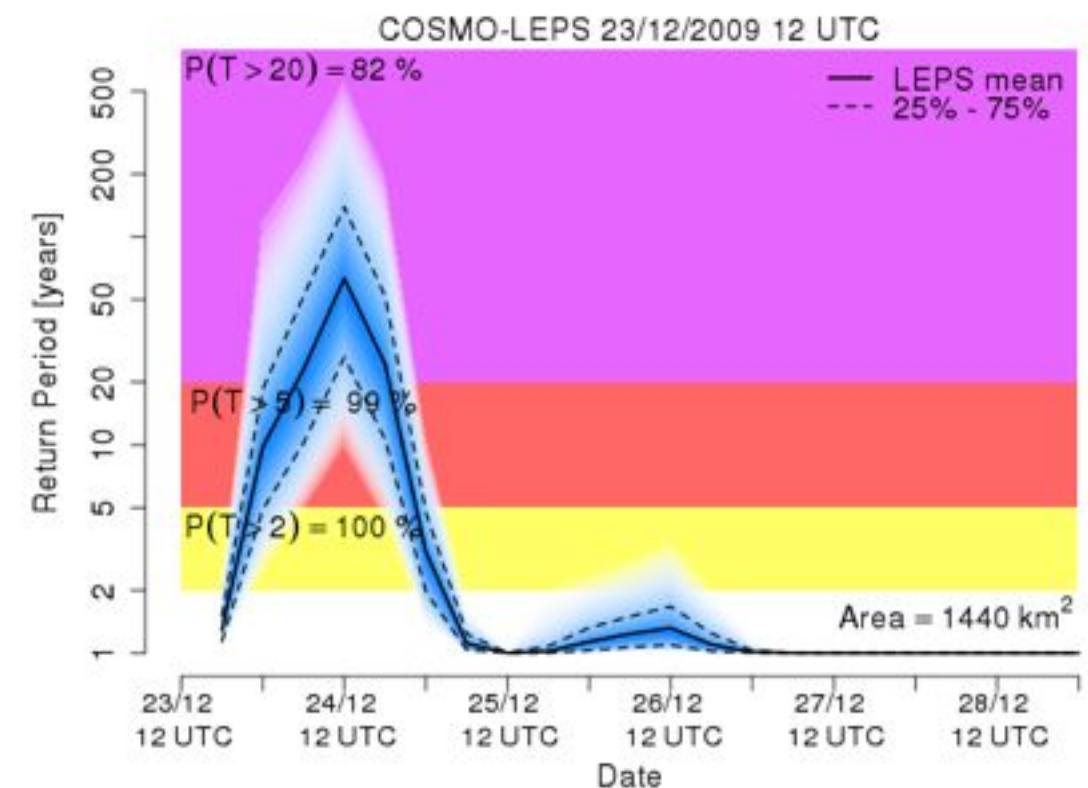
(ANSA) - Rome, November 1 - Three people have been killed in mudslides as heavy rain wreaked havoc in northern and central Italy for a third day on Monday.

A 39-year-old mother and her two-year-old son died when a mudslide hit their home near the Tuscan town of Massa Carrara Sunday night and a 38-year-old man was killed after another landslide hit a nearby village.





EPIC time plot for COSMO-LEPS forecast on 23/12/2009 12 UTC, for Andalusia (Spain).



the olive press
Spain's No.1 English news website

Search:

ANDALUCIA

Almería
Cádiz
Córdoba
Granada
Huelva
Jaén
Málaga
Sevilla

NATIONAL

GIBRALTAR

FEATURES
Business & Finance
Golf
Food & Drink
Entertainment
Environment

Record rainfall sees worst floods since 1940s

DECEMBER 24, 2009 • CADIZ, SEVILLA • 10 COMMENTS

★★★★★ (11 votes, average: 4.45 out of 5)

FREAK flooding has led to the closure of hundreds of roads and railways around Andalucía.

Rivers burst their banks in many parts of the region, leading to hundreds of homes being flooded over the Christmas period.

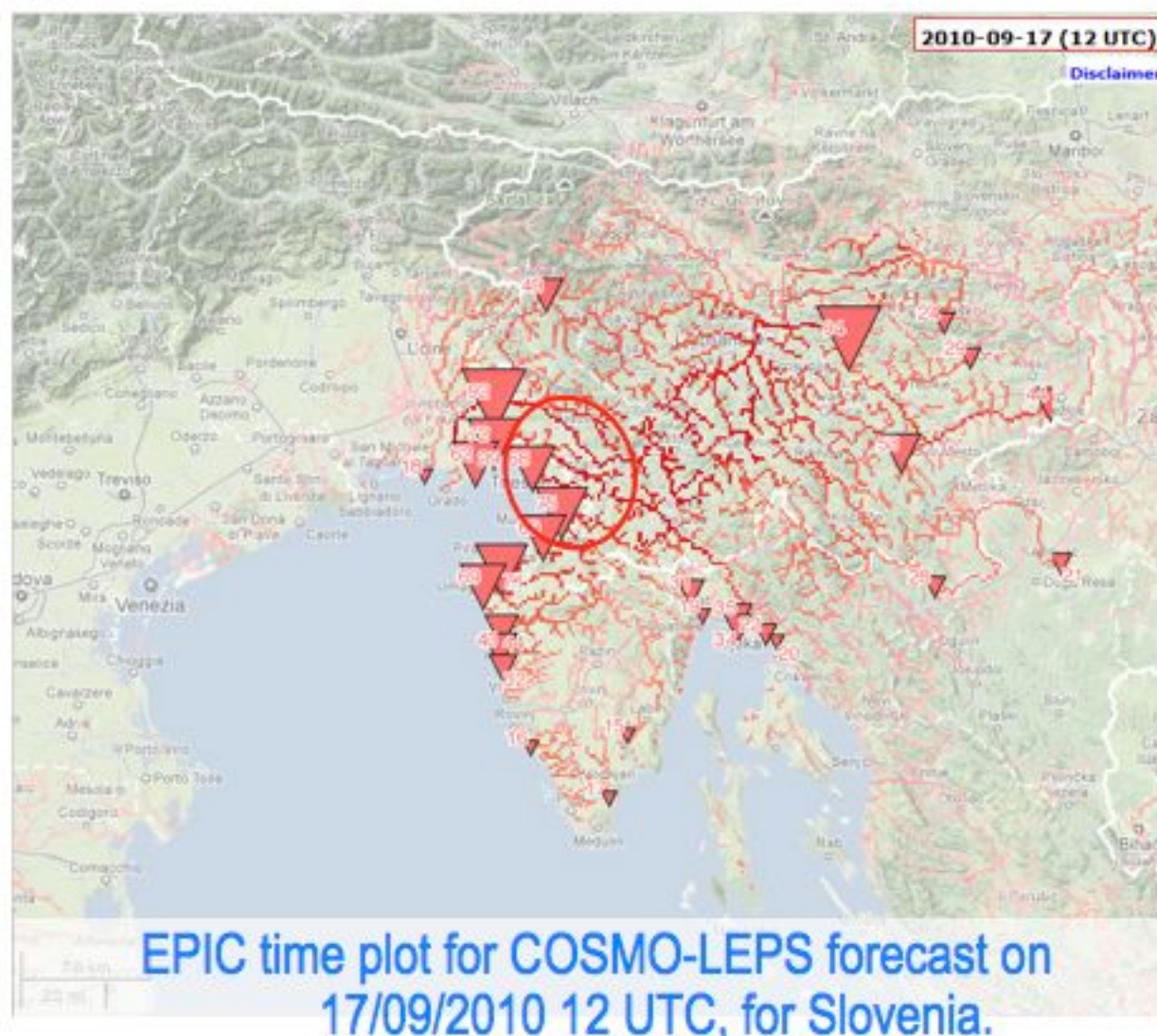
In Ronda a number of horses were allegedly swept to their death at La Indiana, while a horse was also killed when a river flooded in Setenil.

Dozens of homes were flooded in the La Indiana and Llano de la Cruz areas of Ronda, as well as in nearby Benaoján and Jímar de Libar.

Subscribe: RSS or Email Thursday, April 21, 2011



Photograph by Karl Smallman



2010 Slovenia floods

From Wikipedia, the free encyclopedia

The **2010 Slovenia floods**, on the weekend of 17–19 September 2010, were caused by heavy rains in Slovenia, resulting in one of the worst floods in the country's history. Among the regions affected were the capital Ljubljana, the Zasavje region, Lika, the Slovenian Littoral and the Lower Carniola region.^{[1][2]} Initial damage was estimated to reach €15 million.^[3] Three people were killed.^{[1][2]}

In Ljubljana, the river Gradaščica – together with the Mali graben stream – flooded several parts of the Vž Community Quarter, and record water levels were reached.^{[1][2][3]} Several transformers were shut down to prevent accidents, leaving some 3,000 people without electricity.^[1]

In Zagorje ob Savi, a great part of the town was flooded by the Sava river and several landslides were reported.^{[1][2]}

The town of Lika was flooded by the Sava river and road connections were cut by the flood waters.^{[1][2]}

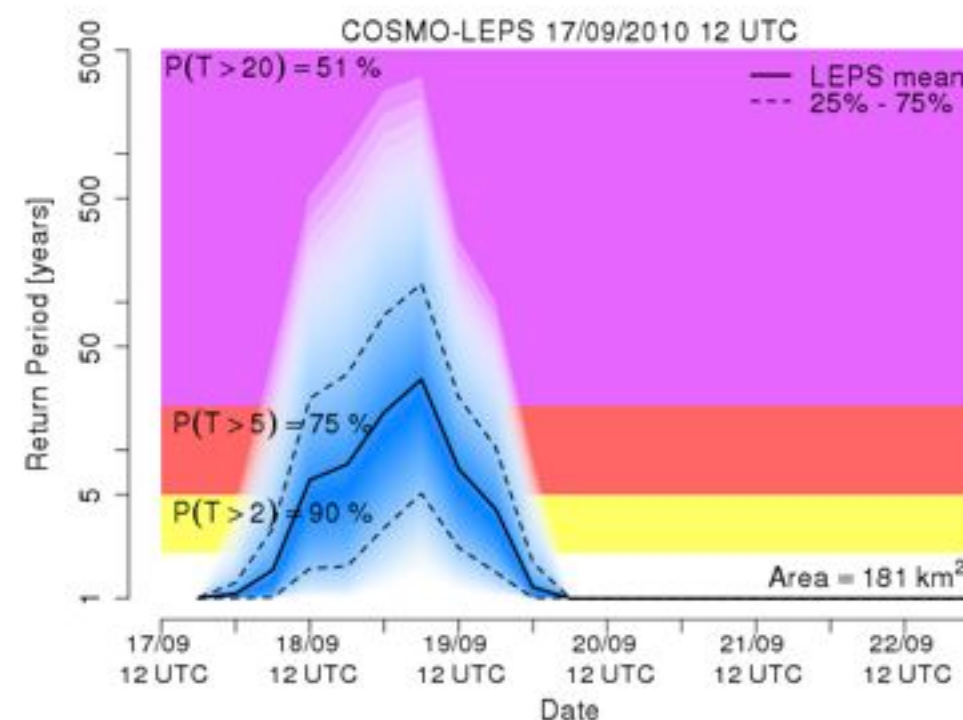
In the Littoral region, the Ržana and Dragonja rivers flooded several roads, closing all three border crossings with Croatia in the region. Parts of Portorož Airport and the Sečovelje salt fields were flooded as well.^[1] Vipava river was flooding in the northern Littoral.^[1]

The Sava, Krka and Kolpa rivers flooded in the Lower Carniola. The towns of Krško, Brežice and Otočec were partially flooded.^[1]

In Upper Carniola, the town of Žiri was affected by Poljanska Sora. In Železniki, a town that was most affected in the floods exactly three years before,^{[1][2]} no bigger problems were reported.^[1]

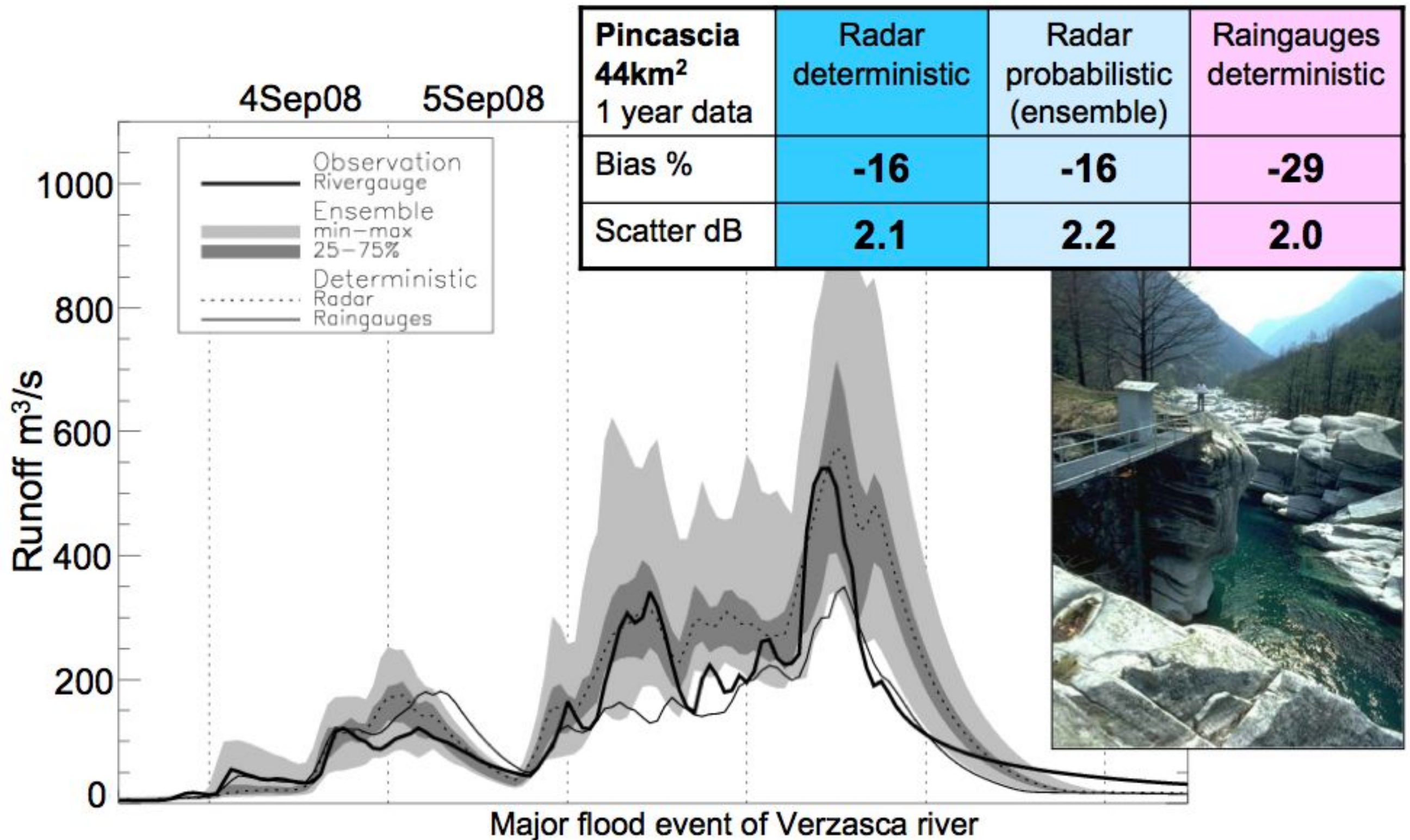
Some parts of Croatia along the Sava river were also flooded.^{[1][2]} around 20 people were evacuated around Zagreb.^{[1][2]}

By Monday, 20 September, the water levels began to decrease, although landslides in some regions remained a threat.^{[1][2]} Four days after the flooding, the area of Dobropolje municipality was still 6 meters above the usual water-level.^{[1][2]}





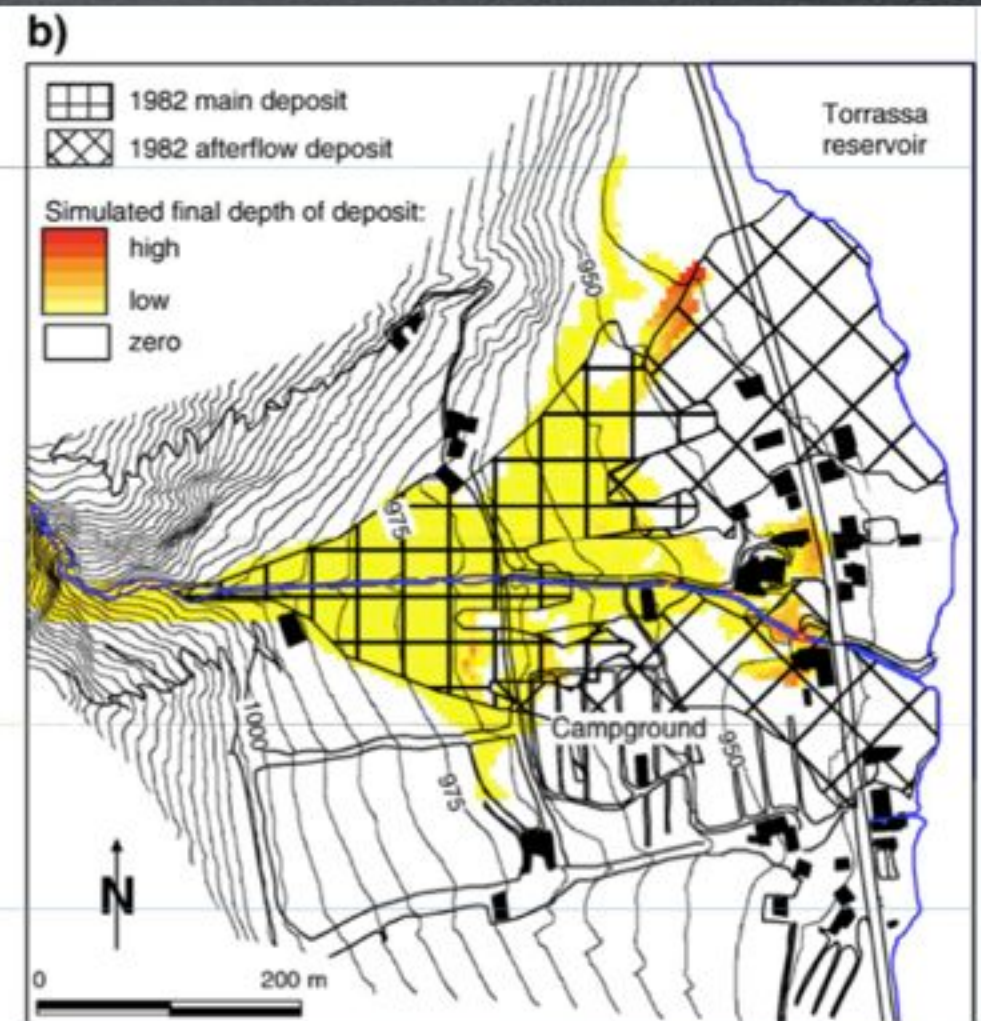
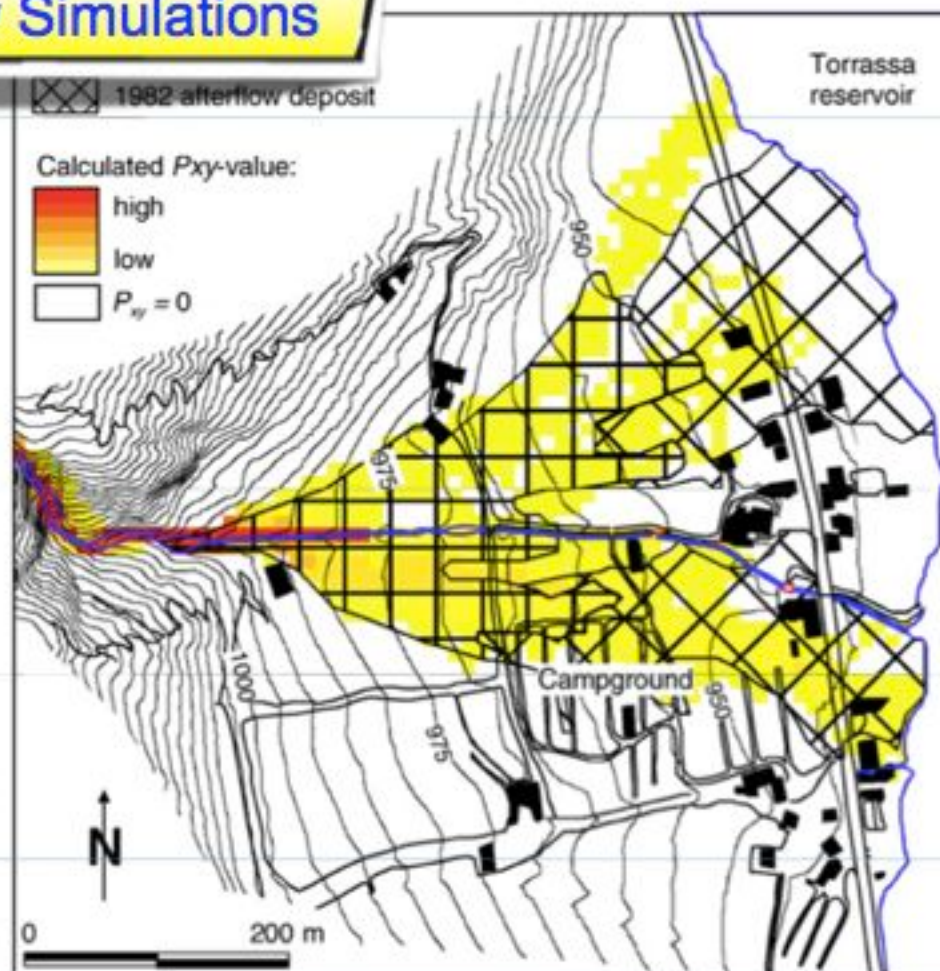
Verzasca river



FF/DF Probabilistic Early Warning using a Rule-Based system for complex processes

- Identification of the **governing variables** of the process (rainfall, terrain, land use, vegetation, debris availability)
- **Rule-based system** associating values of **triggering inputs** and the **model outputs** through models.
- **Fuzzy-logical** methodology to use it **in real-time**

Debris Flow Simulations



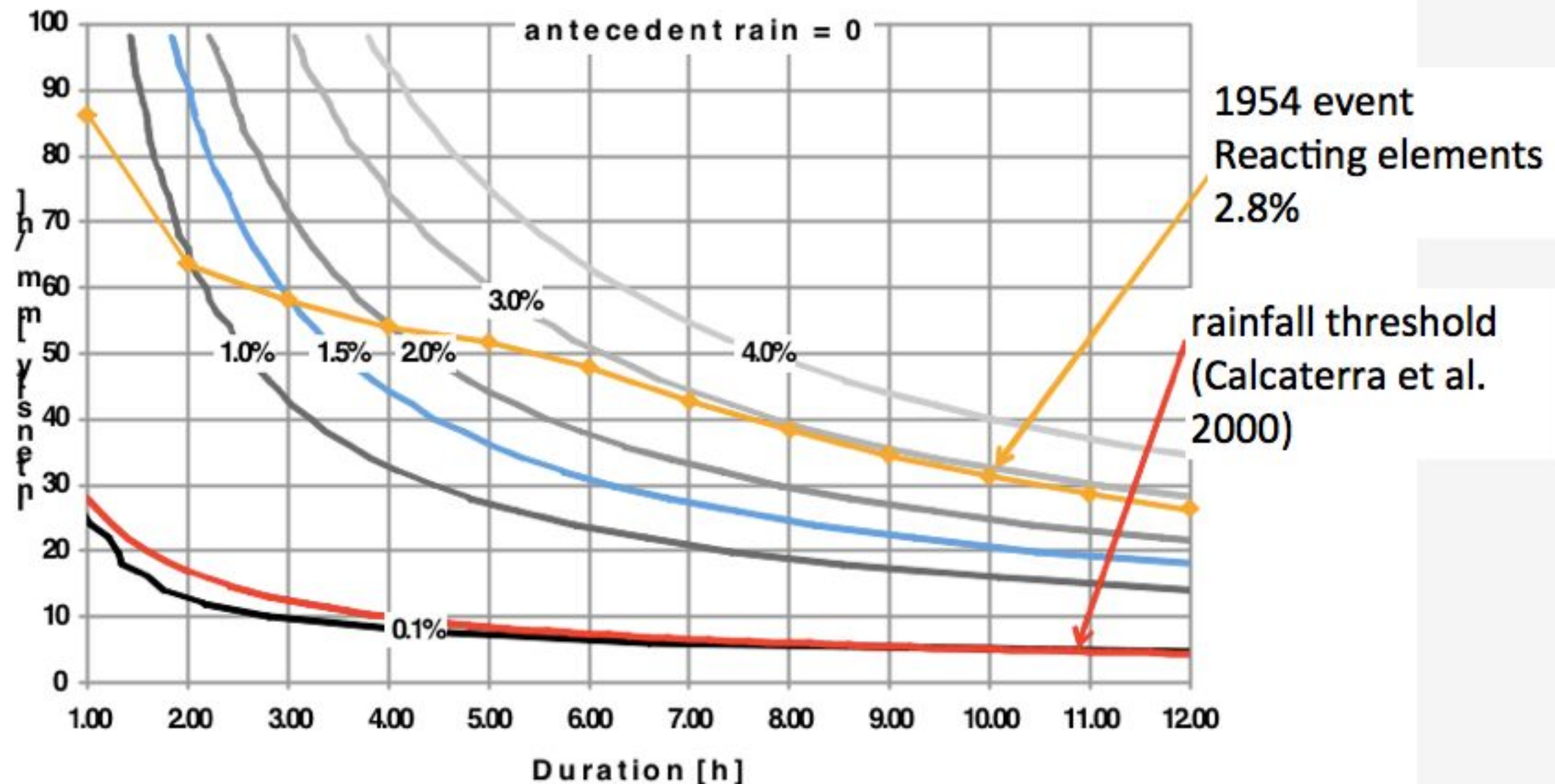
Jou creek, Eastern Pyrenees.

Source: GITS-UPC

Rainfall thresholds curves

The obtained data set has been elaborated in order to draw intensity-durations curves for any fixed value of the antecedent rain.

Any intensity duration rainfall curve corresponds to a fixed value of the failure percentage



Rules validated through the back analysis of a past event



ID-04

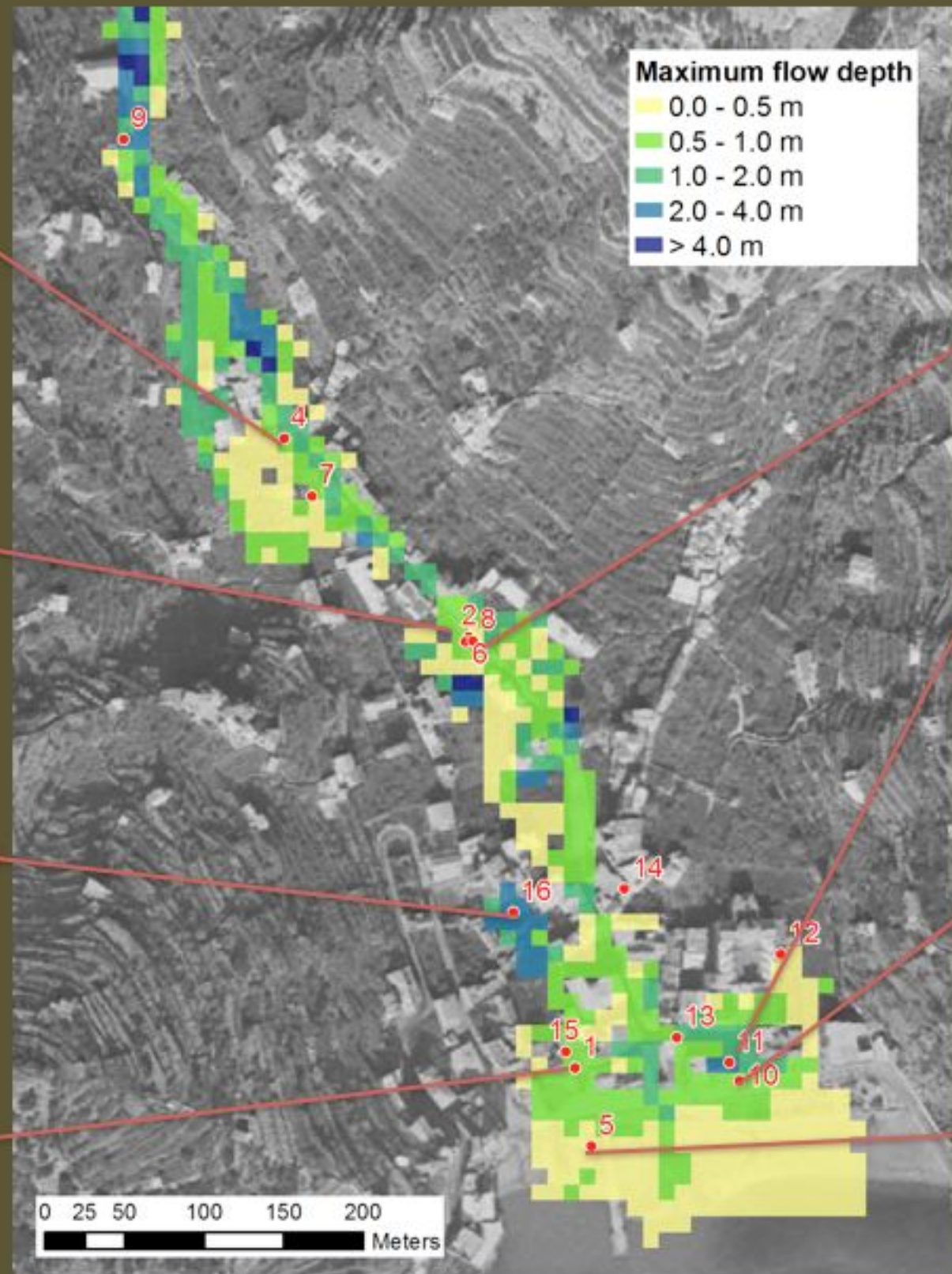


ID-02

ID16 Archaeological site
"villa marittima" filled
with 1500 m³ of debris



ID-01



ID-06

ID11 The mud filled the
first floor of the palace

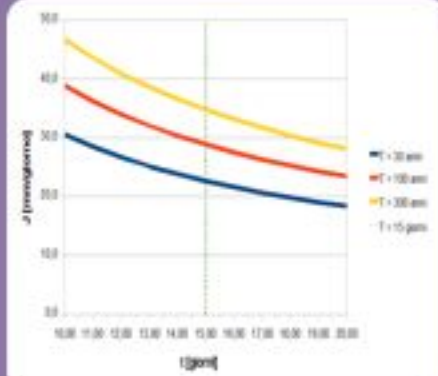


ID-10

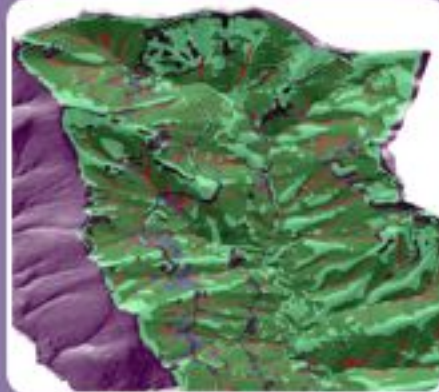


ID-05

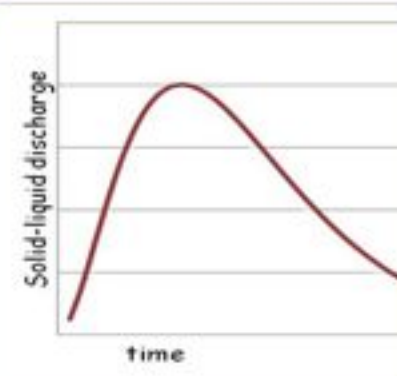
Mapping of debris flow Hazard



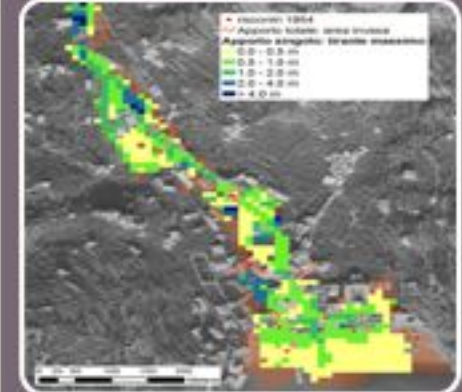
rainfall with a given intensity duration, and probability



land stability model



hydrograph of solid-liquid discharge



flow propagation model

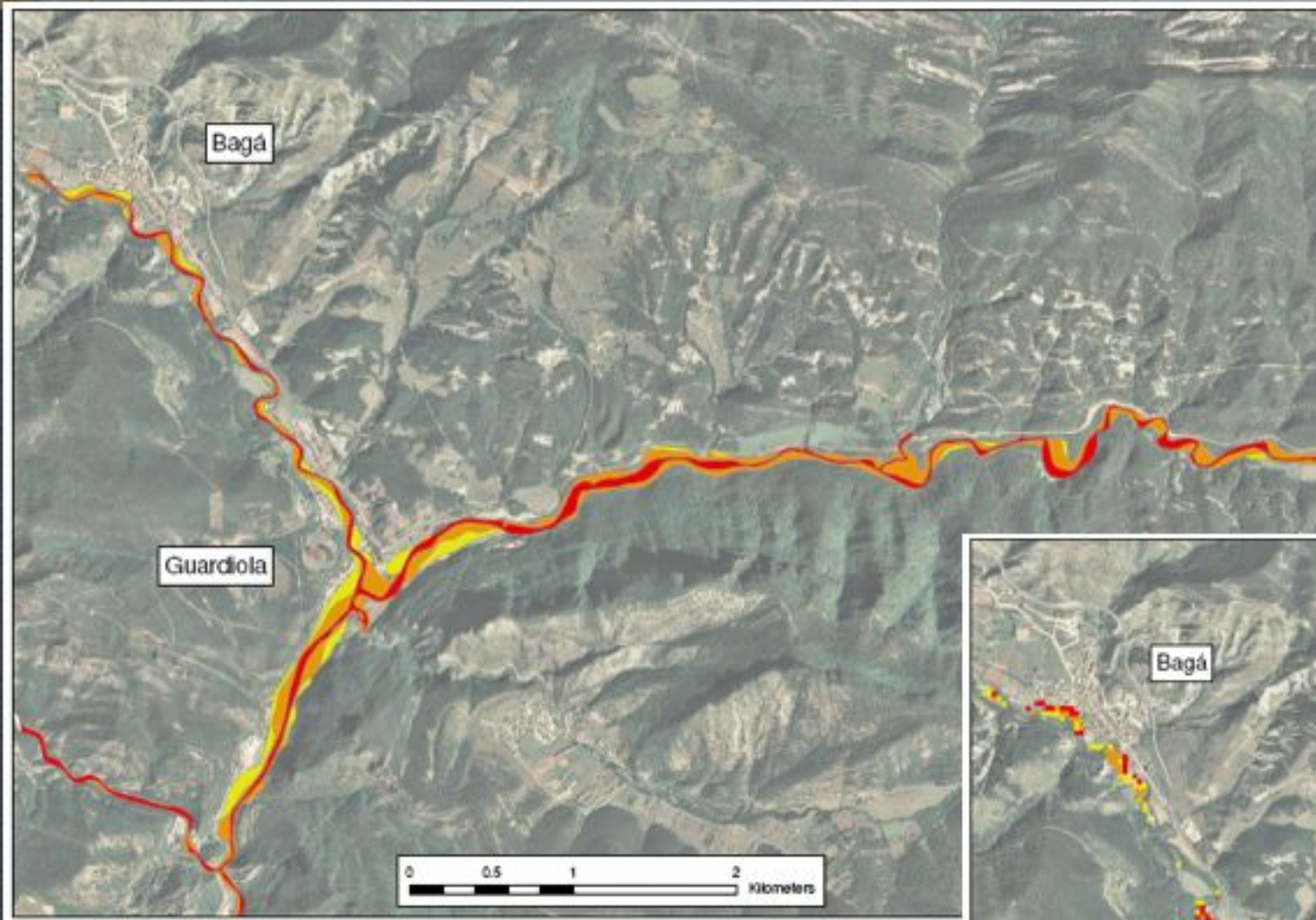
Occurrence probability of the event

warning is given when a the instable total volume is greater than a critical value

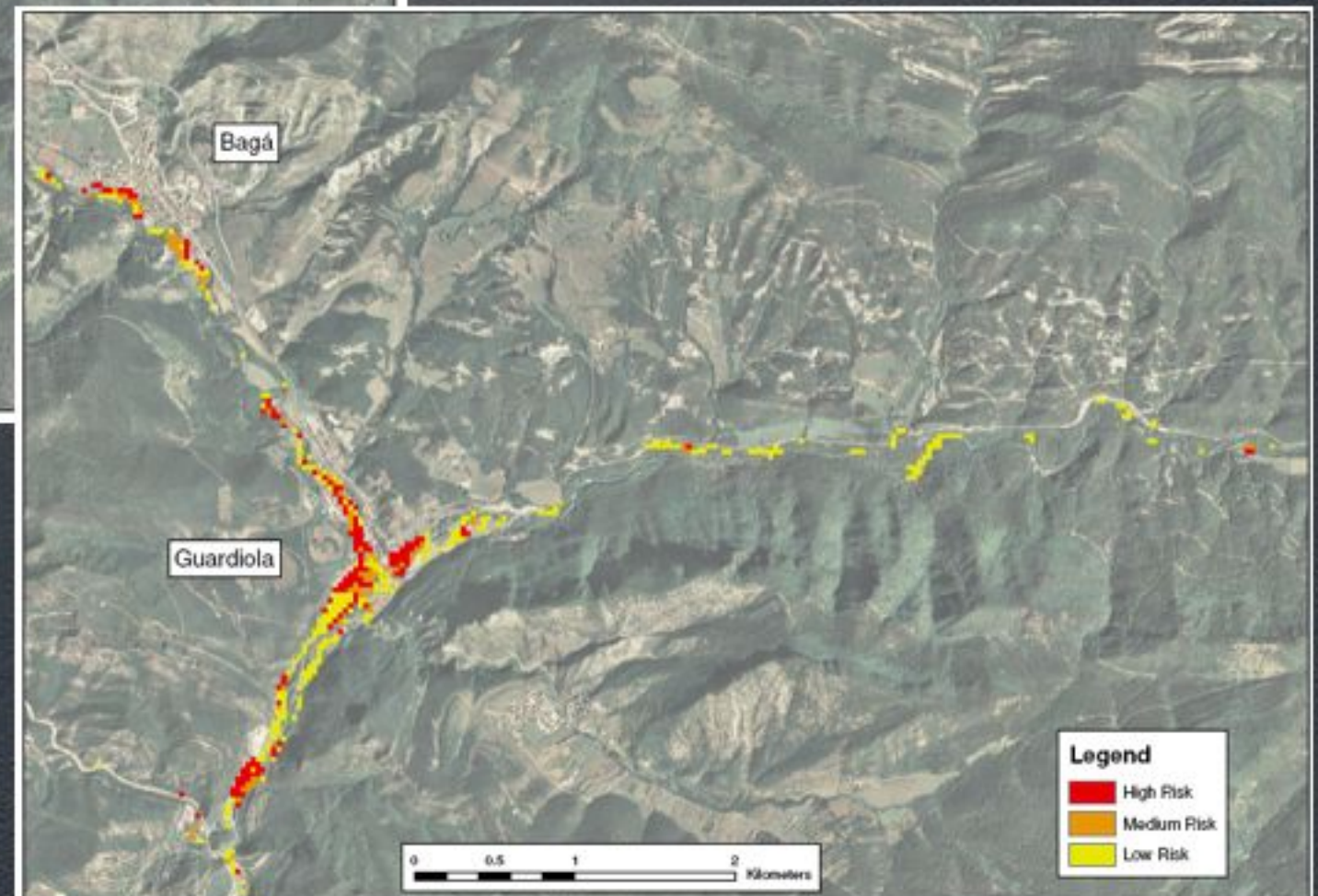
Map of event intensity

**Hazard map
Probability of
occurrence**

IMPRINTS



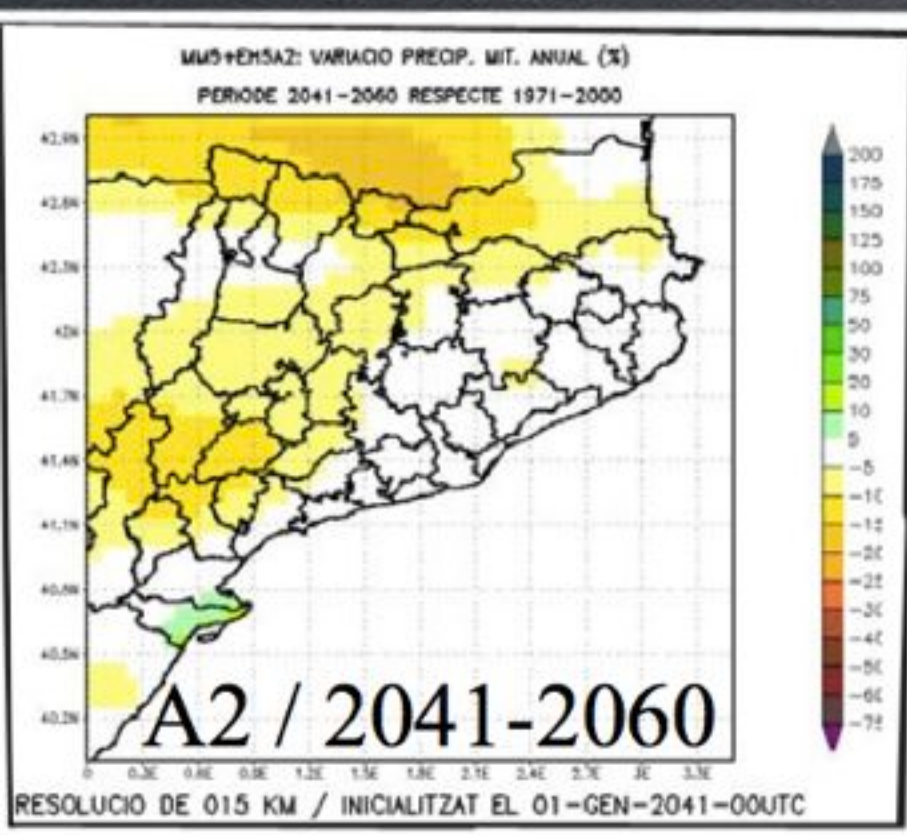
FF & DF Hazard and
FF & DF Risk maps



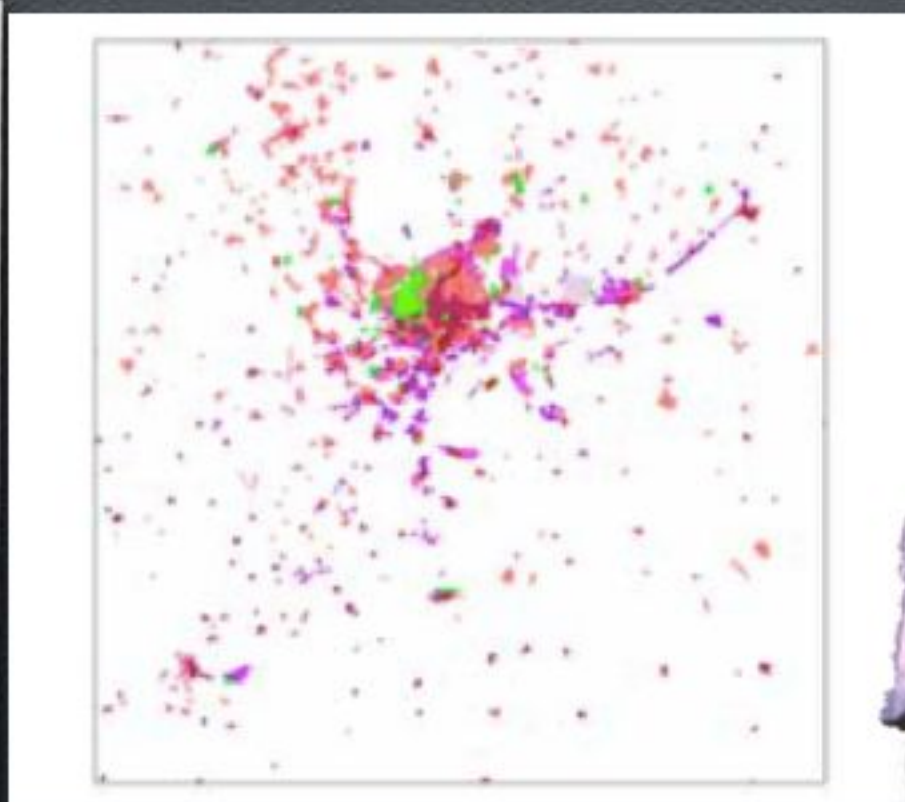
Impact of future changes

IMPRINTS

- Using the ruled-based system to assess impacts on **FF & DF occurrences** due to changes in:
 - Rainfall regime due to climate change
 - Basin responses following scenarios of potential future socioeconomic and land use changes and impact of forest wildfires



Annual variation of Precipitation (%)



Urban area growth based on selected scenarios
Source: JRC



Hydrological Impact of forest fires

Expected Results

IMPRINTS 

***Forecasting and
Warning Systems***

RESEARCH

APPLICATIONS

***Better
Understanding***

***Operational
Tools***

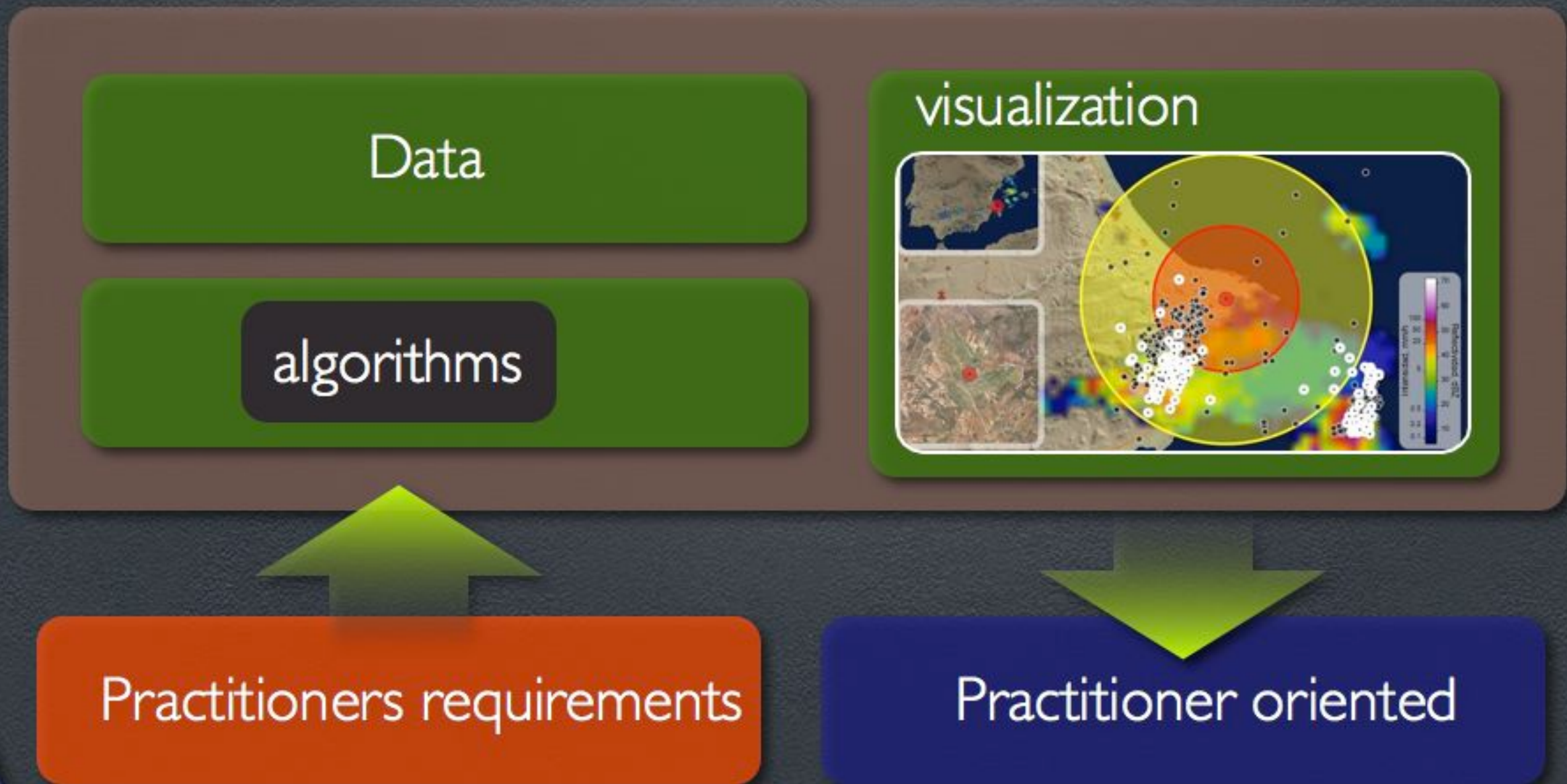
“Papers”

***“Decision making
support systems”***

**Produce a prototype of the Tools' platform
designed to be used around the EU**

Practitioner's Tool

- Development of a prototype of the operational FF & DF forecasting platform



Practitioner's Tool

Expected Tools:

Radar ensemble nowcasting

Probabilistic FF & DF
early warning system

Merging (radar + NWP)
ensemble forecasting

Hydrological probabilistic FF
forecasting system

Areas of high FF & DF
potential risk

Rule-based probabilistic FF &
DF forecasting system

Nowcasting

Forecast



Rainfall field

Radar estimates

30 min accumulation

1h accumulation



Warnings

local warning

flash flood warning

debris flood warning

aggregated warning

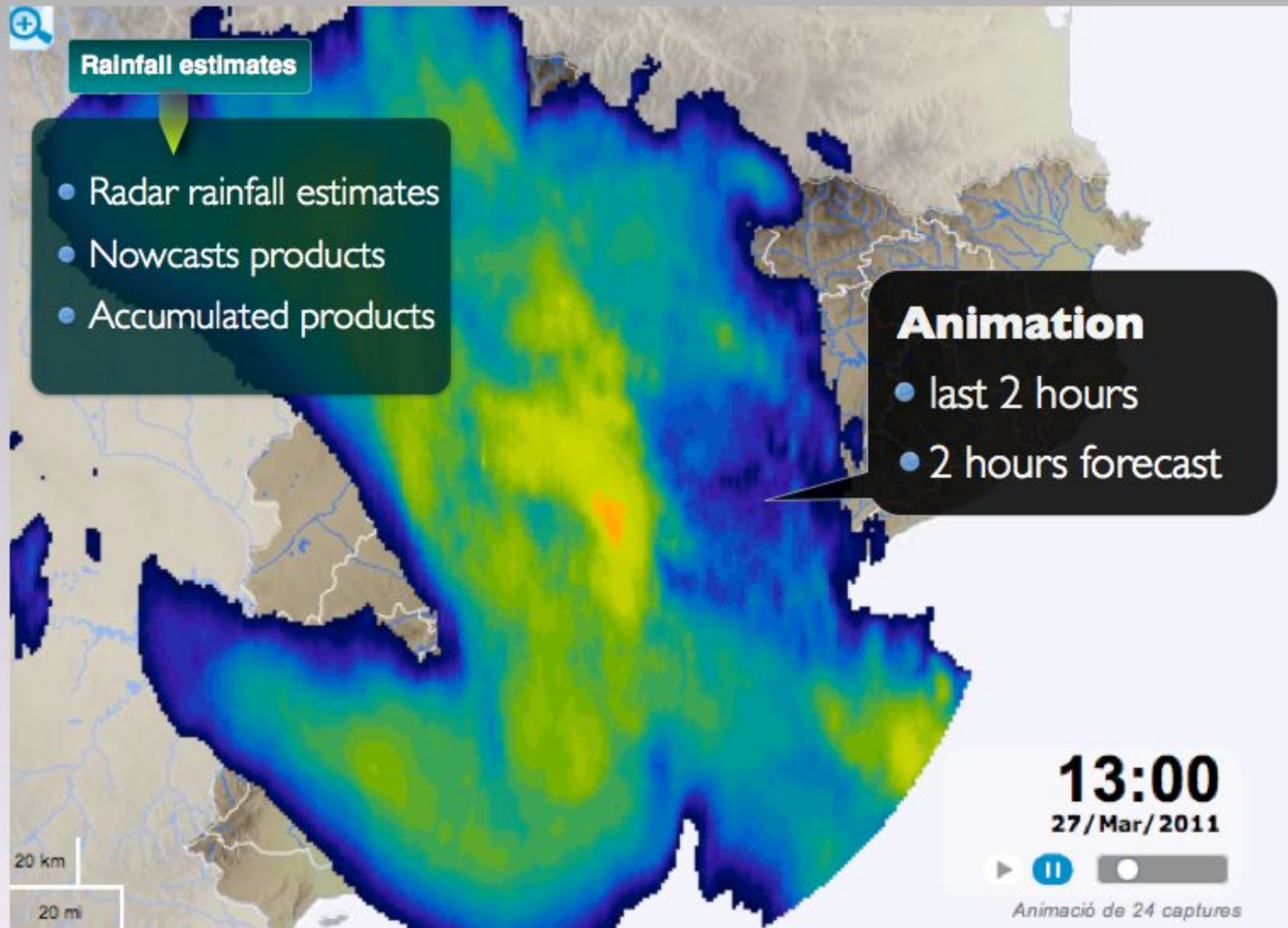


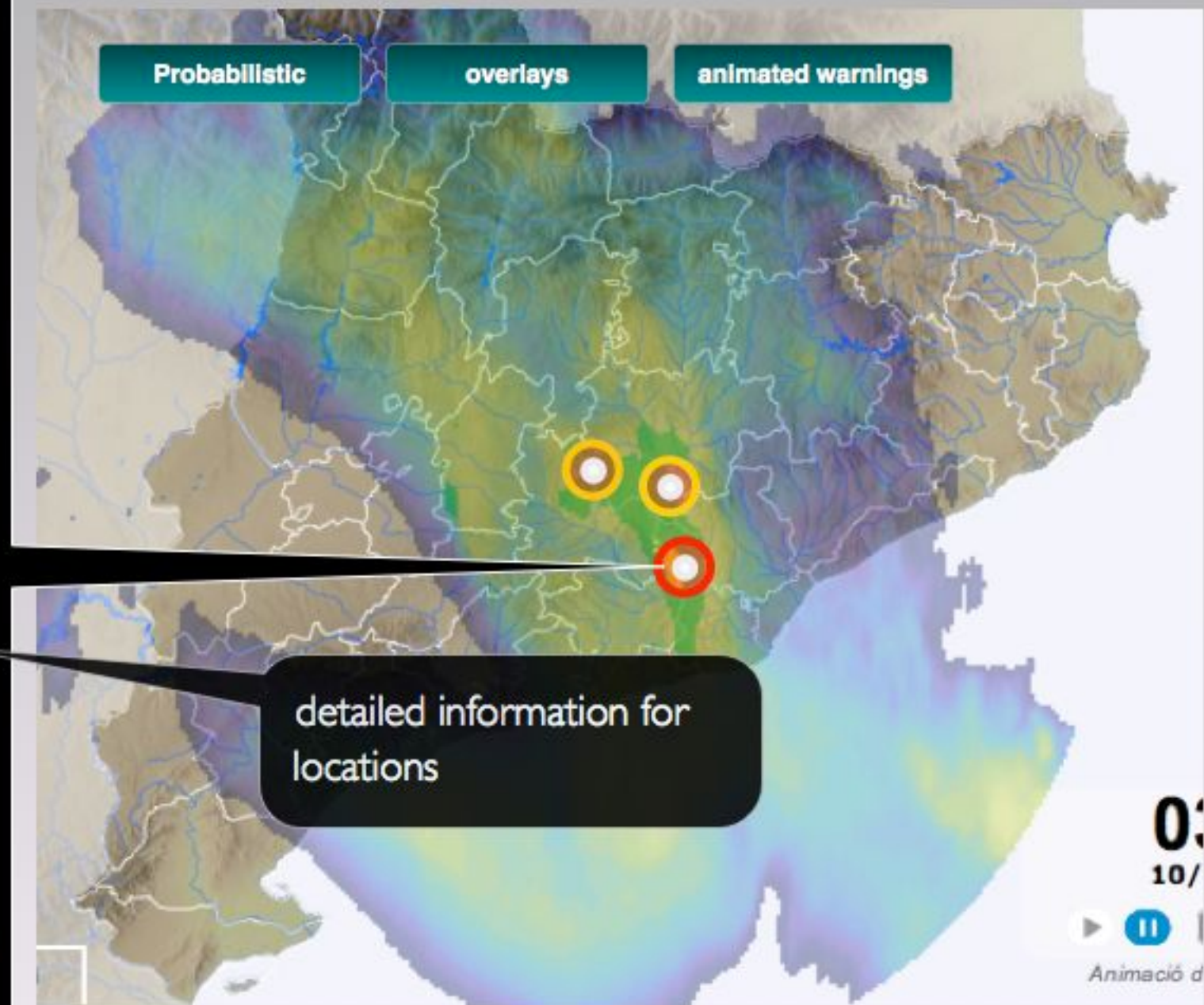
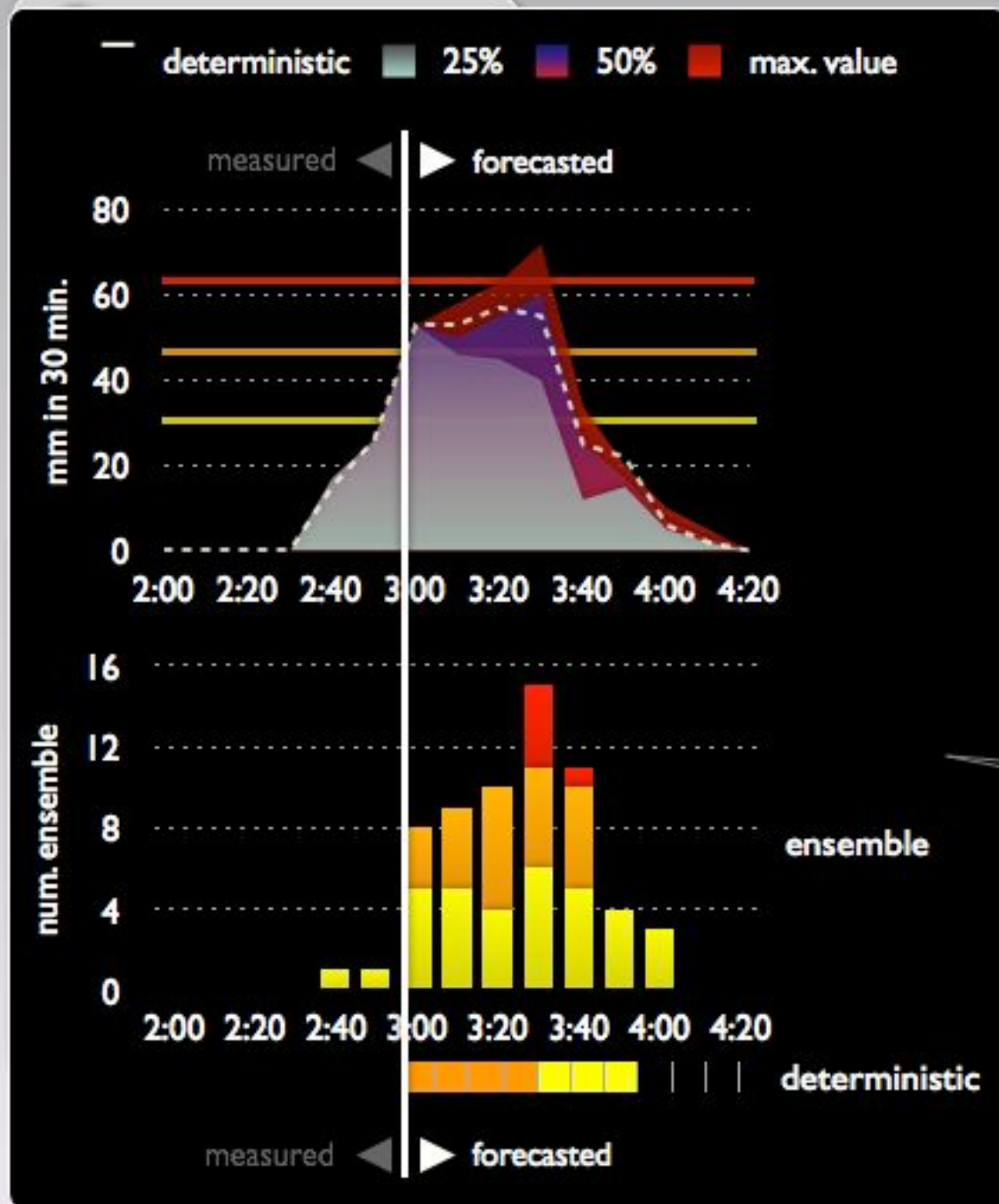
Rainfall estimates

- Radar rainfall estimates
- Nowcasts products
- Accumulated products

Animation

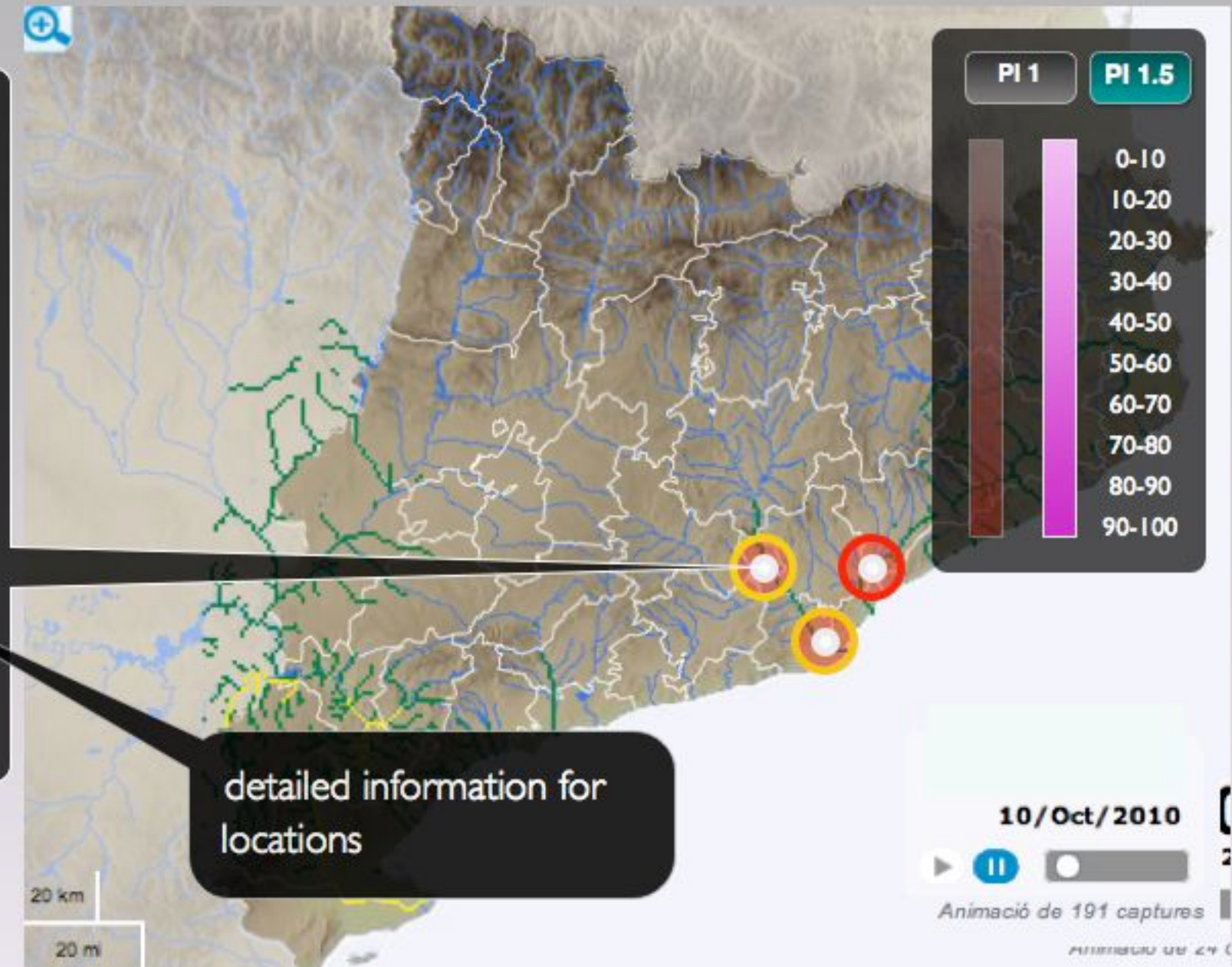
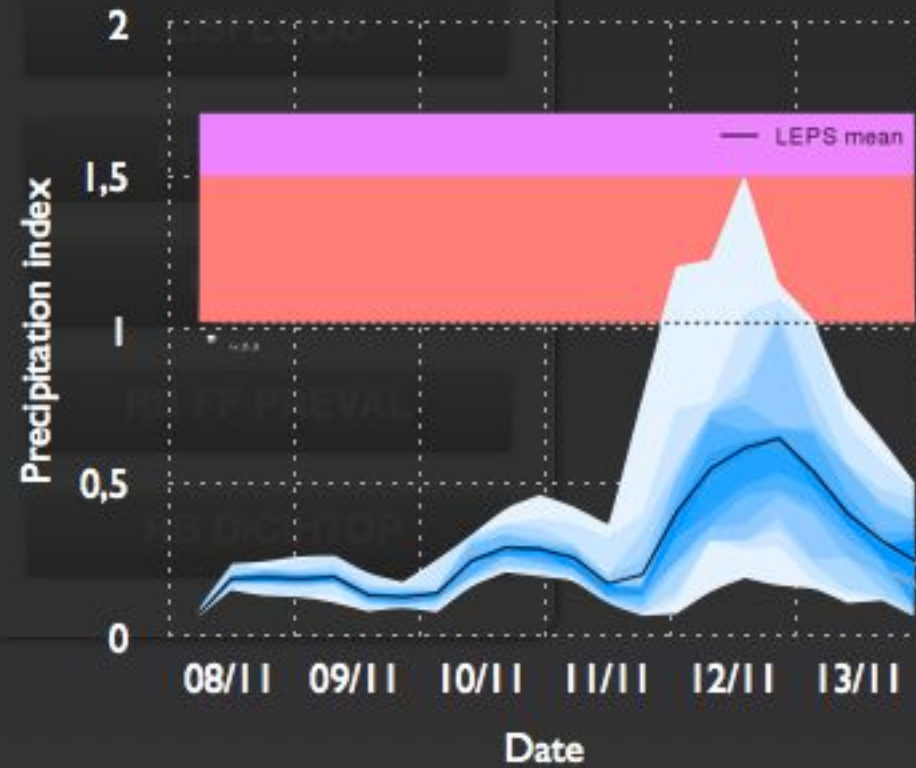
- last 2 hours
- 2 hours forecast







Warnings





Workshops

IMPRINTS 

4 Workshops supporting the Implementation of the European Flood Directive

ET NATIONAL WORKSHOP ON THE implementation of the EU Flood Directive in Mediterranean coastal tools and challenges for risk management

Barcelona, 12th June 2010

Agència Catalana de l'Aigua

IMPRINTS 

Partners:

Escola de Carri

UNIVERSITAT POLITÈCNICA DE BARCELONATECH

FP 7 Cooperation Work Programme: coordination : Daniel Sempere-Torres Universitat Politècnica de Catalunya imprints@imprints-fp7.eu

IMPRINTS

Escola de Carri

UNIVERSITAT POLITÈCNICA DE BARCELONATECH

FP 7 Cooperation Work Programme: coordination : Daniel Sempere-Torres Universitat Politècnica de Catalunya imprints@imprints-fp7.eu

IMPRINTS

METEO FRANCE

Workshops

IMPRINTS 

4 Workshops supporting the Implementation of the European Flood Directive

1st **IMPRINTS Workshop**

Barcelona (Spain) 17th June 2010

Risk identification oriented

2nd **Toulouse (France)** 4th February 2011

Mediterranean area oriented

3rd **Salerno (Italy)** 26th January 2012

Debris flow oriented

4th **Brussels (Belgium)** 20th September 2012

Presentation of the platform for Decision makers



Dissemination videos

IMPRINTS

www.imprints-fp7.eu

[Admin Area](#) | [Project Team Area](#)

IMPRINTS

[Home](#)

[Overview](#)

[WorkPlan](#)

[Status & Results](#)

[Events & Activities](#)

[Dissemination](#)

[News](#)

[Links](#)



Natural Hazards

IMproving Preparedness and Risk maNagementT for flash floods and debriS flow events
(IMPRINTS) - EC FP7 project

[Disclaimer](#) [Contact us](#)

IMPRINTS



www.imprints-fp7.eu

TECNIO

Be tech. Be competitive

