



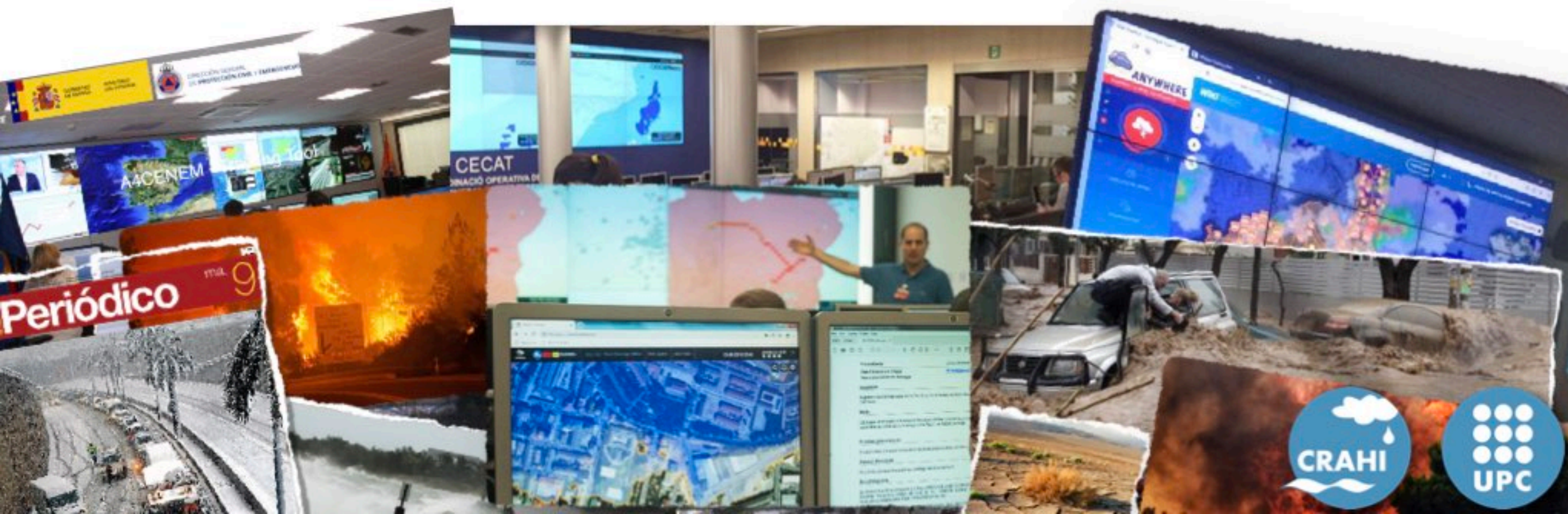
ANYWHERE



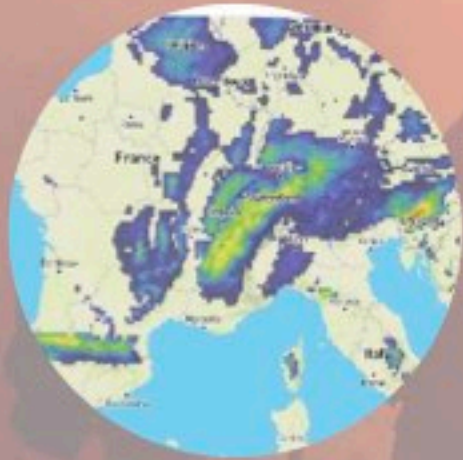
www.anywhere-h2020.eu

The ANYWHERE operational decision support tools for emergency management centres

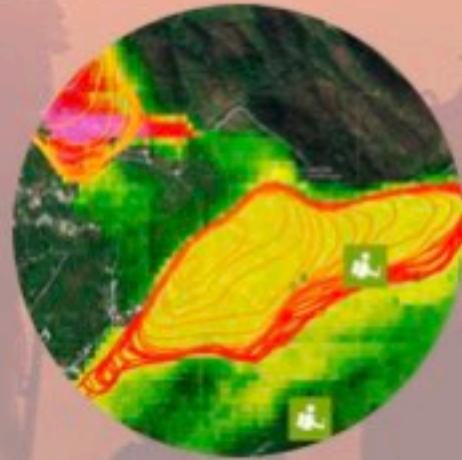
Prof. Daniel Sempere-Torres
UPC-CRAHI - Barcelona



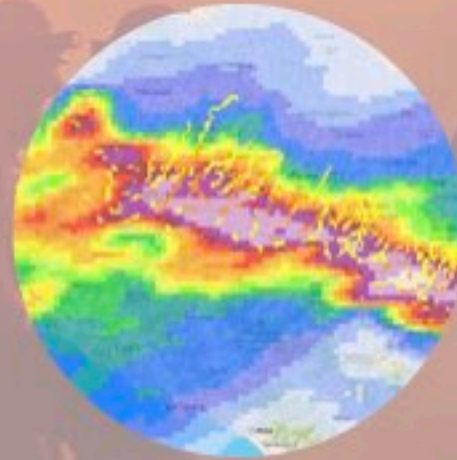
The ANYWHERE approach based on **impact forecasting** represents a disruptive innovation in the field of the **climatic emergencies operational management**



**Meteorological
forecasts**



**Hazard
forecasts**



**Impact
forecasts**



**Actionable
decisions**



**Operational
solutions**





Catalogue products

[All products](#)
[Meteorological forecast](#)
[Floods and flash floods](#)
[Weather-induced Forest Fires](#)
[Droughts](#)
[Heatwaves](#)
[Convective storms and severe winds](#)
[Storm surges](#)
[Snowfall](#)

 Accumulated rainfall forecasts	 Daily total precipitation probability	 Extreme Forecast Index
 Most probable precipitation type	 Observed daily rainfall accumulation	 Probability of precipitation type
 Radar-based rainfall accumulation forecasts	 Radar-based rainfall accumulation probability	 Deterministic gust forecast
 Wind gust probability	 Average daily temperature	 Flash flood hazard forecasts
 Flash flood impact forecast	 Landslide and debris flow hazard forecast	 River flood impact forecasts
 Probabilistic river flood hazard forecasts	 Simulated snow accumulation	 Simulated soil moisture
 Burned area	 Fire Danger early warning	 Fire Danger Index
 Rate of spread	 Fire Weather Index	 Build Up Index
 Duff Moisture Code	 Drought Code	 Fine Fuel Moisture Code
 Initial Spread Index	 Drought in precipitation	 Drought in precipitation-evapotranspiration
 Drought in soil moisture	 Drought in runoff	 Drought in discharge
 Drought in groundwater	 European air quality forecasts	 Heatwave Index (UTCI)
 Deterministic gust forecast	 Wind gust probability	 Convective storms
 Storm surge sea level	 Storm surge inundation hazard	 Storm surge hazard level
 Safe Corridor Width	 Deterministic snow and hoar load	

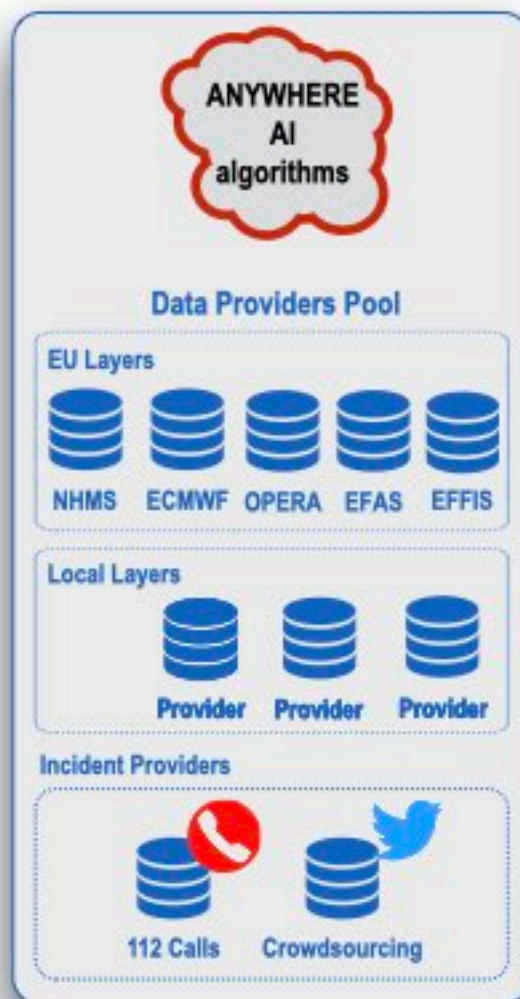
**Translate best adapted
METEOROLOGICAL
FORECASTS into *IMPACT*
FORECASTS**

**Multi-Hazard
impact-based
Early Warning System
MH-EWS products**

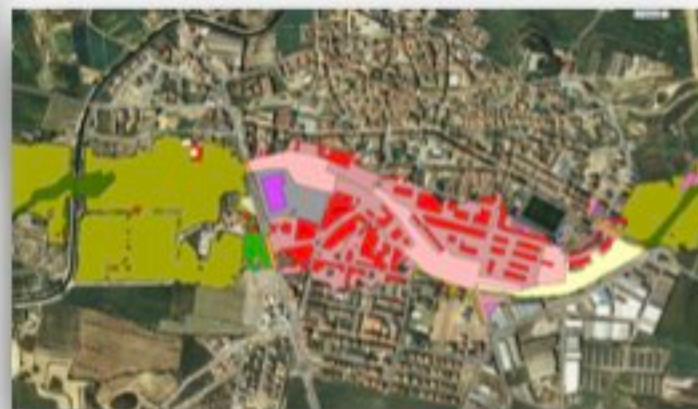
www.anywhere-h2020.eu/catalogue

ANYWHERE FOR EU (A4EU): MULTI-HAZARD EARLY WARNING AND DECISION SUPPORT SYSTEM

Multi-Hazard Impact forecasting EWS



Impact forecasting Products





7 Pilot Sites: 24/7 Operational Demonstrations

*(but can be implemented
ANYWHERE in EUROPE...)*





Excellent results during experienced emergencies



"We've made a huge change of the way we deal emergency situations, specially in the case of floods, because now we are able to move forward and be advance to the impact, so we are able to alert citizens of one area to avoid damage. Previous to this tool we had to wait to the impact and have a rapid response but always after the impact."

Sergio Delgado, Deputy-Director of Catalonia Civil Protection

Catalonia



"It's a very useful platform for our command centre and simple to use. We've used it to assist and to improve the anticipation managing different climatic events. The platform provides very precise information and allows you to best anticipate, to best dispatche means on the field and to be able to alert the population and the Mayor to avoid damage when facing these events."

Patric Botey, Service Incendie et Secours de Corse

Corsica



"Using this tool, the Civil Protection authorities are actually able to raise the preparedness levels even before the formal notification from the Finish Meteorological Institute is sent. Now everything is authomatisized and we have better data, the system automatically reacts and we can start to advise people."

Pekka Tiainen, Finnish Ministry of Interior (FMol)

Finland



"A4CENEM allows the National Emergency Centre to have access to complementary information in a centralized way, when managing serious risks, providing added value compared to the use of isolated and dispersed data. The possibility of integrating products from different sources, topics and geographical areas (local, regional, national and European) into a single viewfinder."

Bibiana Andújar, DGPCE Chief of Operations

Spain

(can be implemented ANYWHERE in EUROPE...)



ANYWHERE 



European
Civil Protection

How we can support decision making at operational control centers during flood emergencies?



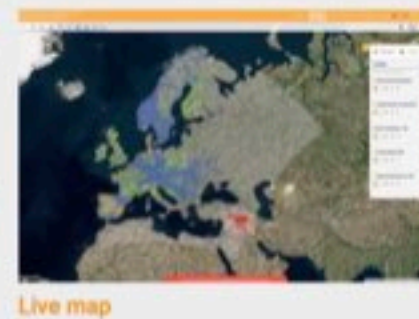
Flood and flash floods forecasting

EUROPEAN FLOOD AWARENESS SYSTEM (EFAS)

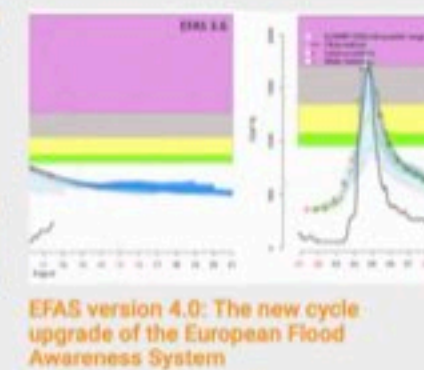
Latest events



Access the map viewer



Latest news



European Flood Awareness System

The aim of the European Flood Awareness System (EFAS) is to support preparatory measures before major flood events strike, particularly in the large trans-national river basins and throughout Europe in general

SERVICES



Map viewer

The new EFAS viewer with an intuitive graphical interface



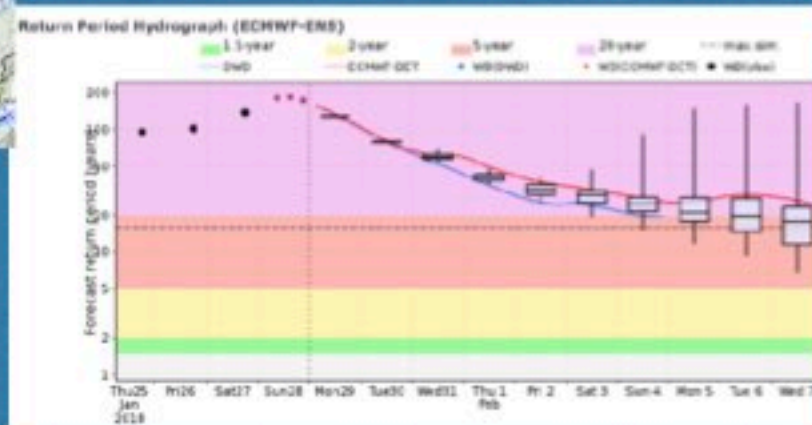
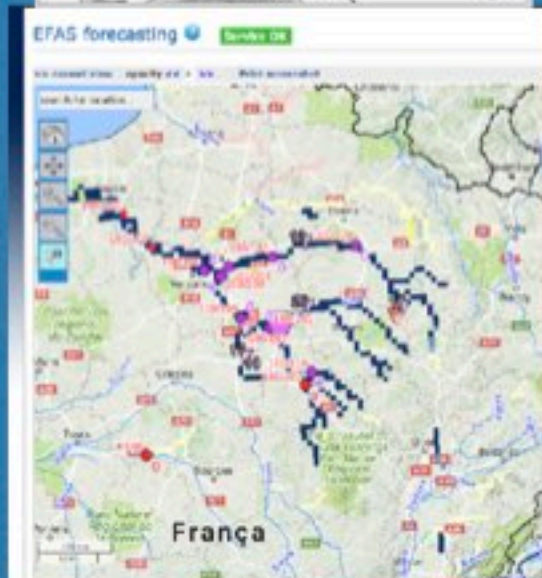
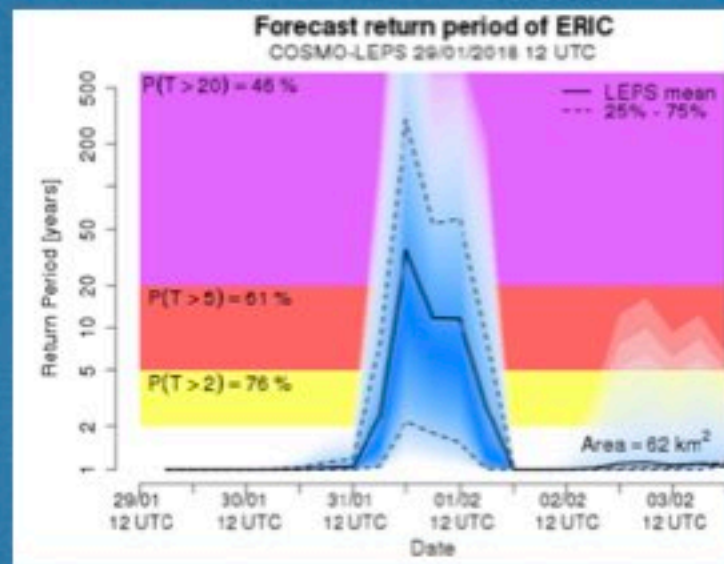
Data Access



Training

EUROPEAN FLOOD AWARENESS SYSTEM (EFAS)

FROM 72h to 6h ahead
NWP forecasts

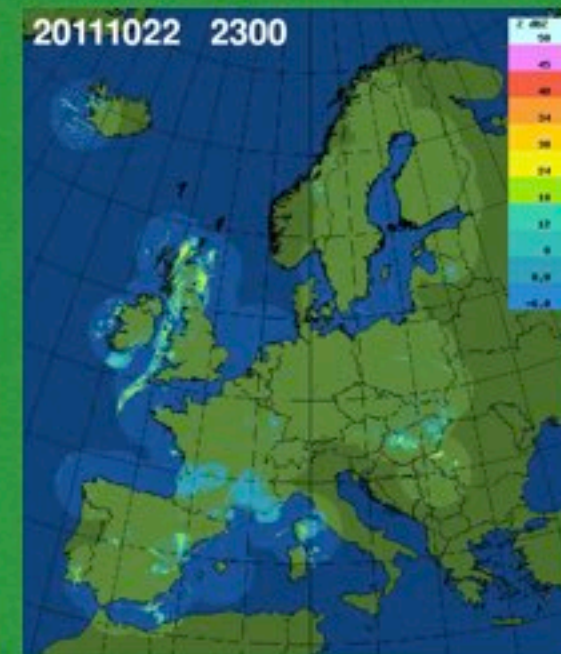


EFFS

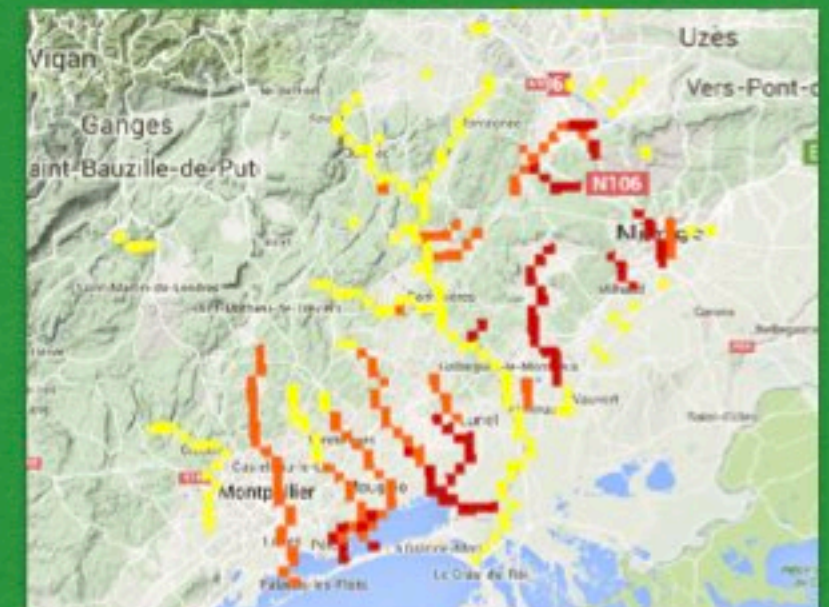
IMPRINTS



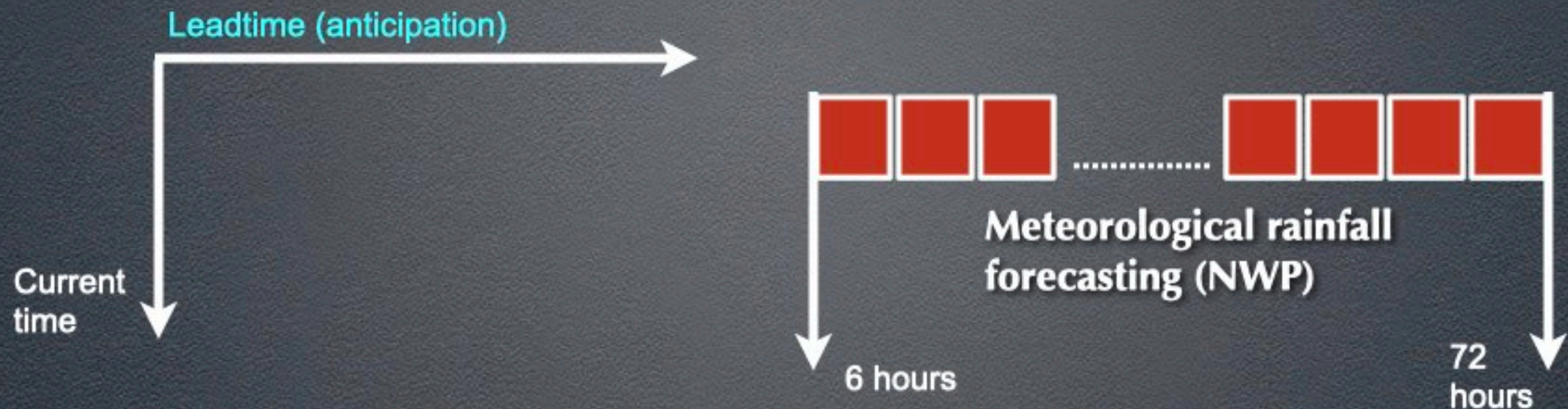
FROM 6h to 2h ahead
RADAR BASED Nowcasting



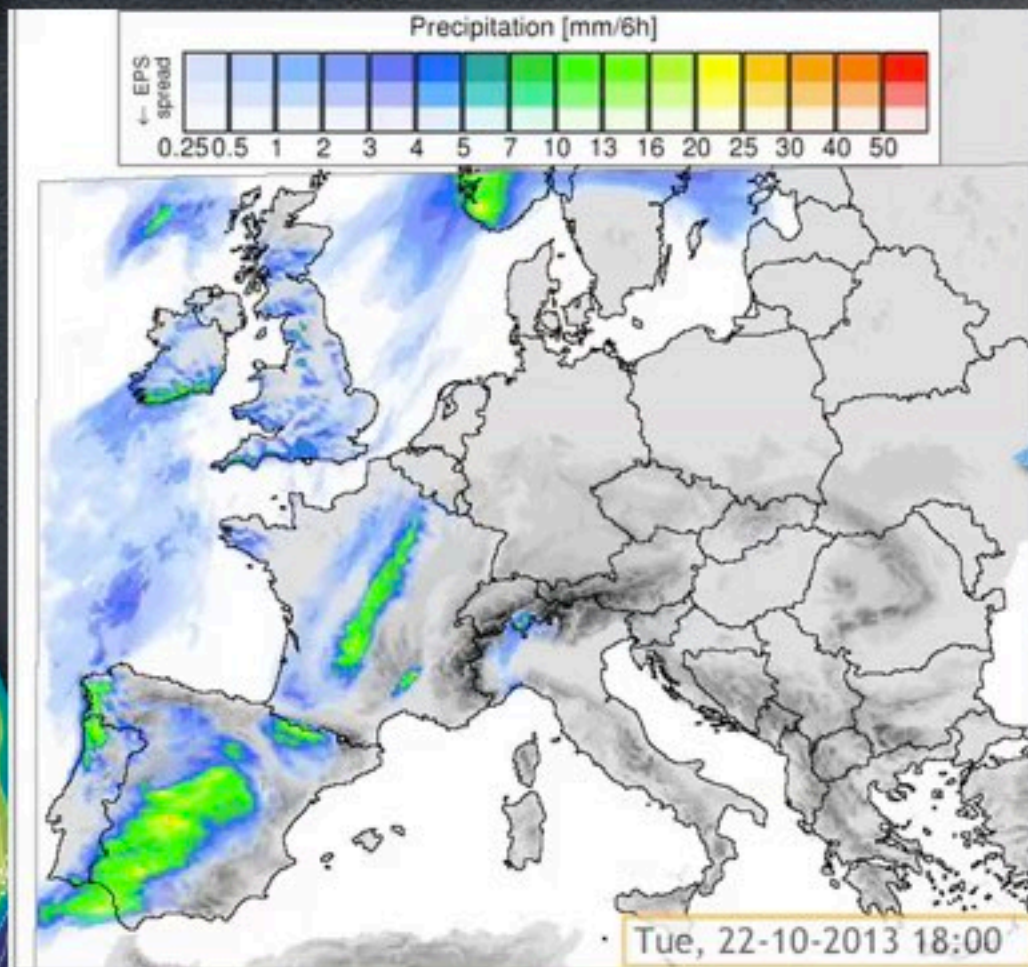
ERICA
FLASH FLOOD
INDICATOR



Increasing anticipation of heavy rainfalls



- Adapting high-resolution meteorological weather forecasts to their use for FF & DF early warnings (from 6h to 72 h)



Initialisation with ECMWF-VAREPS
(15 days, 51 members, 32 km resolution)

Operational COSMO-LEPS
7 km spatial resolution
since Dec 2009

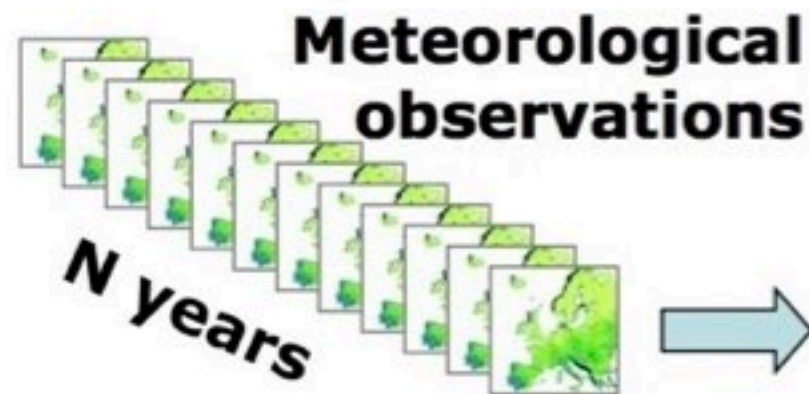
Probabilistic Forecast COSMO-LEPS
20 Ensembles

Source: MeteoSwiss-
COSMO Consortium

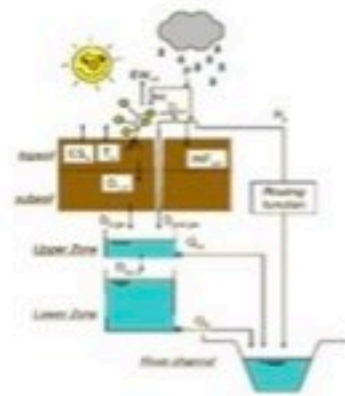


EUROPEAN FLOOD AWARENESS SYSTEM (EFAS)

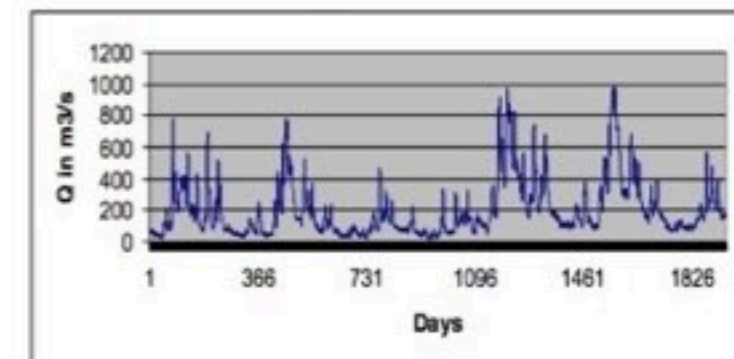
Establish thresholds – from model climatology



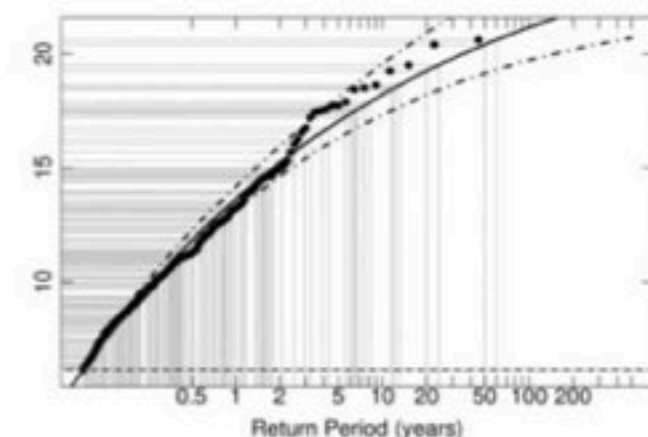
LISFLOOD



Discharge time series

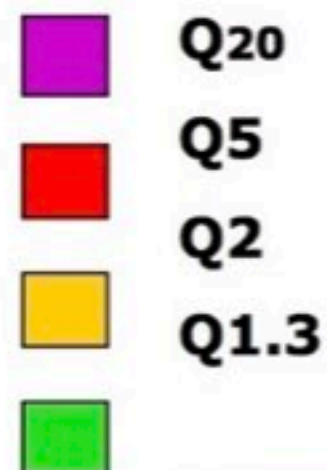


Return period statistics



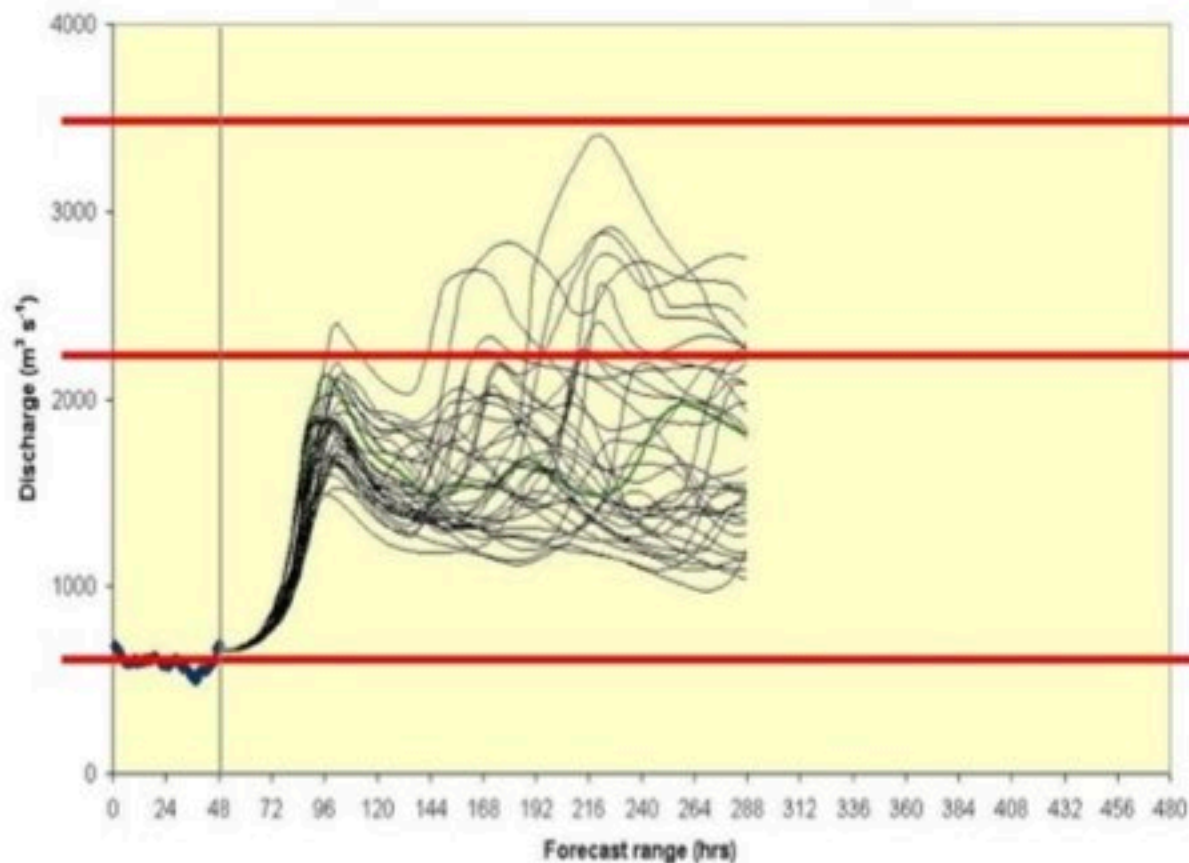
- Thresholds are derived from simulated time series.
- The same model set-up and parameterisations are used in the forecasts to remain model consistent

Thresholds



Concept of threshold exceedance

For flood early warning we want to know if critical discharges are exceeded – not necessarily the discharges themselves



If the threshold for flooding is here, there is no problem

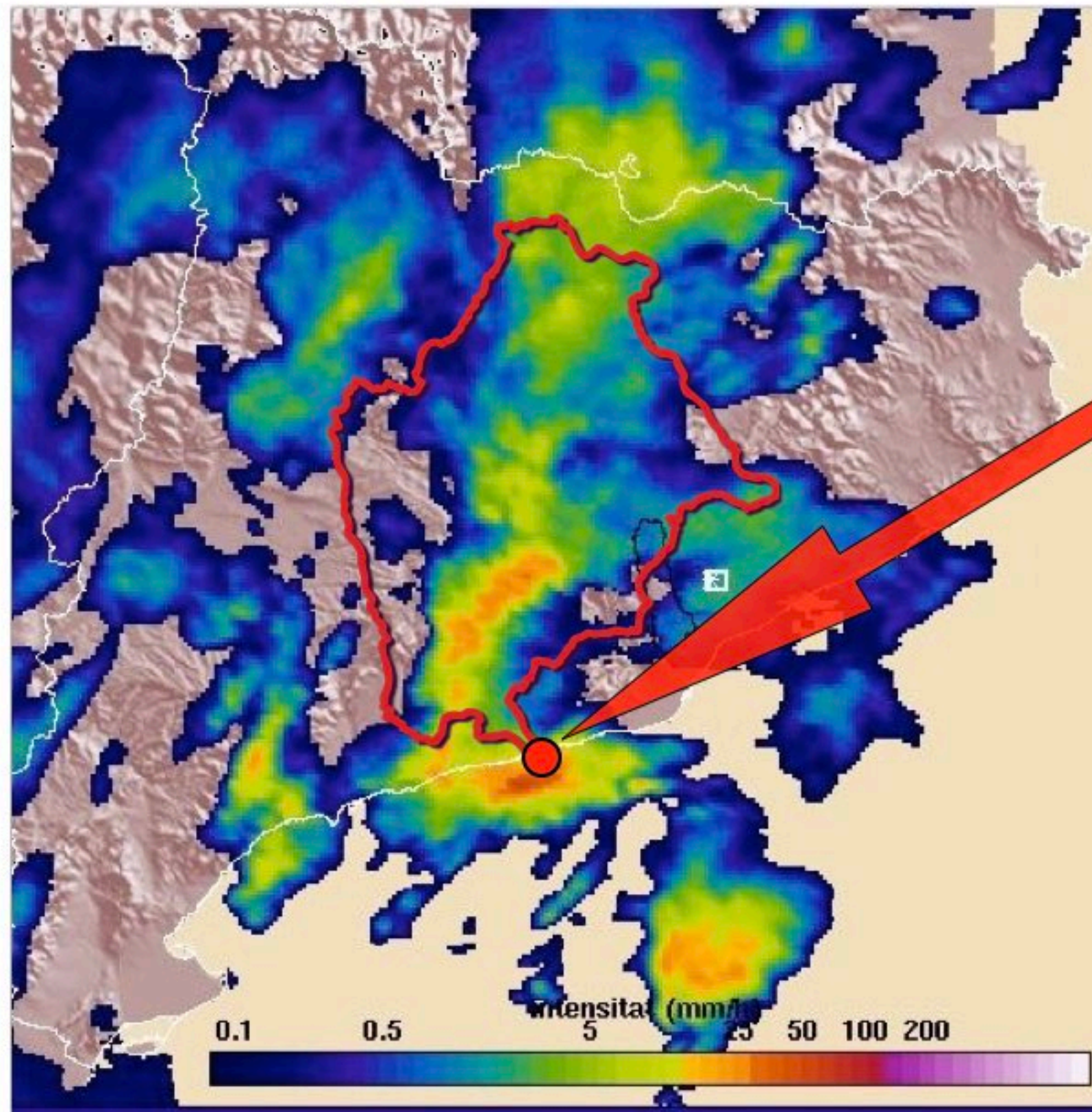
If the threshold for flooding is here, there might be a problem

If the threshold for flooding is here, there is almost certain a problem

In Flash Floods, the basins affected are small (tenths of Km²) and show very quick responses (from 1/2 hour to few hours)



FF-EWS Flash Flood Indicator: Basin aggregated rainfall exceedances



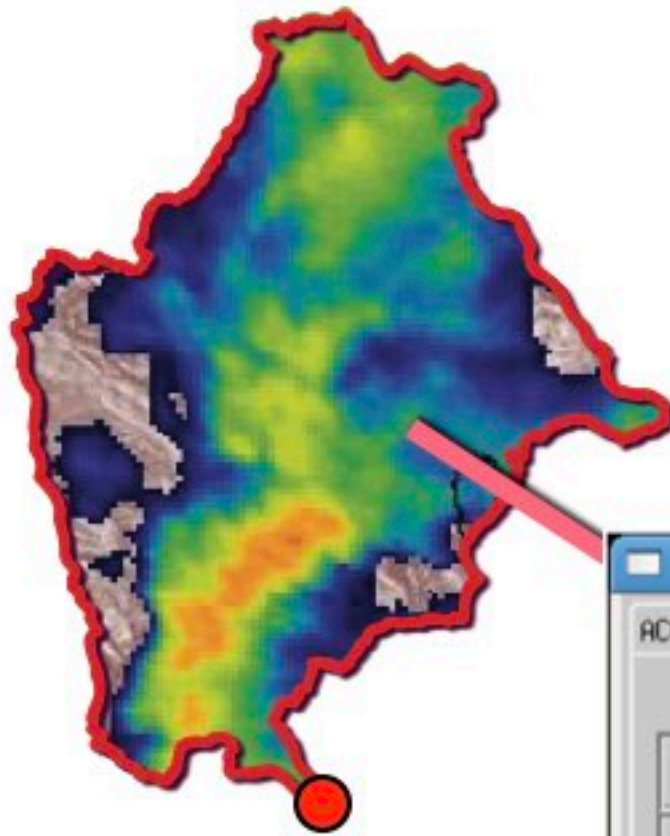
Given a point in the
drainage system,

We can define the
associated basin, and
calculate the rainfall
that will be collected
by the selected point

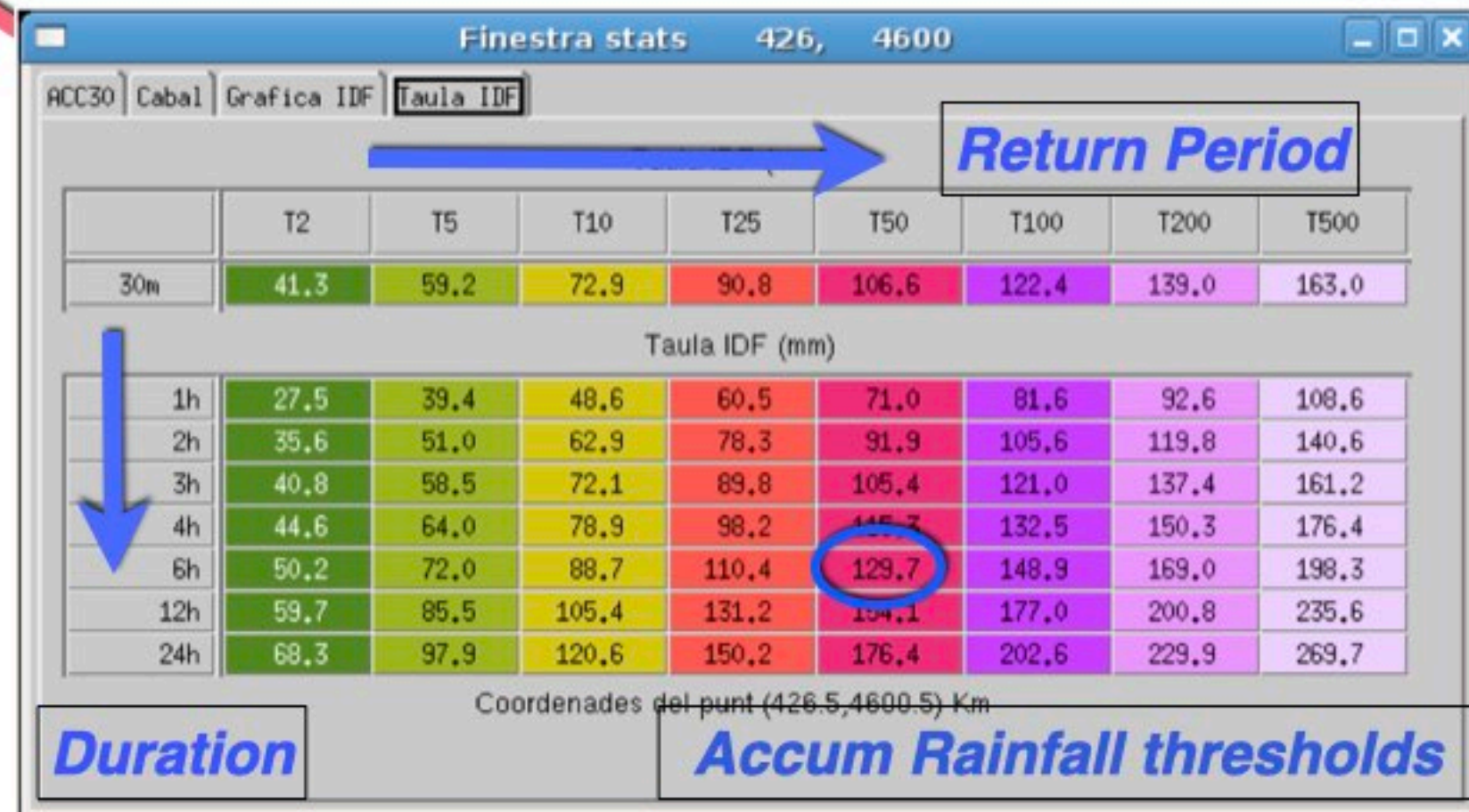


FF-EWS Flash Flood Indicator: Basin aggregated rainfall exceedances

This basin aggregated rainfall is accumulated over the hydrological characteristic time of the basin



And a **probability of Exceedance** is associated (return period in years)



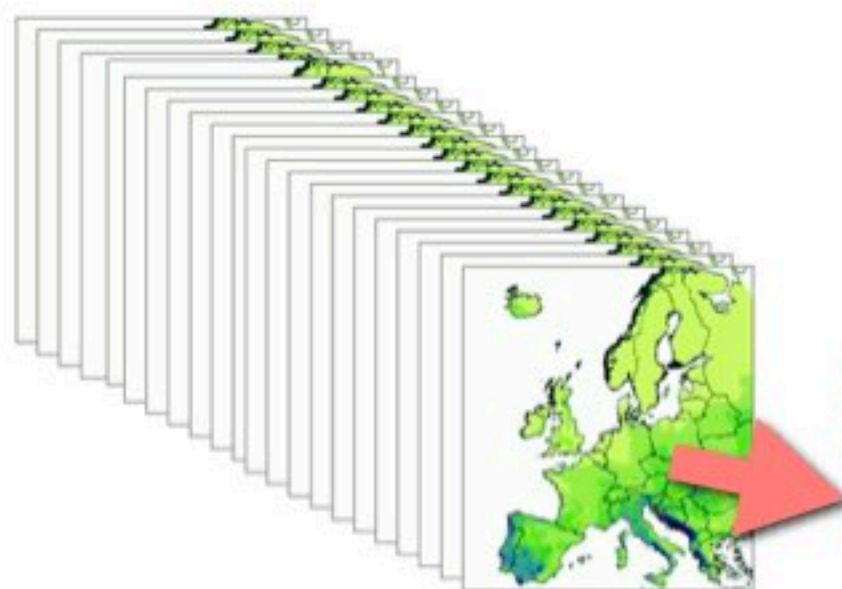
EPIC: European Precipitation Index Climatology

- **30 Years of COSMO-LEPS** reanalysis have been generated.
- For any point in the river system (1 km^2) a **Climatology of its basin aggregated rainfall** is calculated.
- A Precipitation Index based on Climatology is thus calculated at European scale (**EPIC**).
- For any new event the rainfall forecasted is used to calculate the **basin aggregated rainfall, and compared against the EPIC CLIMATOLOGY.**

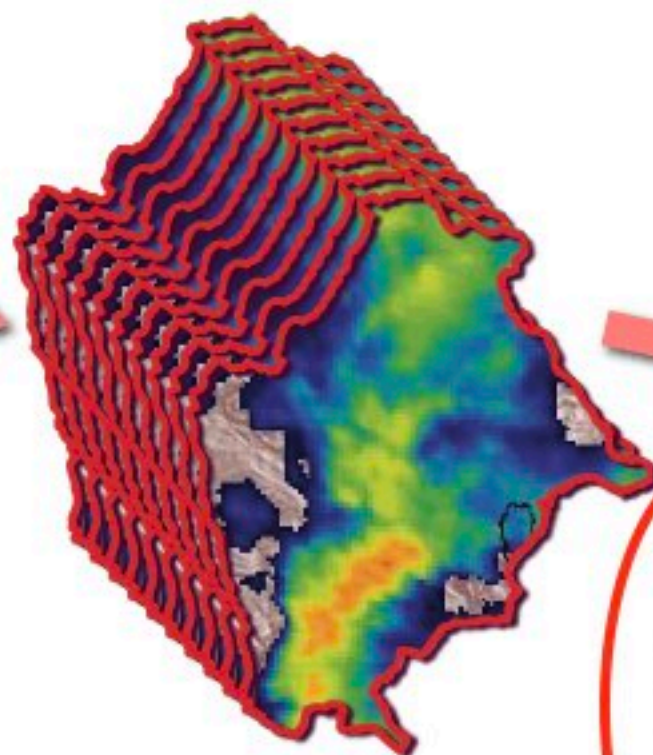
FF & DF early warning systems

IMPRINTS

COSMO-LEPS Probabilistic Rainfall forecasts

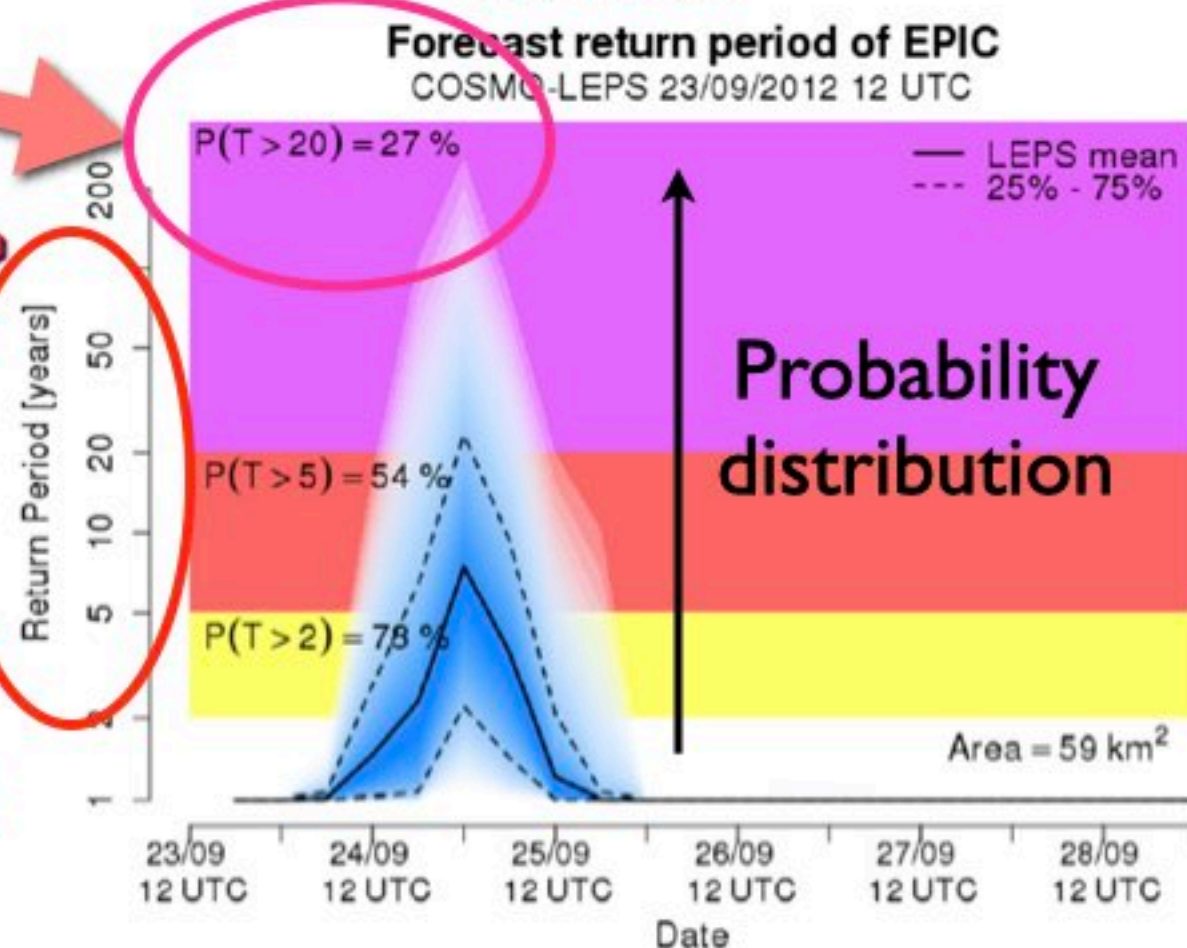


Probabilistic basin aggregated rainfall forecasts



Return Period of any
member calculated by
comparison against EPIC
climatology

Warning code associated
to the 75% percentile
member

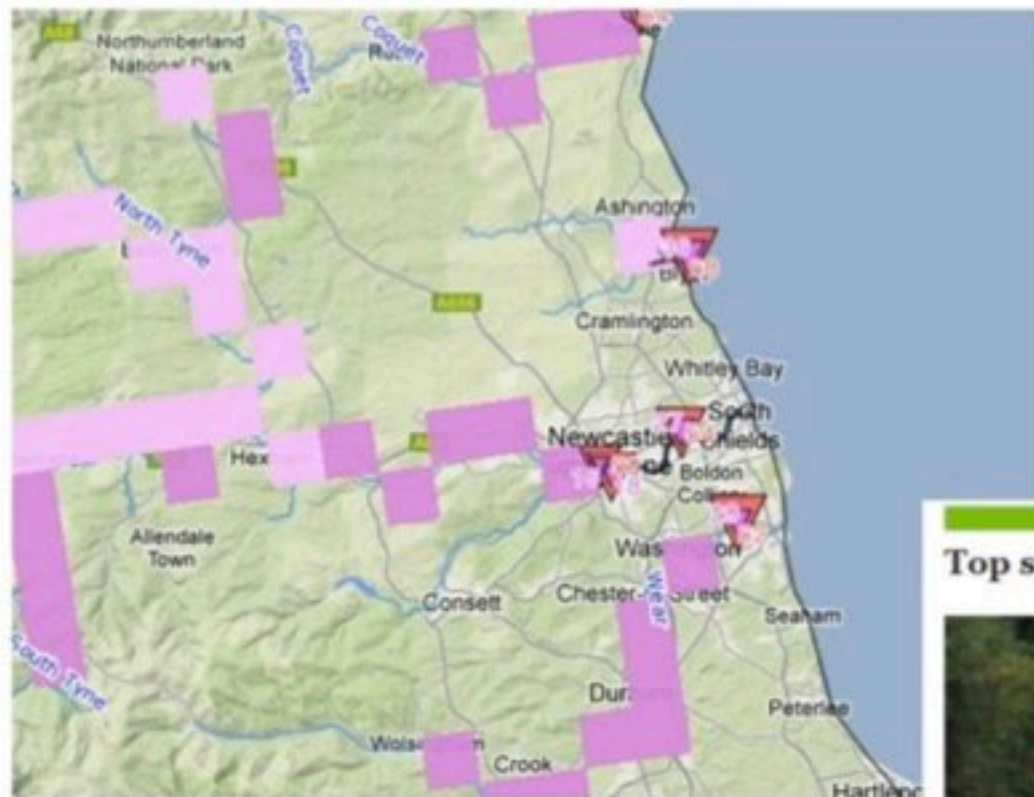


FF & DF early warning systems

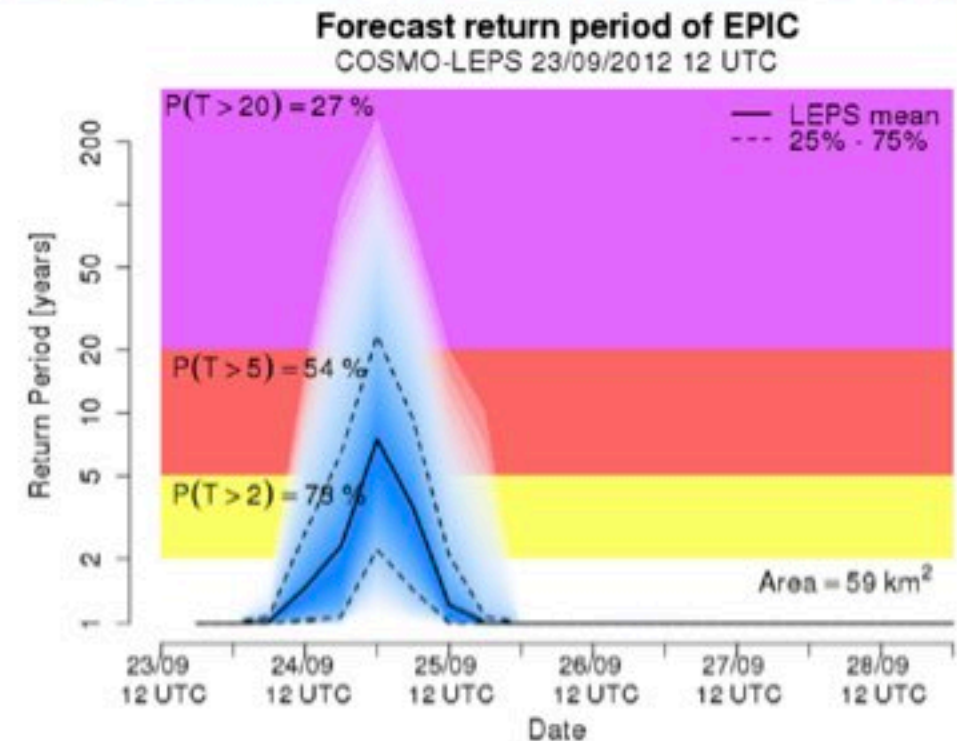
IMPRINTS

Event of 2012-09-25 in Newcastle Upon Time (UK)

EPIC 2012-09-23 12:00



**Forecast 48h
in advance**



Top story



Floods hit 300 homes in north England

26 Sep 2012: River defences under pressure in downpours, while fishing village is left covered in sea foam

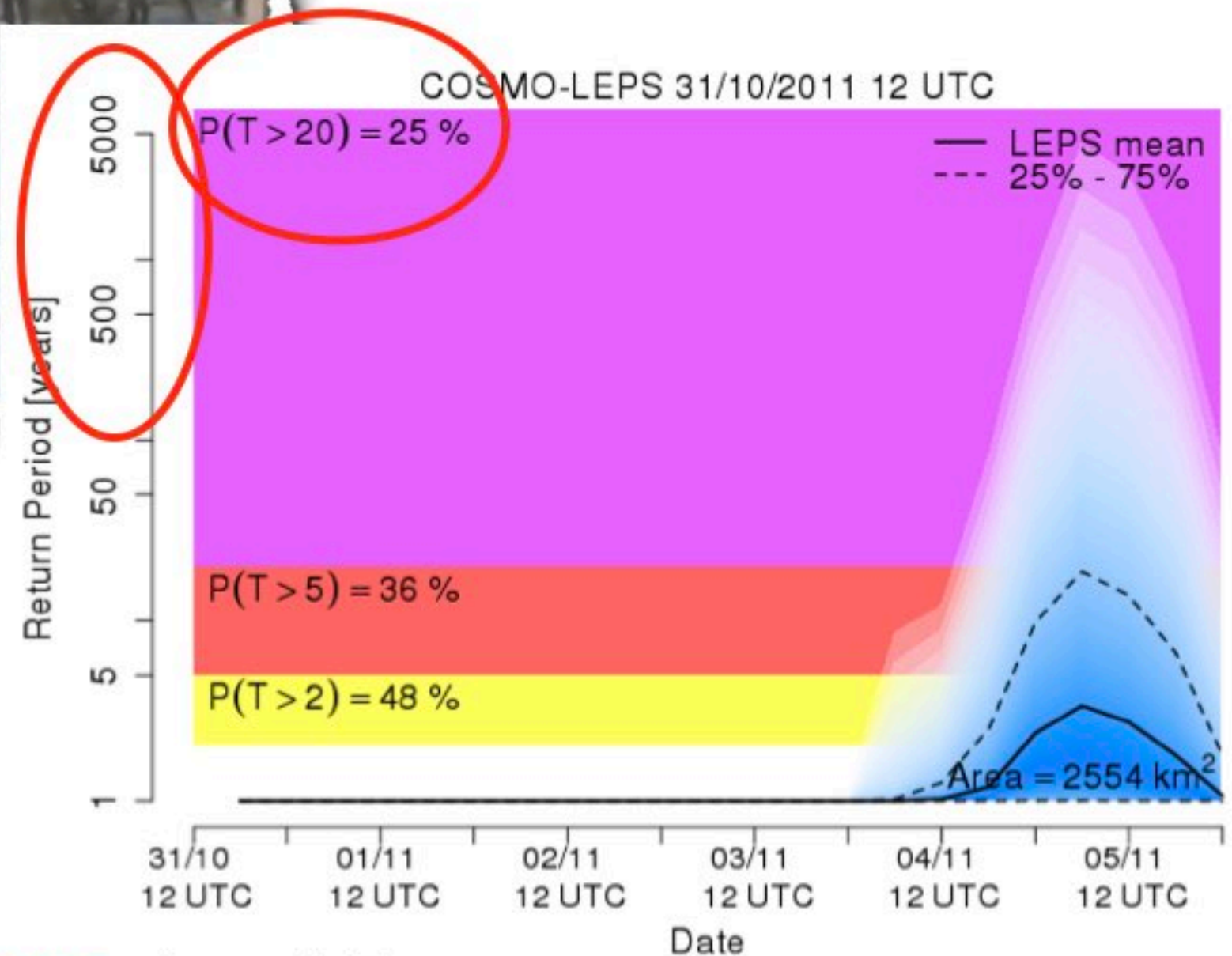
Most recent



Looters of flooded shop condemned by police

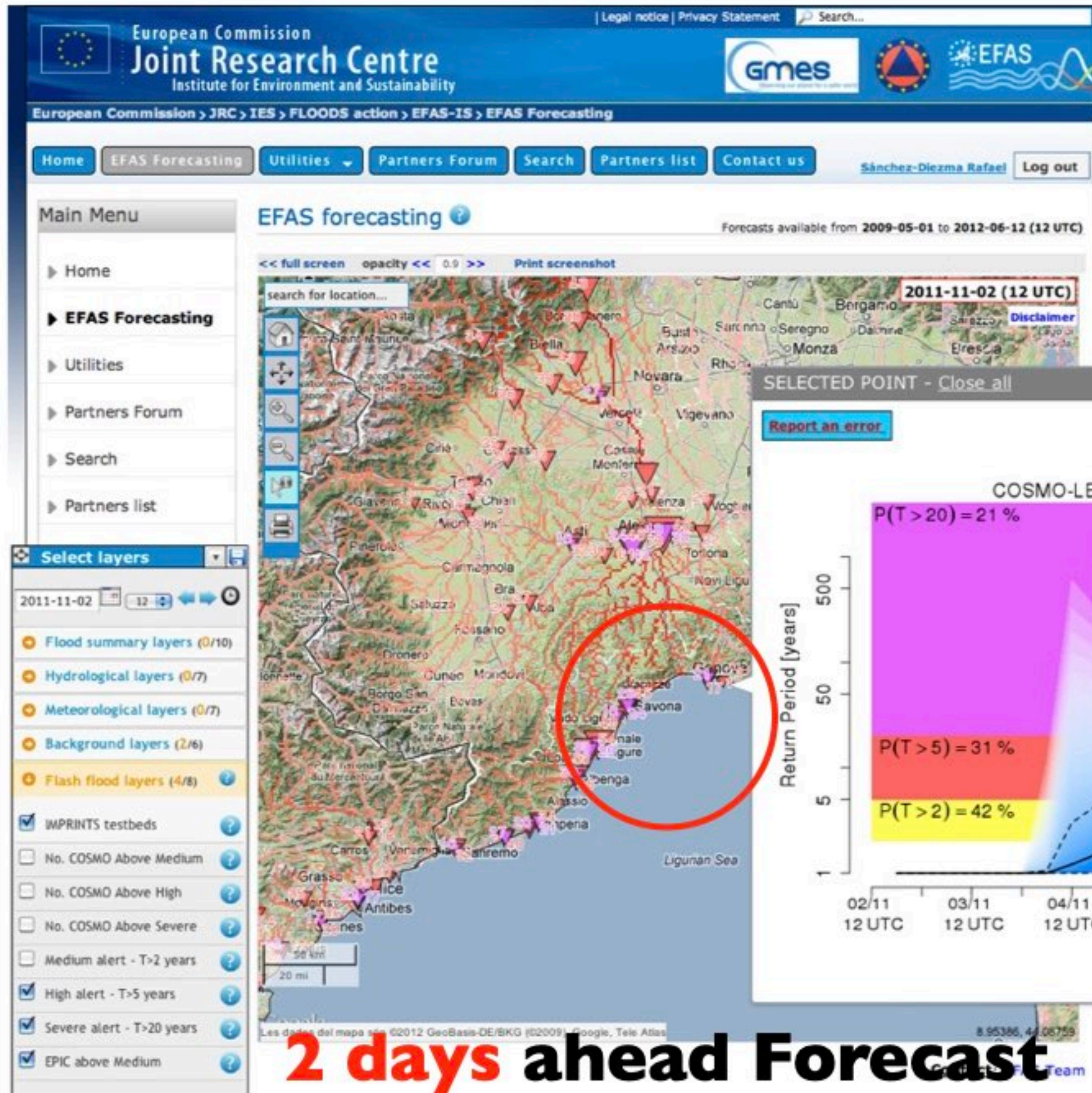
26 Sep 2012: Newcastle upon Tyne cycle shop targeted as swollen rivers cause havoc in northern England

Genova (Italia) 4/11/2011



4 days ahead Forecast

Genova (Italia) 4/11/2011



EUROPEAN FLOOD AWARENESS SYSTEM (EFAS)

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 **JOINT RESEARCH CENTRE**

EFAS European Flood Awareness System

European Commission > JRC Science Hub > IES > EFAS-IES

[Home](#) [About](#) [Bulletins](#) [Archive](#) [Partners](#) [National Information](#)

European Flood Awareness System (EFAS)

The European Flood Awareness System (EFAS) is the first operational European system monitoring and forecasting floods across Europe. It provides complementary, flood early warning information up to 10 days in advance to its partners: the National/Regional Hydrological Services and the [European Response and Coordination Centre \(ERCC\)](#).

The Operational EFAS consists of four centres executed by different consortia

- **EFAS Computational** centre - [European Centre for Medium-Range Weather Forecasts \(UK\)](#) executes forecasts and hosts the EFAS-Information System platform
- **EFAS Dissemination** centre - [Swedish Meteorological and Hydrological Institute](#), [Rijkswaterstaat \(NL\)](#) and [Slovak Hydro-Meteorological Institute](#) analyse EFAS on a daily basis and disseminate information to the partners and the ERCC
- **EFAS Hydrological data collection** centre - [REDIAM \(ES\)](#) and [ELIMCO \(ES\)](#) collect historic and realtime discharge and water level data across Europe
- **EFAS Meteorological data collection** centre - [KISTERS AG](#) and [Deutscher Wetterdienst](#) collect historic and realtime meteorological data across Europe.

EFAS is an operational service under the umbrella of the [Copernicus emergency management service](#) and is fully operational since October 2012.

EFAS consortia

Information on EFAS: info@efas.eu
Contact to join the EFAS network: dissemination@efas.eu

Last Updated on Wednesday, 11 November 2015 08:02

PARTNER LOGIN

Username

Password

Remember Me ☐

Login

[Forgot your password?](#)

[Forgot your username?](#)

IMPRINTS



Flash Flood FF-EWS
module
2009-2012



<http://www.efas.eu/>





ANYWHERE



ERICA



European
Civil Protection

**Can we increase the resolution
in time and space
using radar data?**



TECNIO

Be tech. Be competitive

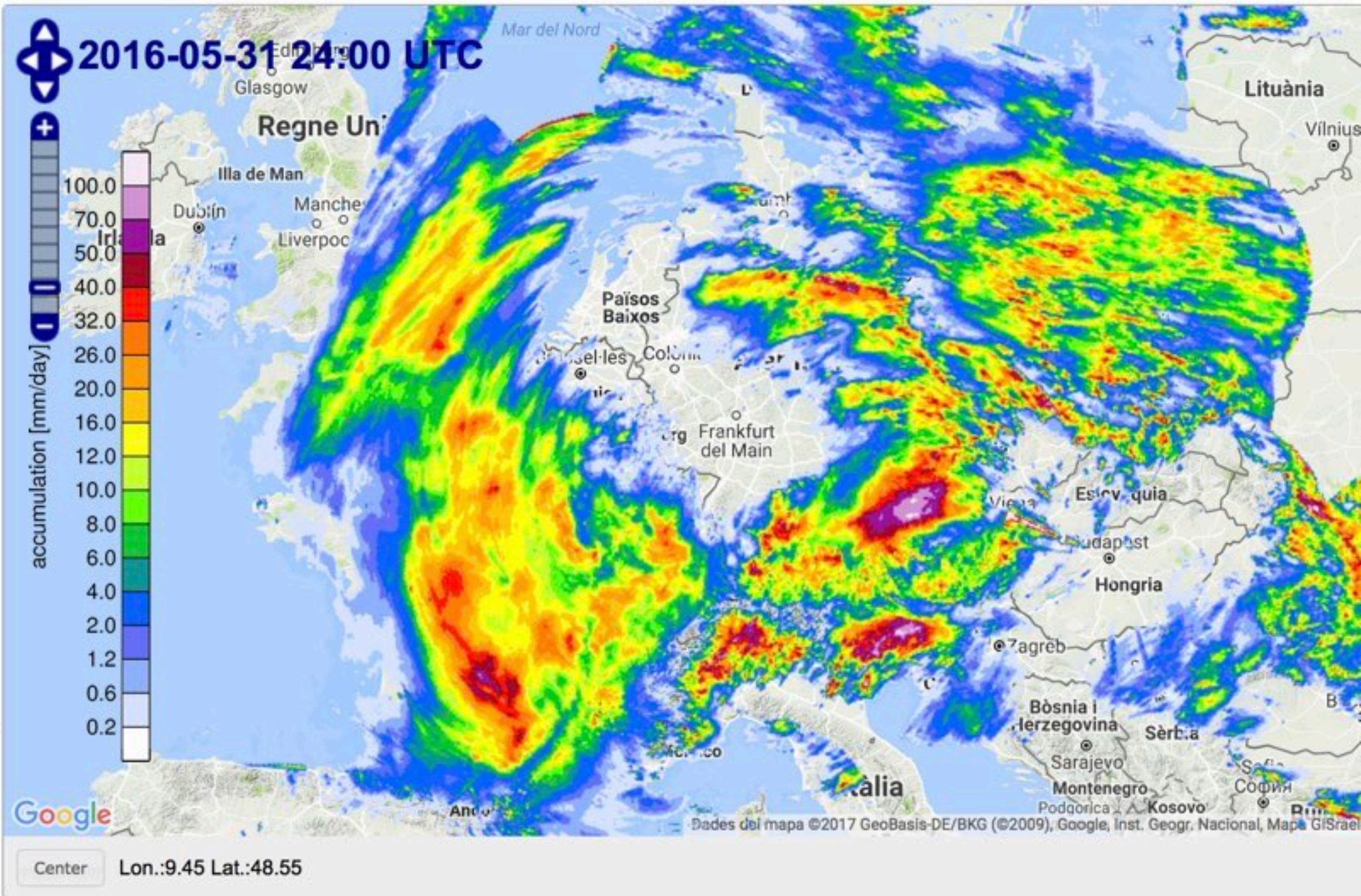
Daily rain accumulation

31/05/2016

Select layers

2016-06-03 24:00 UTC

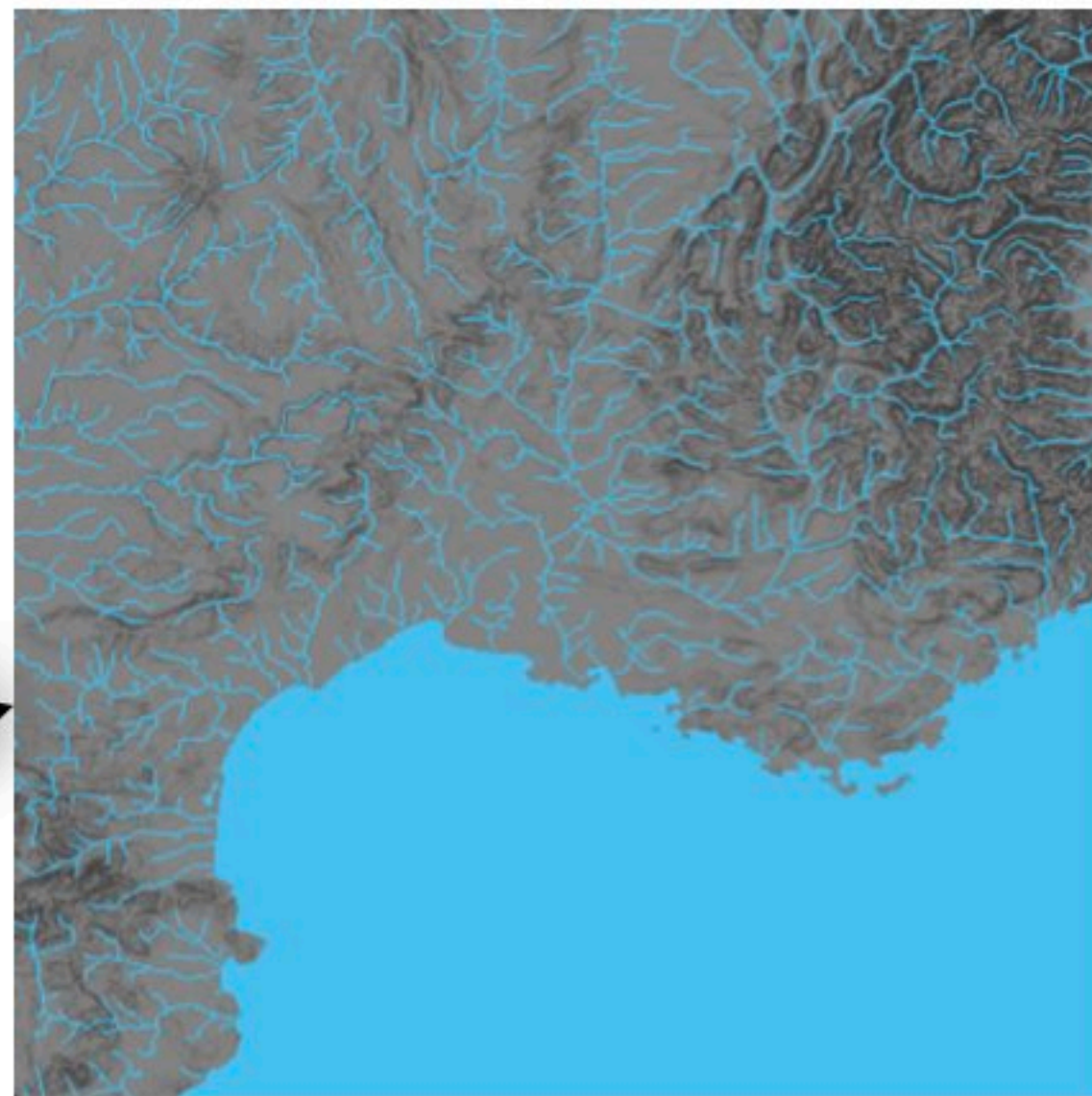
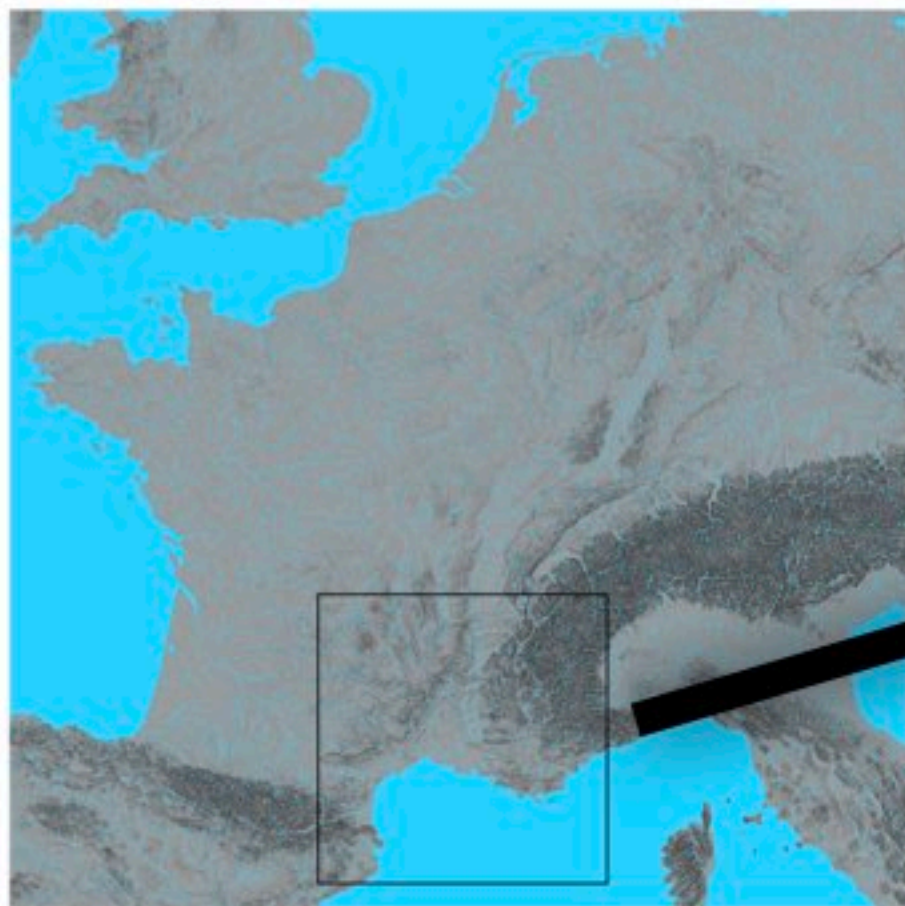
- ☒ Meteorological layers (0/5)
- ☒ Hazard assesment layers (0/2)
- ☒ Convective weather layers (0/4)
- ☒ Daily products (1/6)
 - ☐ Rainfall accumulation (24h)
 - ☐ Rainfall accumulation (24h)
 - ☒ Corrected Rainfall acc (24h)
 - ☐ Flash flood hazard summary (24h)
 - ☐ Correction factor (24h)
 - ☐ Raingauge accum. (24h)
- ☒ Background layers



ERICA Flash Flood Indicator: Basin aggregated rainfall exceedances

Based on observations & nowcasts of **basin-aggregated rainfall** at each point of the drainage network.

Drainage network (@ 1km)

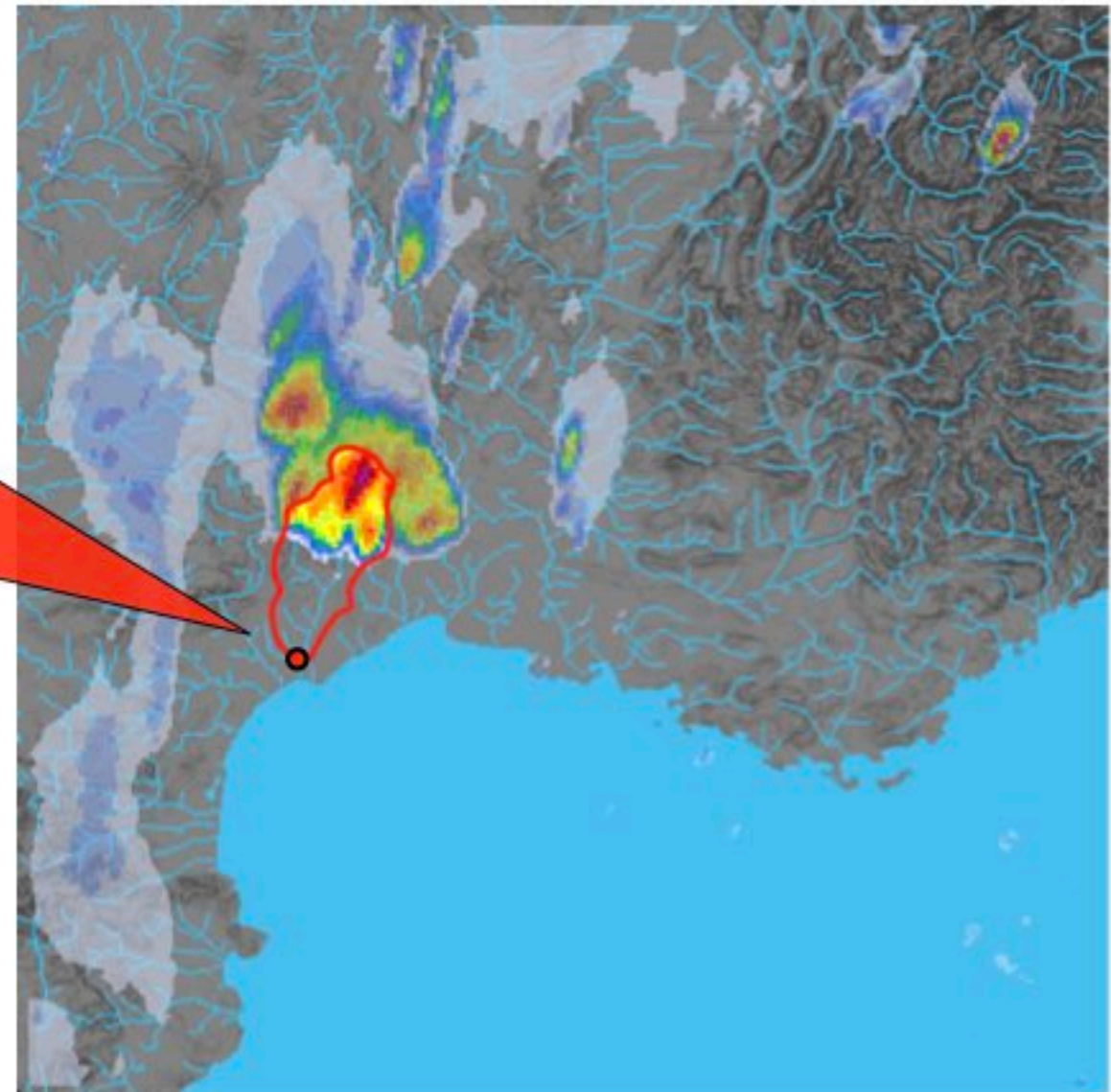


ERICHA Flash Flood Indicator: Basin aggregated rainfall exceedances

Based on observations & nowcasts of **basin-aggregated rainfall** at each point of the drainage network.

Given a point in the
drainage system,

We can define the
associated basin, and
calculate the rainfall
that will be collected
by the selected point



The **basin-aggregated** rainfall is accumulated over the hydrological characteristic time of the basin (1-24 hours)

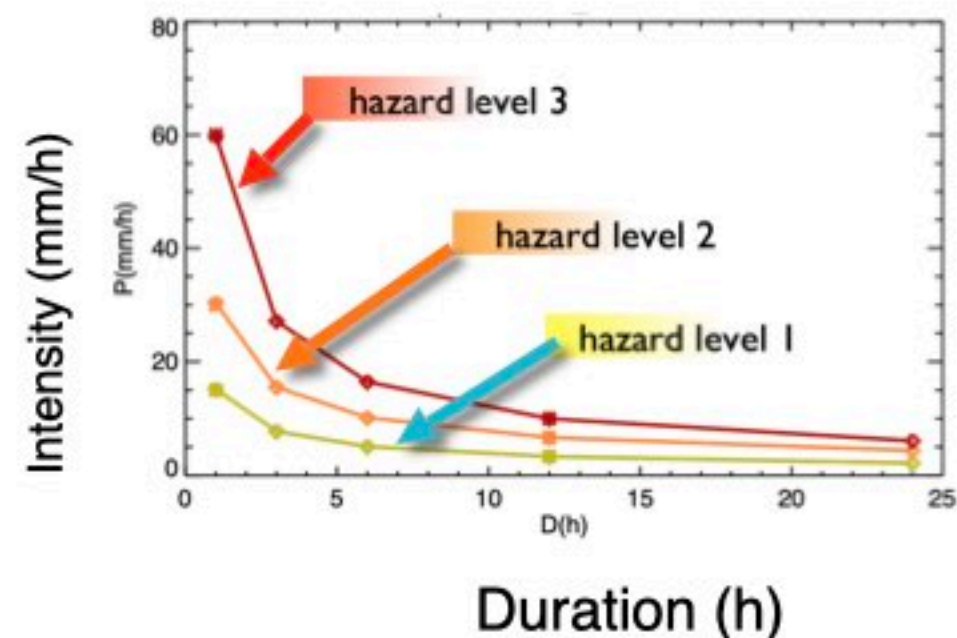
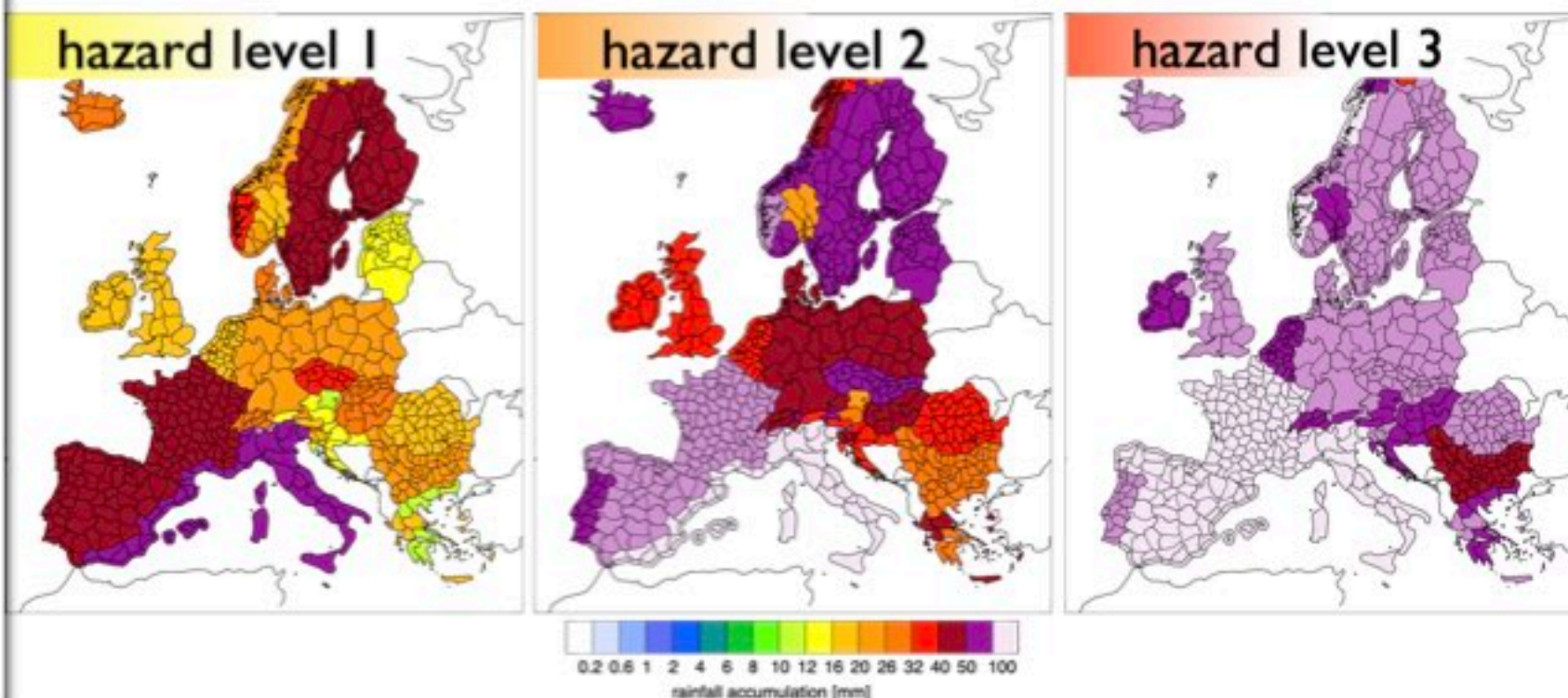
ANYWHERE Flash flood hazard impact forecasting - ERICHA

ERICHA flash flood indicator

METEOALARM color code:

Green	No particular awareness of the weather is required.
Yellow	The weather is potentially dangerous. The weather phenomena that have been forecast are not unusual, but be attentive if you intend to practice activities exposed to meteorological risks. Keep informed about the expected meteorological conditions and do not take any avoidable risk.
Orange	The weather is dangerous. Unusual meteorological phenomena have been forecast. Damage and casualties are likely to happen. Be very vigilant and keep regularly informed about the detailed expected meteorological conditions. Be aware of the risks that might be unavoidable. Follow any advice given by your authorities.
Red	The weather is very dangerous. Exceptionally intense meteorological phenomena have been forecast. Major damage and accidents are likely, in many cases with threat to life and limb, over a wide area. Keep frequently informed about detailed expected meteorological conditions and risks. Follow orders and any advice given by your authorities under all circumstances, be prepared for extraordinary measures.

12-h accumulations

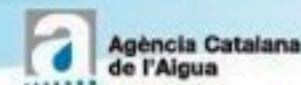


FF-EWS CONCEPT First developed in Catalonia for the Water Agency and **OPERATIONAL SINCE 2006**

IMPRINTS 

Català Castellano English

OPERATIONAL CENTER
Catalonian Water Agency



L'Aigua
en temps real

Dades d'avui

Pluja

Mapa d'avisos

Històrics



Mapa d'avisos

Detecció d'indrets on cal posar-hi una atenció especial.

Avisos Hidrològics

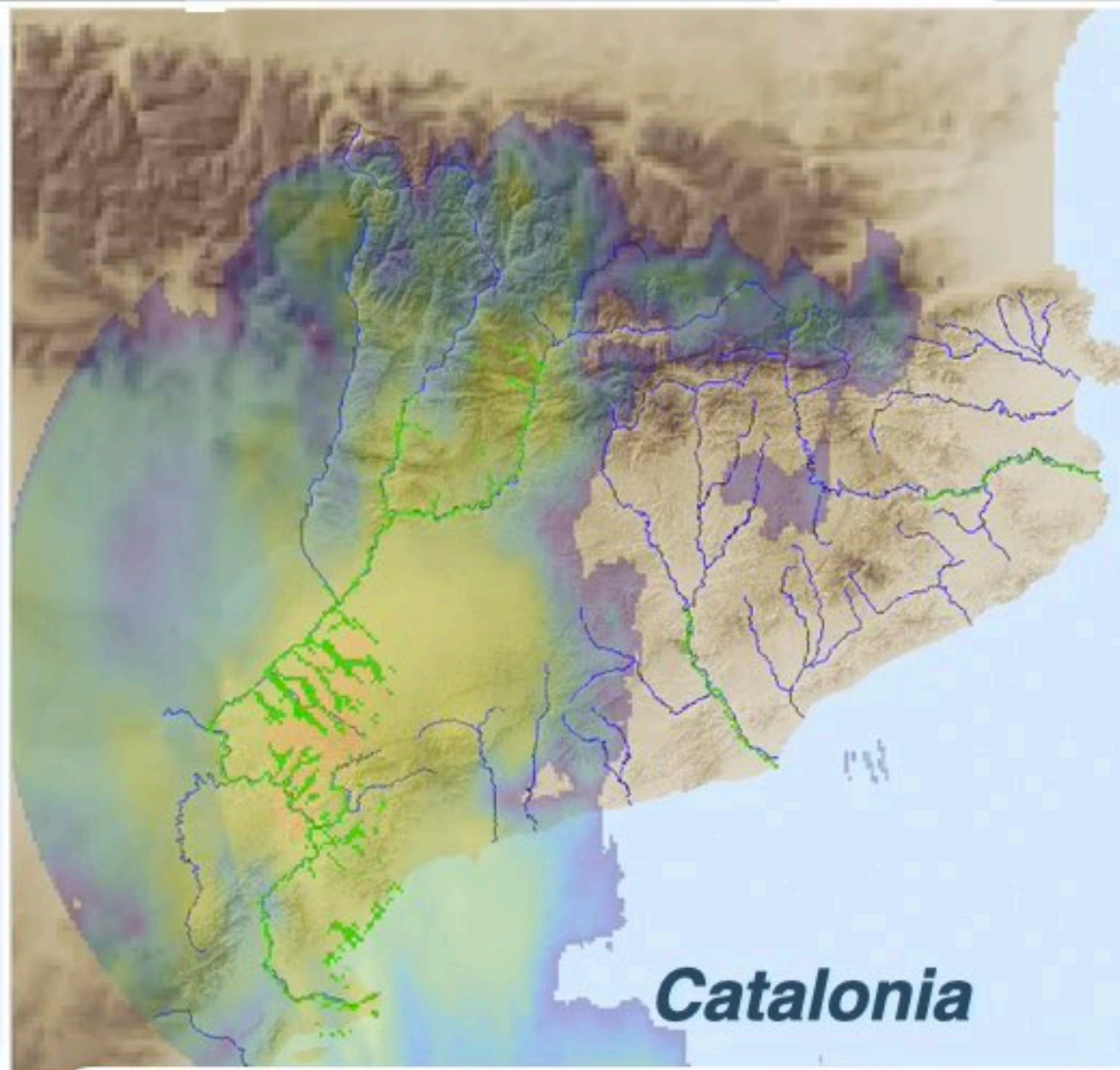
Aigua acumulada

Aigua al riu

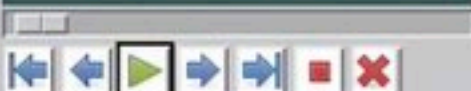
Avisos Meteorològics

Avisos (SMC)

Estat Hidrologia:

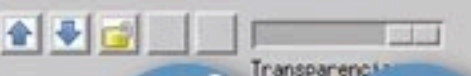


Catalonia



Informació de les capes | Gestió de capes

- (100%) Alerta pluja agregada
- (100%) Acum30
- (31%) Acum30 combi
- Capa Rius
- (100%) Acum1dia
- (100%) Comb1dia
- (100%) Comb30
- (100%) Alerta pluja puntual
- (100%) Topografia2
- Definicions



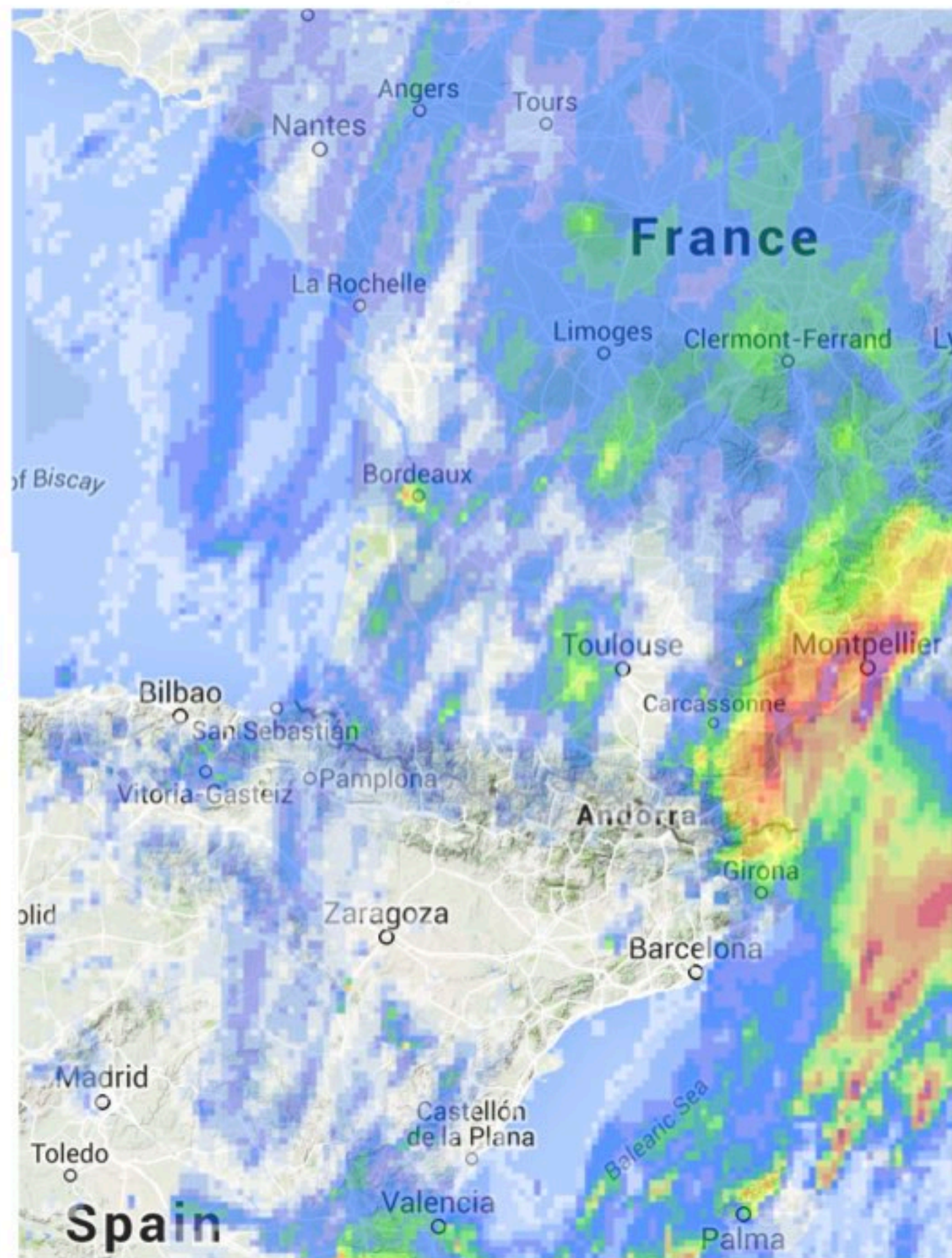
<http://aca-web.gencat.cat/aetr/vishid/>

© 2000-

Montpellier - 29 Sep 2014 ERICHA



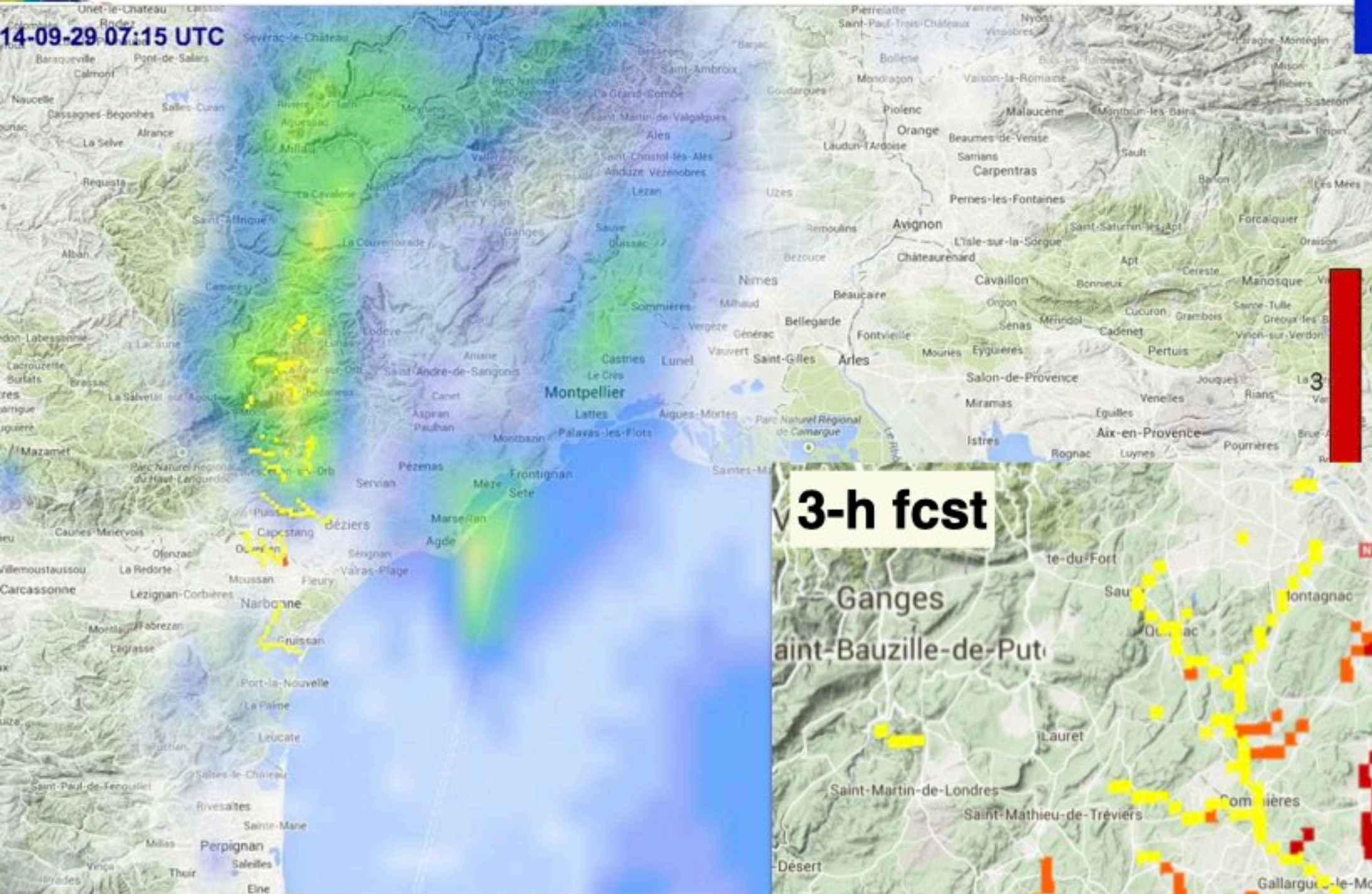
European
Civil Protection



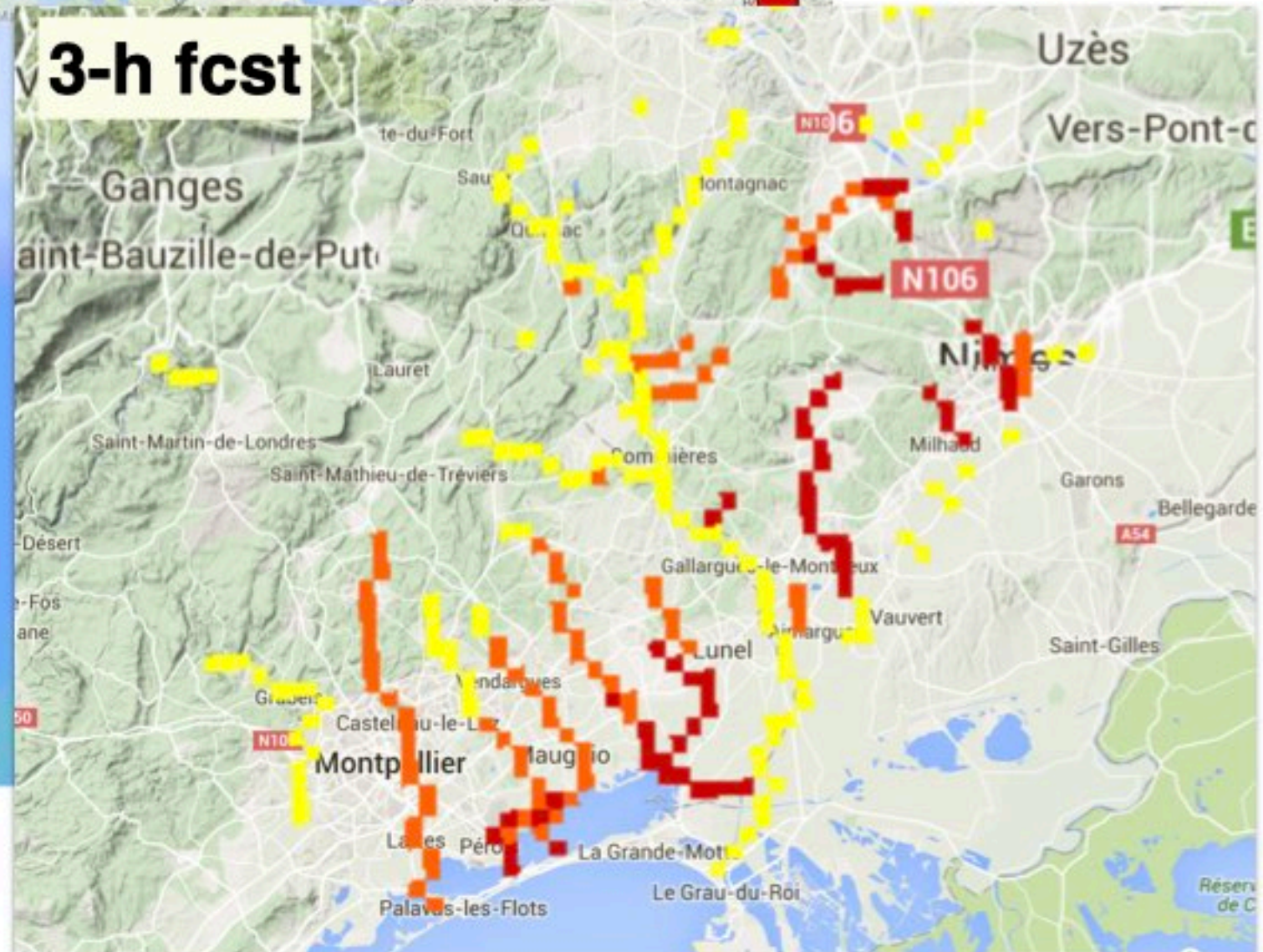
Montpellier - 29 Sep 2014



14-09-29 07:15 UTC



3-h fcst



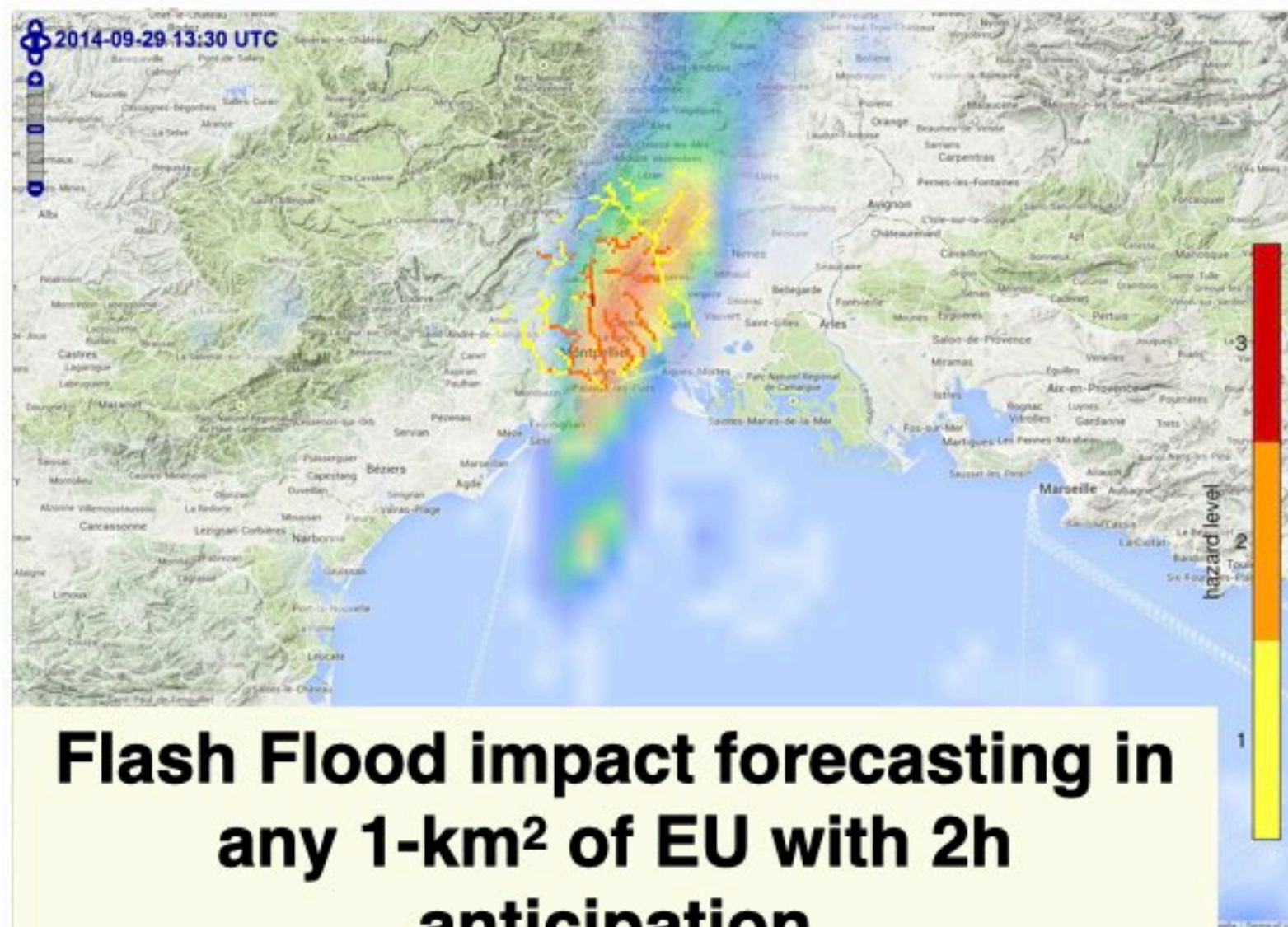
Hourly accumulation
updated every 15min

Challenges to Goals



**Translate best adapted
METEOROLOGICAL
FORECASTS into *IMPACT*
FORECASTS**

**Forecasting impacts:
Flash Flood Impacts**



**Flash Flood impact forecasting in
any 1-km² of EU with 2h
anticipation**

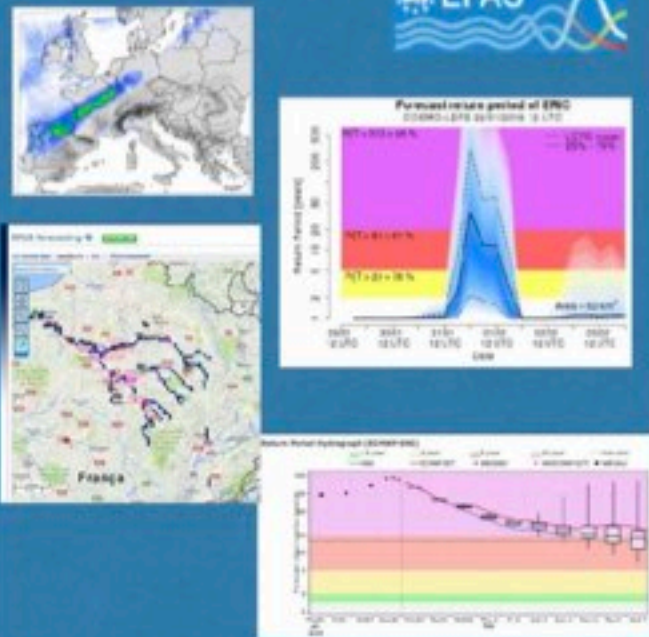
At 1km over the entire EU, at 200m in pilot sites



MULTI HAZARD EARLY WARNING SYSTEM

EUROPEAN FLOOD AWARENESS SYSTEM (EFAS)

FROM 72h to 6h ahead
NWP forecasts



FROM 6h to 2h ahead
RADAR BASED Nowcasting



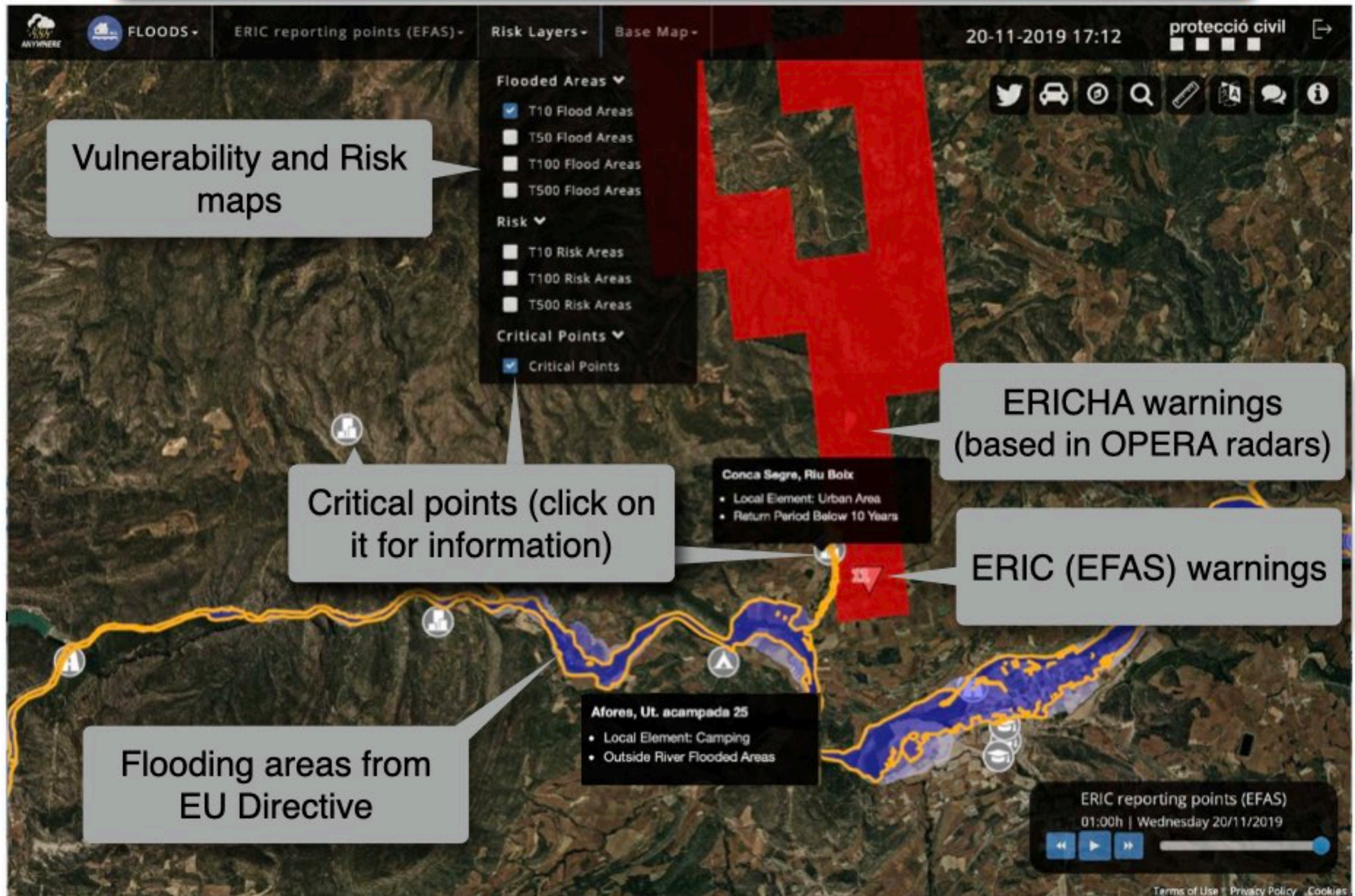
@ 200 m
resolution



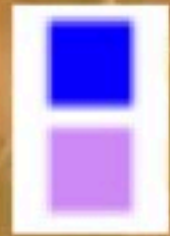
CIVIL PROTECTIONS
More efficient RESPONSE

SELF-PROTECTION FRMPs
Citizens / Activities

A4EU Platform - Impact products - Floods



9 October 2018 Mallorca Event



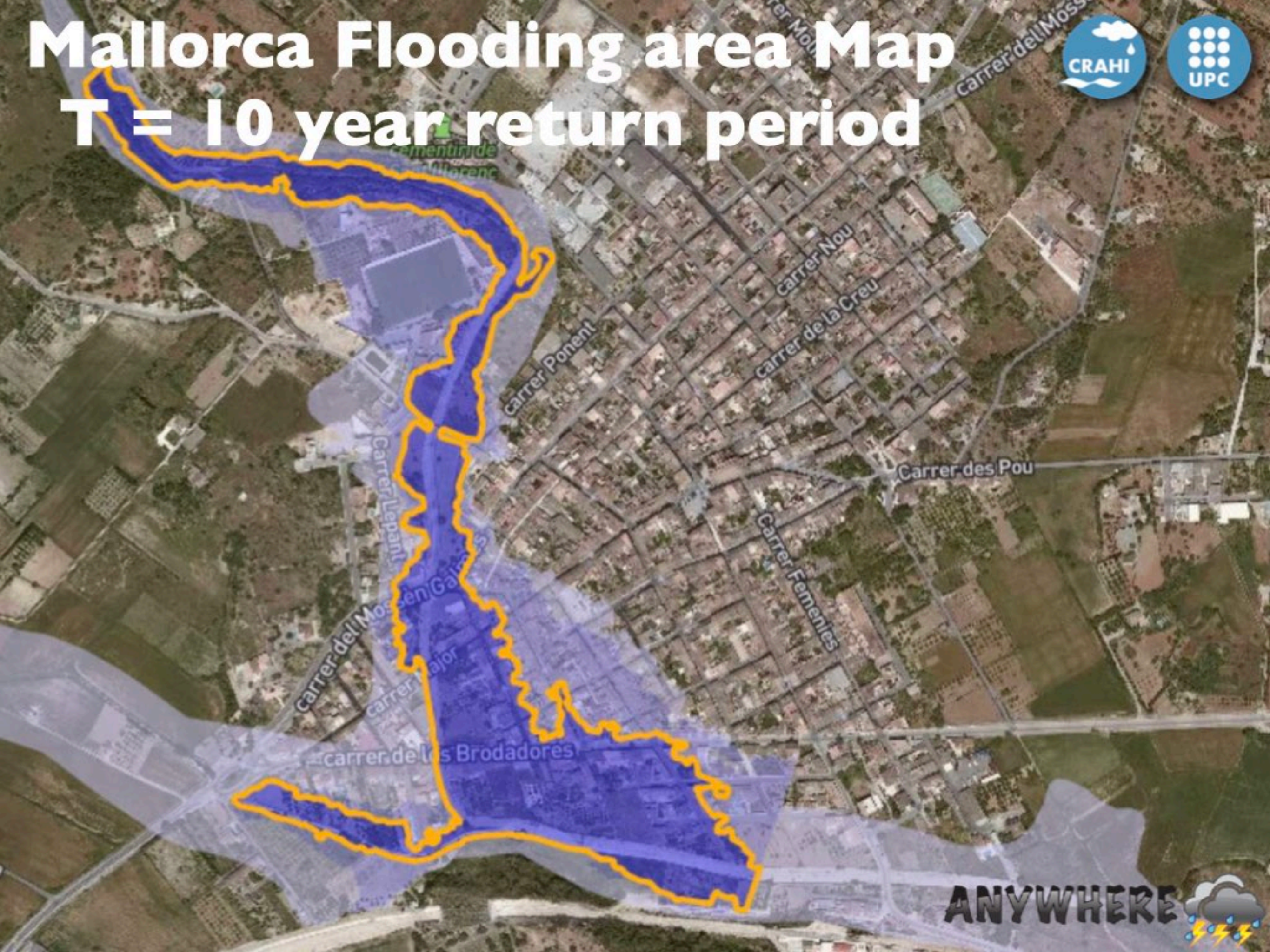
T = 10 years
T = 100 years



ANYWHERE 

Mallorca Flooding area Map

T = 10 year return period



A4EU: Flood impact example

1

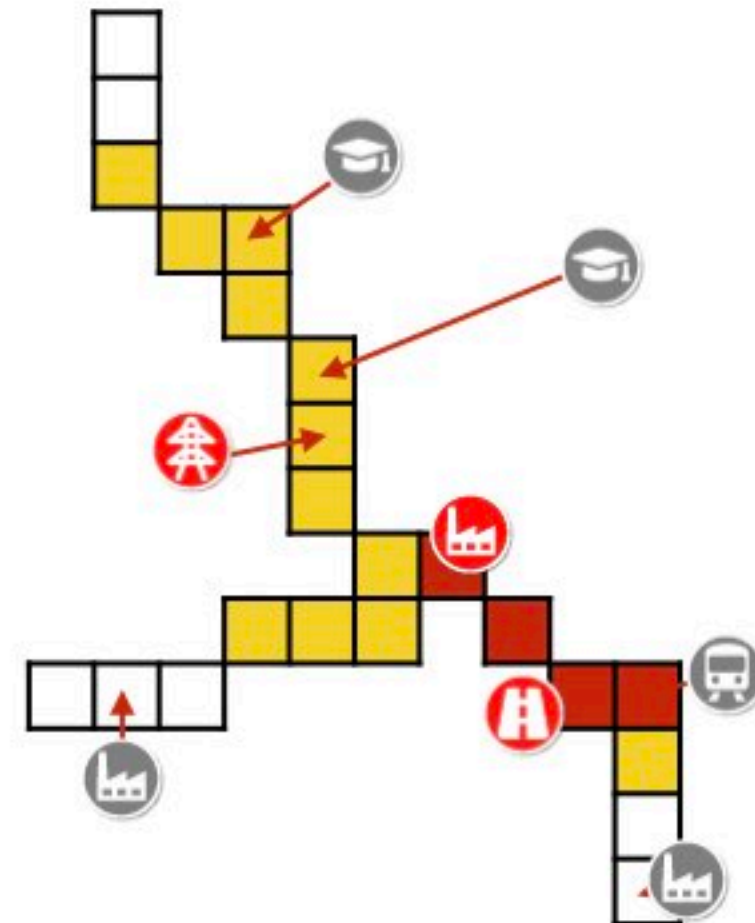
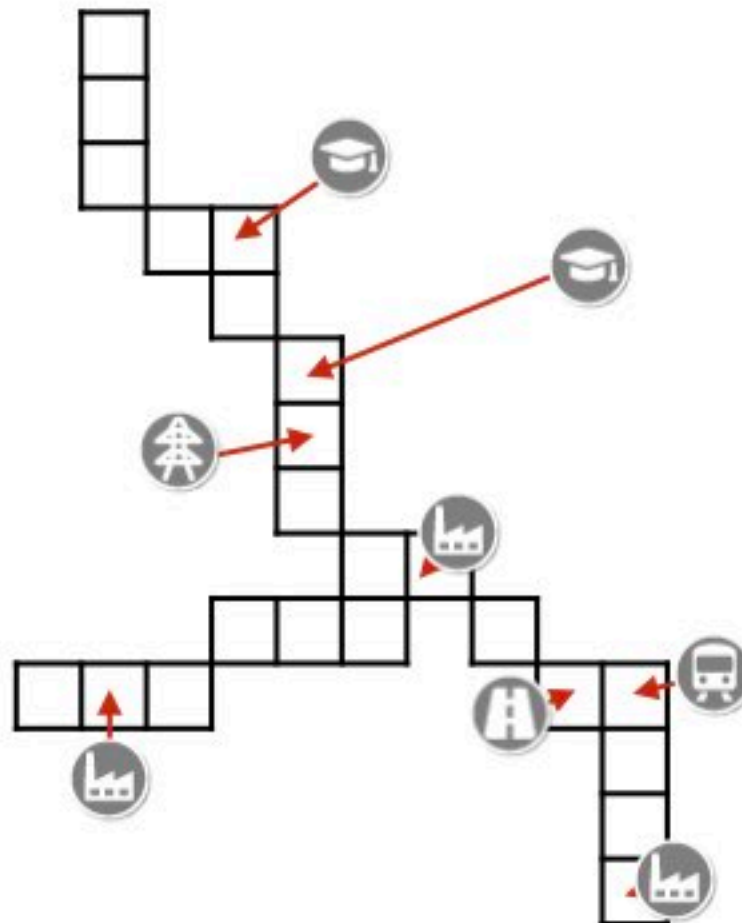
Set thresholds for most vulnerable points

2

Link with impact products

3

Activate in Real Time using Impact Forecasts

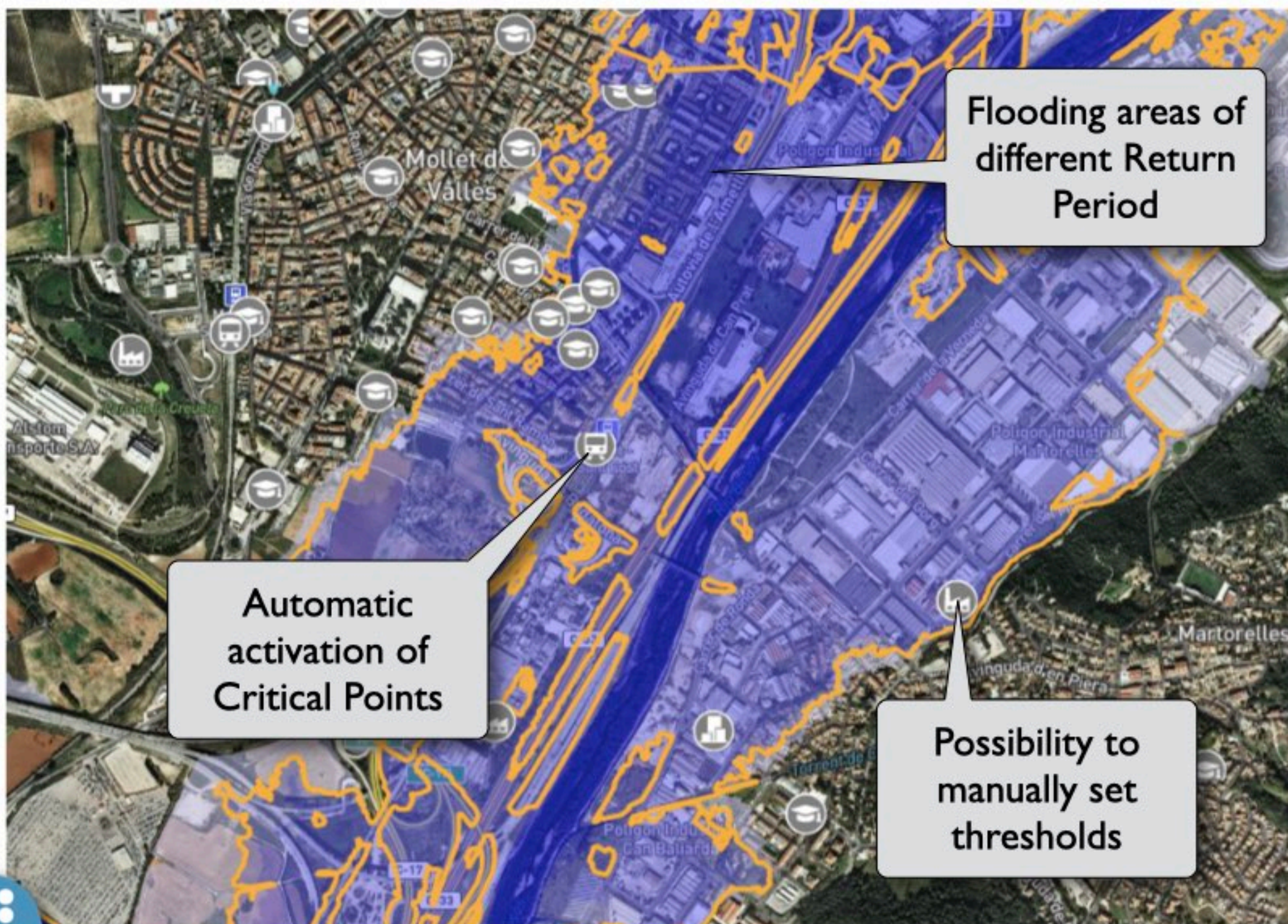




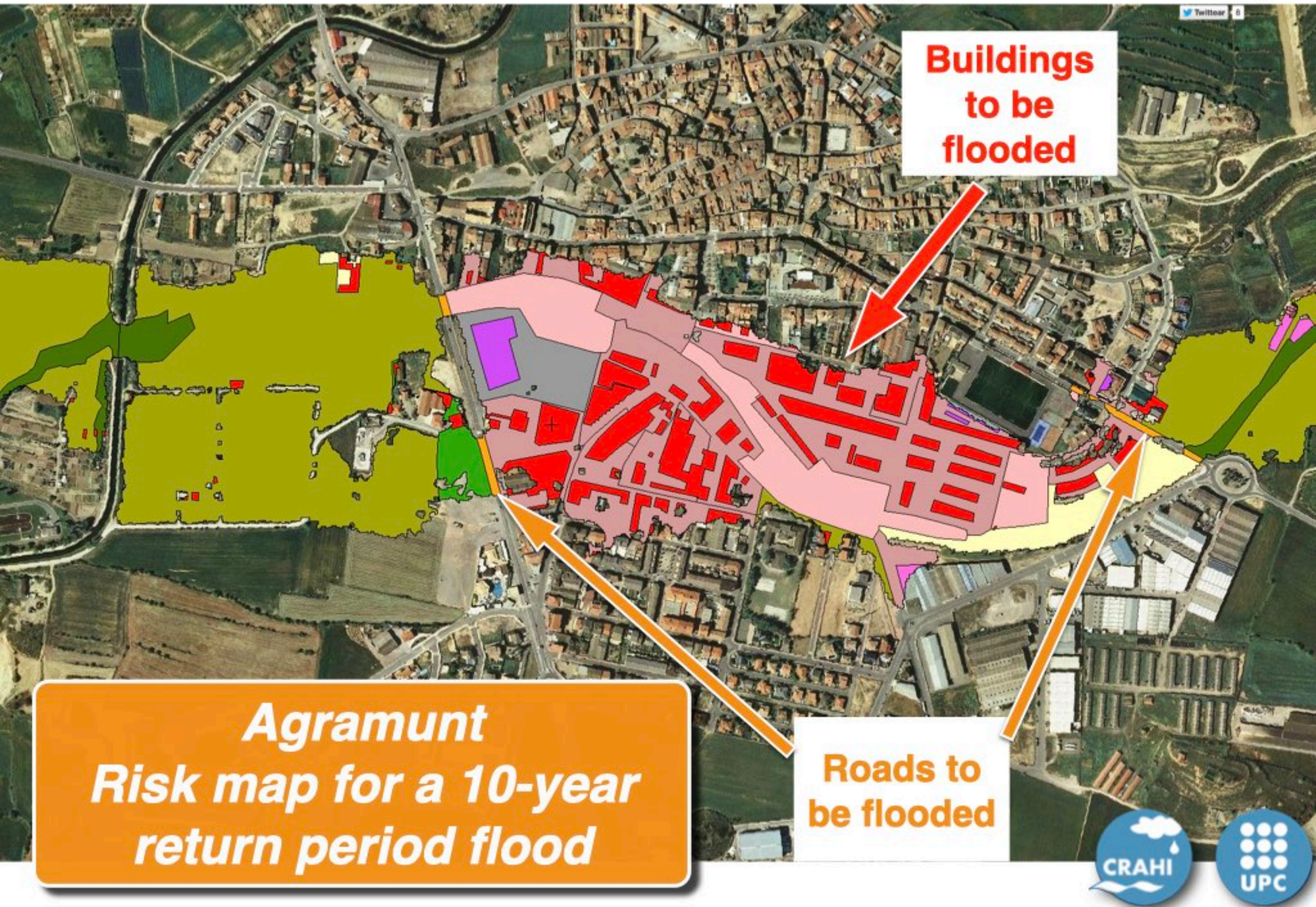
ANYWHERE - A4EU impact calculation: Floods

ANYWHERE

Automatic activation of critical elements at risk



AGRAMUNT Flash Flood: 2-3 November 2015 (Over 100 mm in 6h)



AGRAMUNT Flash Flood: 2-3





VIDEO

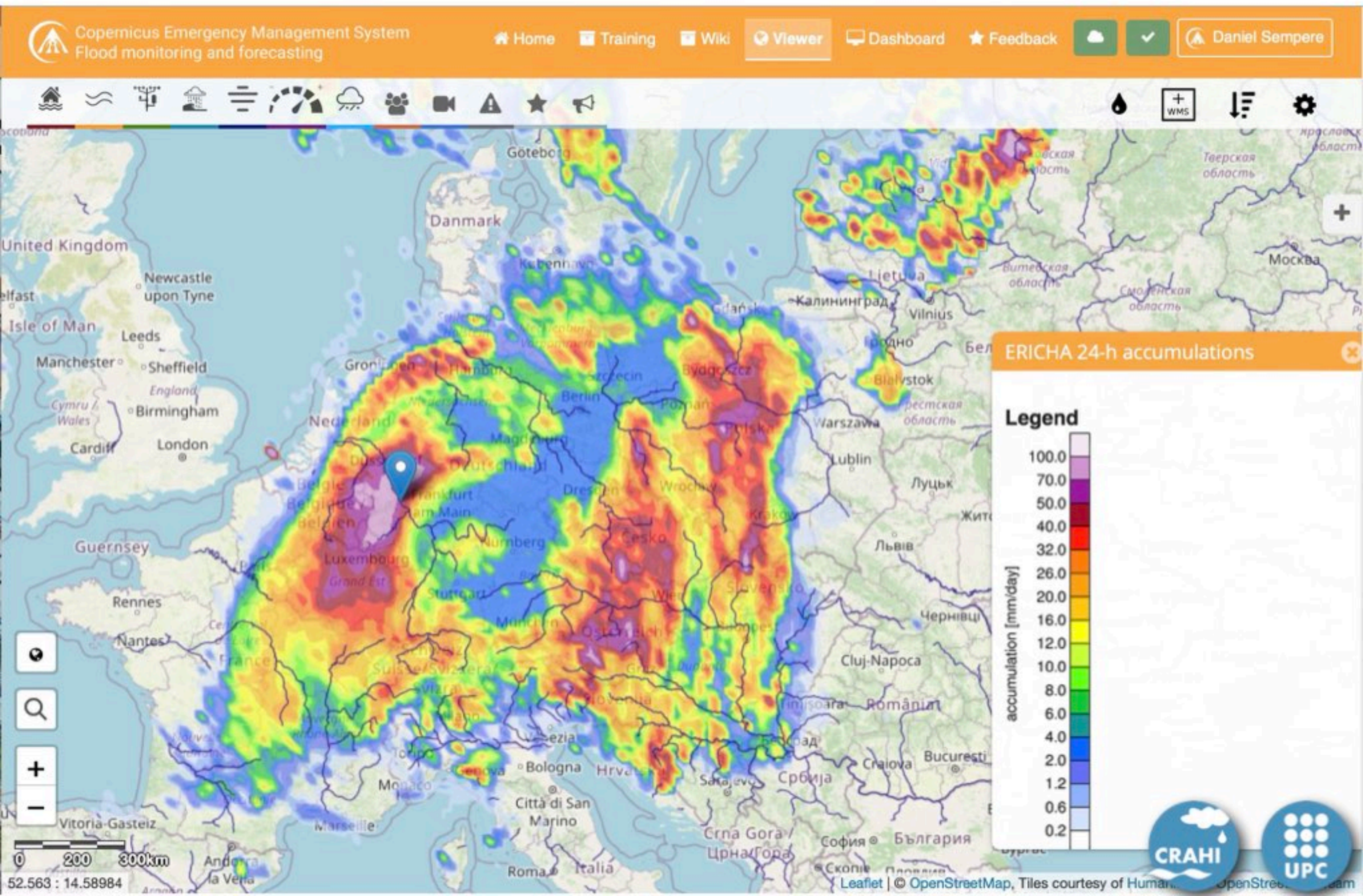
Germany knew the floods were coming, but the warnings didn't work

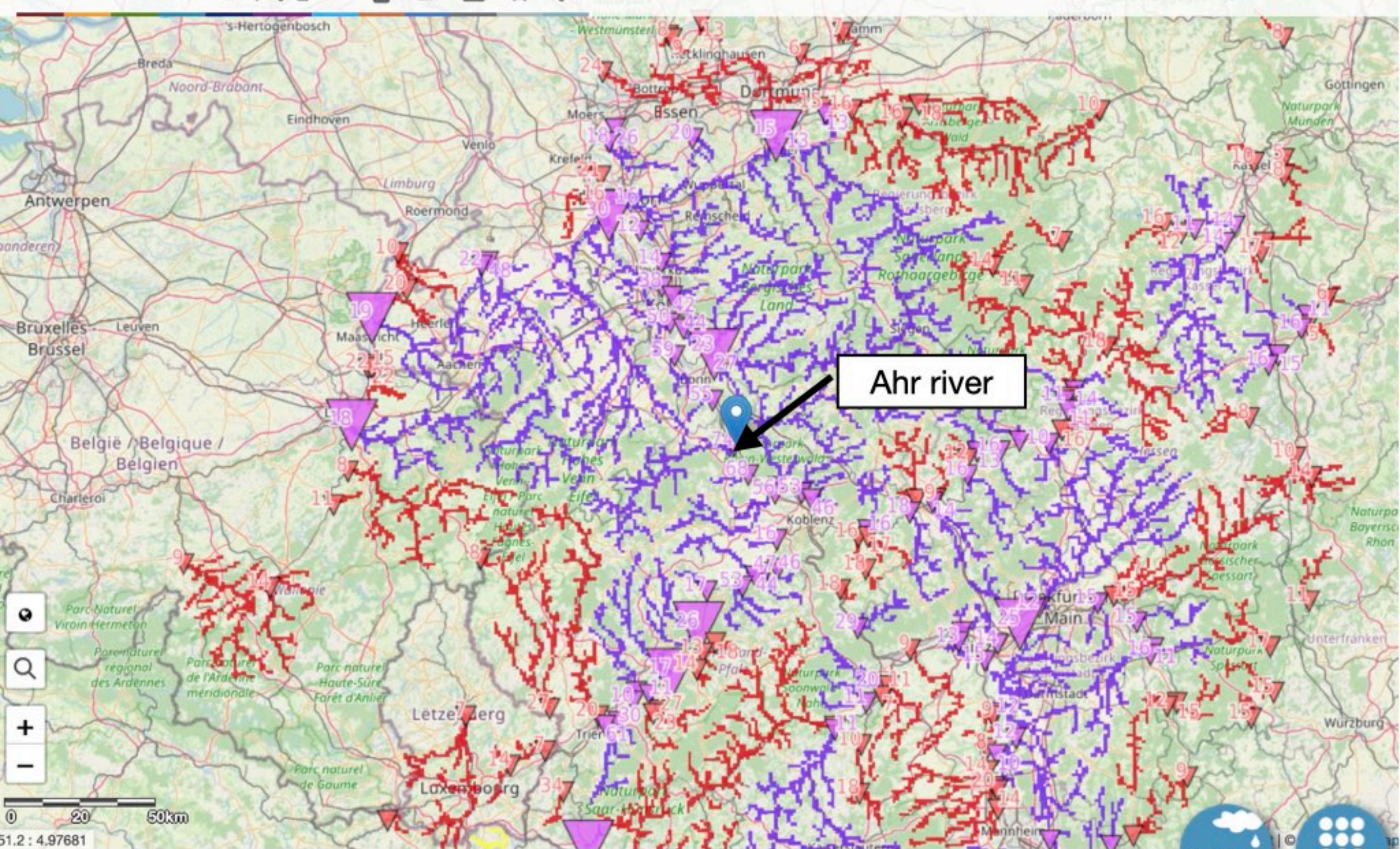
Weather scientists say a 'monumental failure of the system' is directly to blame for the death and devastation triggered by a month's worth of rain that fell in two days this week



Daily rainfall accumulation - 14 Jul 2021

ERICHA product on Radar from OPERA network, (seen through EFAS)





Ahr river



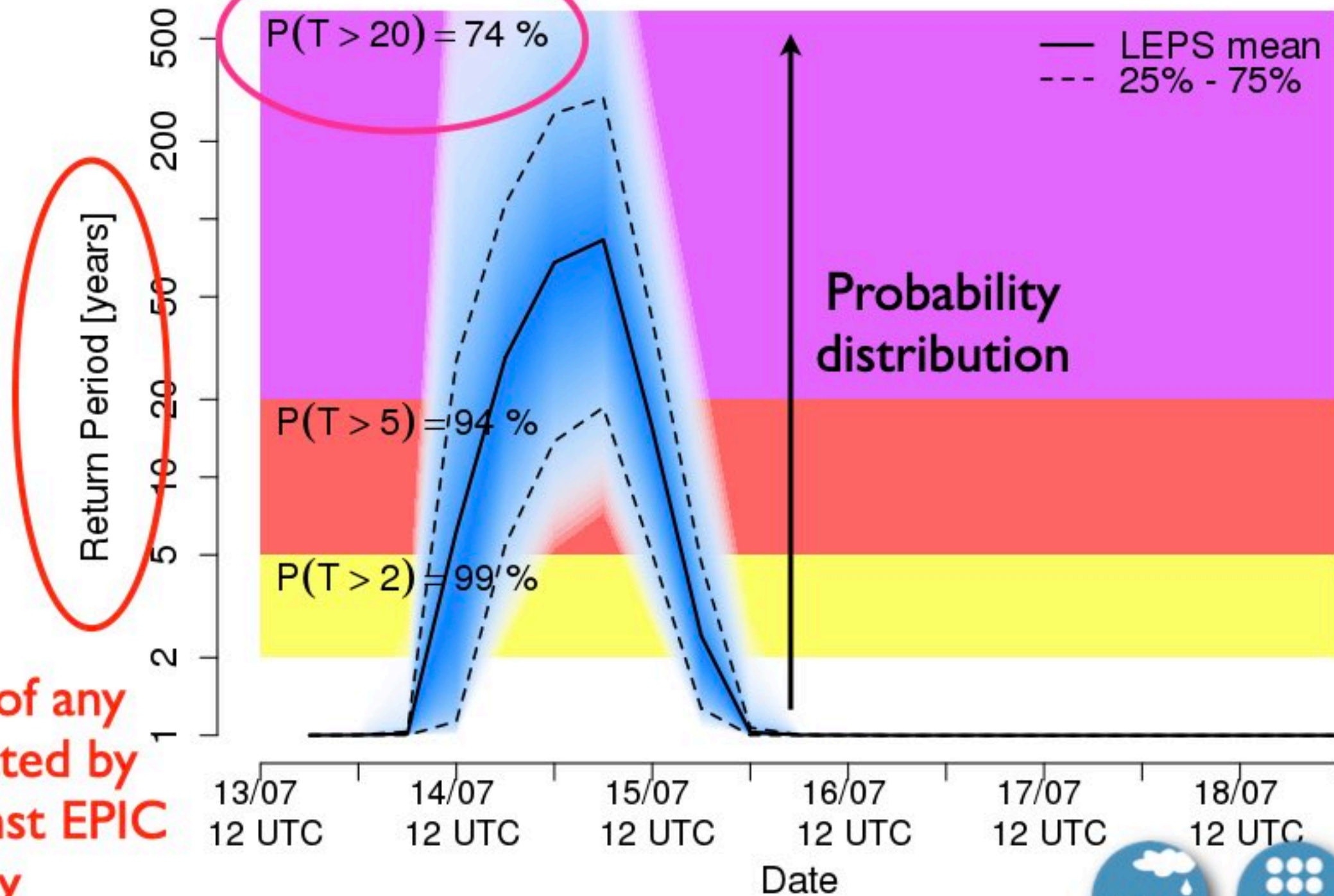
ERIC INDICATOR FOR AHR RIVER

(issued on 13 July at 00h UTC, 31h in advance)

Warning code associated
to % percentile member

Forecast return period of ERIC

COSMO-LEPS 2021-07-13 12:00 UTC



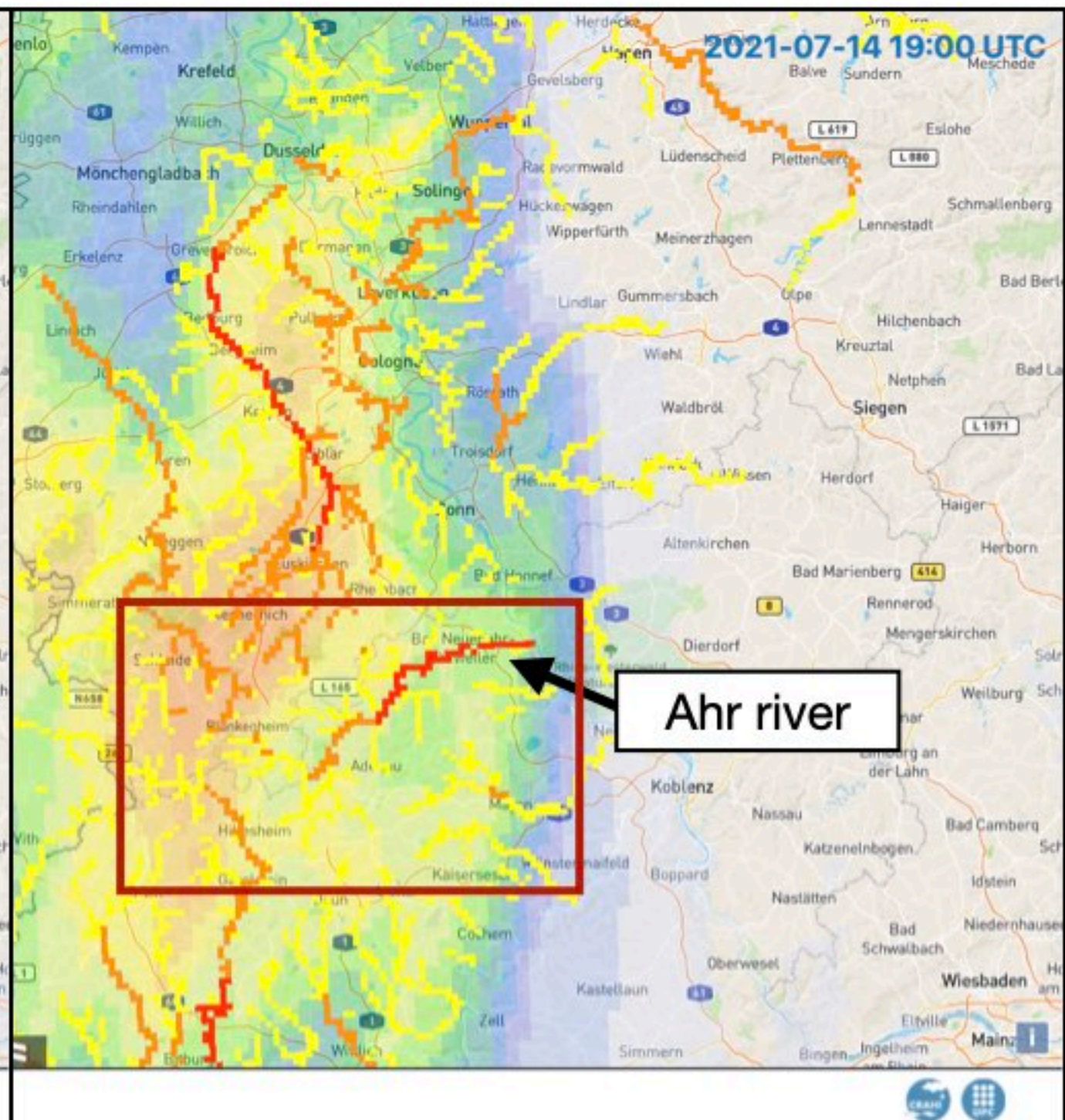
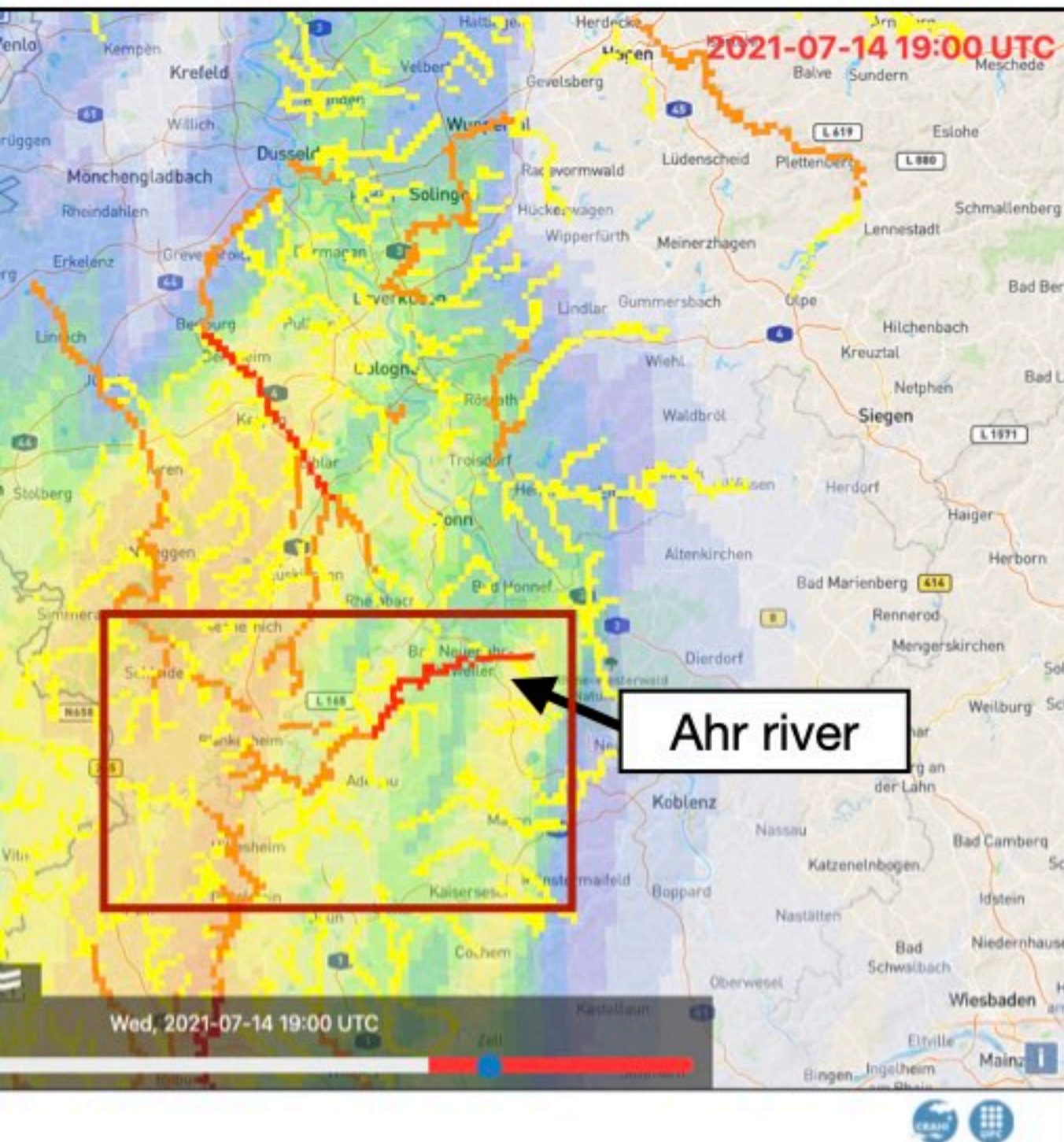
Return Period of any
member calculated by
comparison against EPIC
climatology



Situation over the Ahr river on 14 July 2021 at 2100 CEST (1900 UTC)

Nowcasts lead time: **120 min**

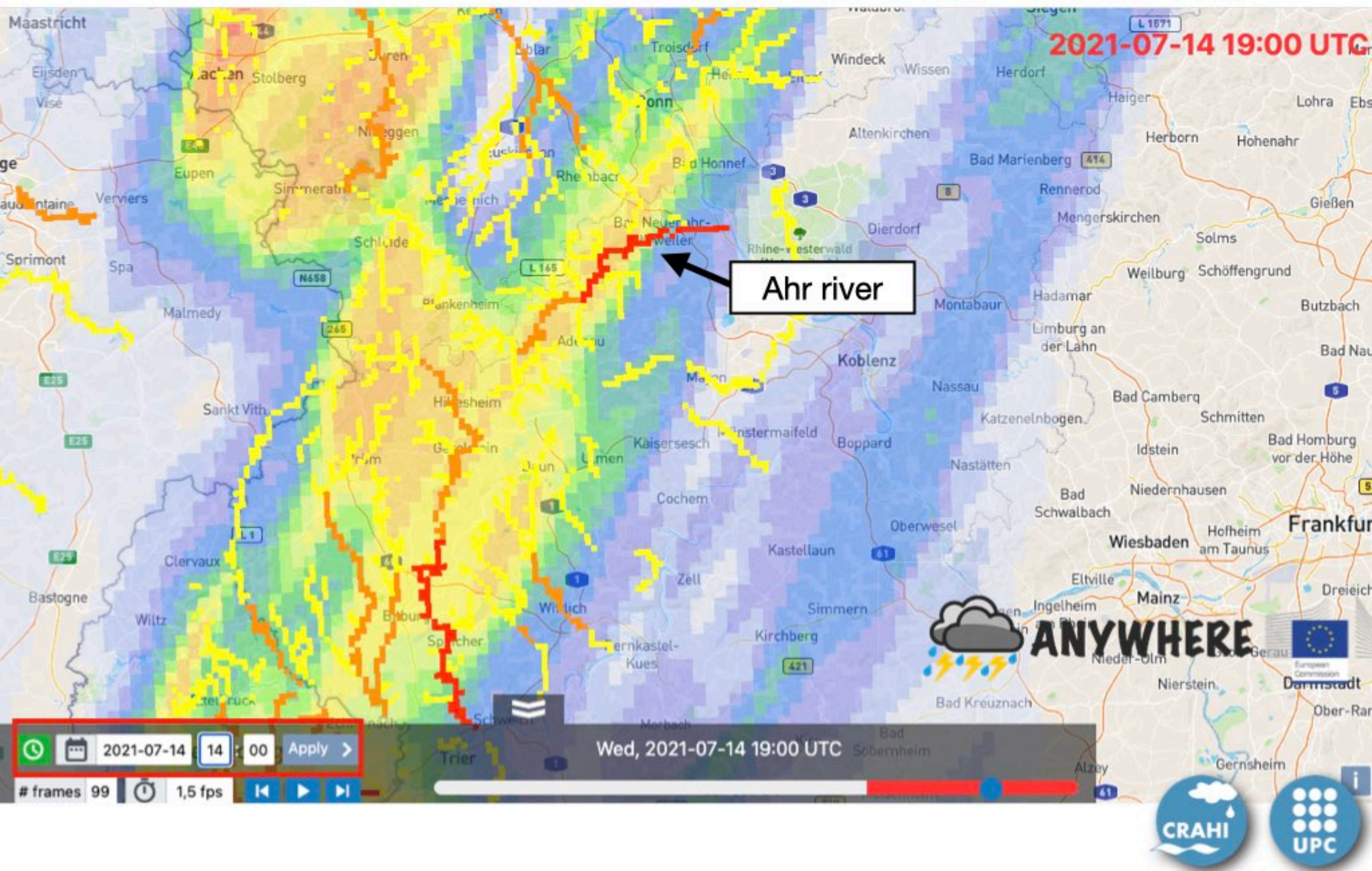
Observed at 1900 UTC



Good!

Situation over the Ahr river on 14 July 2021 at **2100 CEST (1900 UTC)**

Nowcasts lead time: 300 min





ANYWHERE

Daily maximum hazard level over the river network on 14 Jul 2021

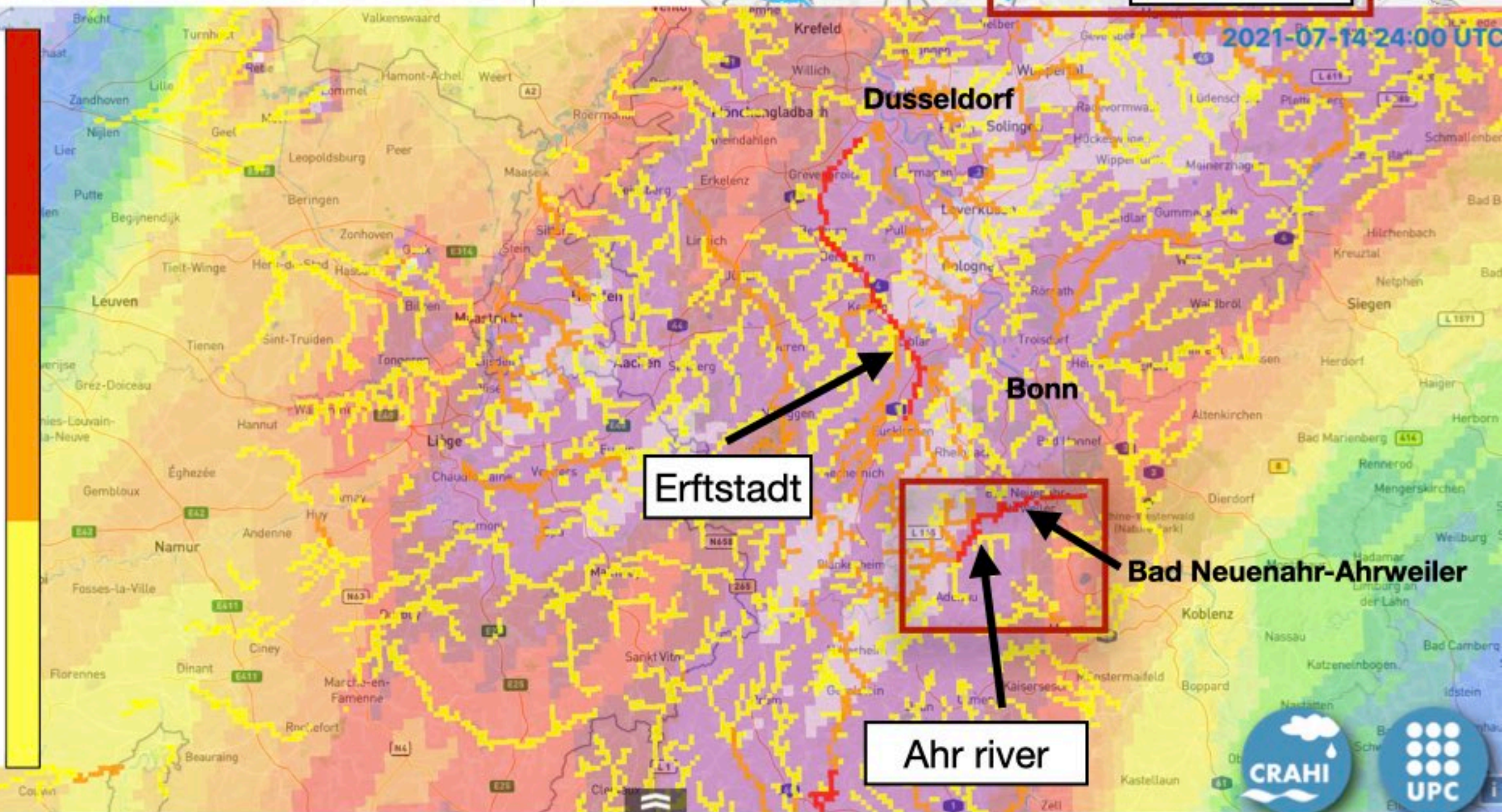


flash flood warning level

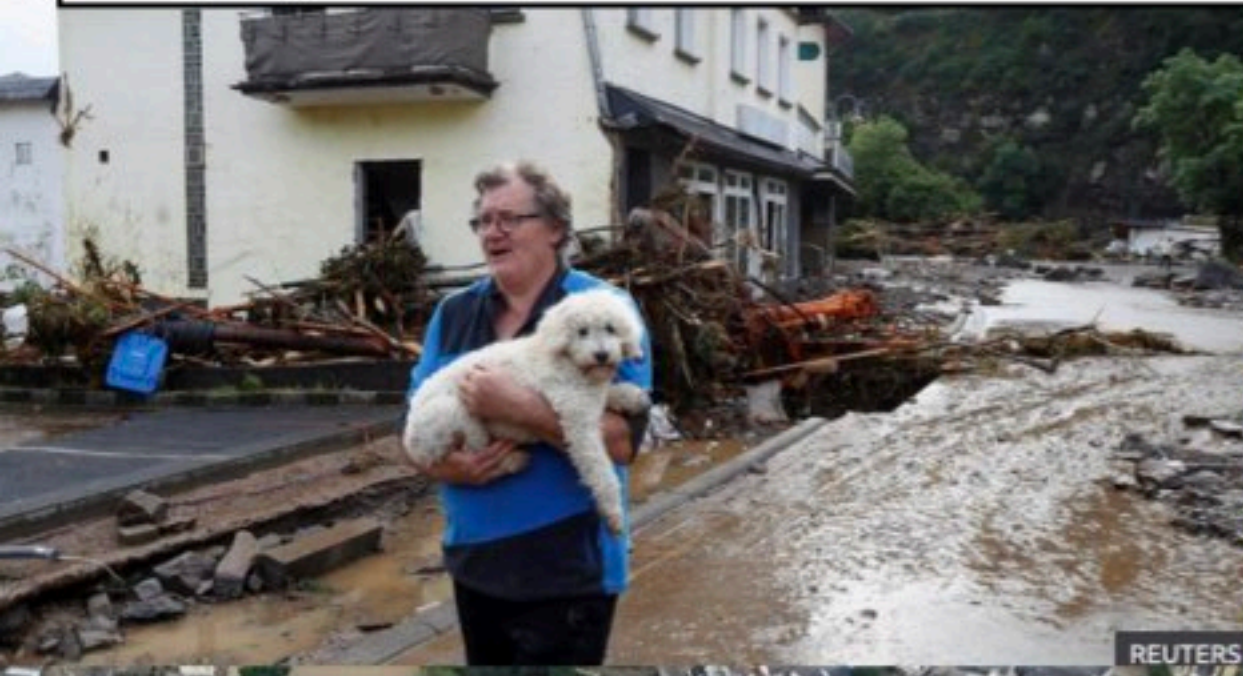
3

2

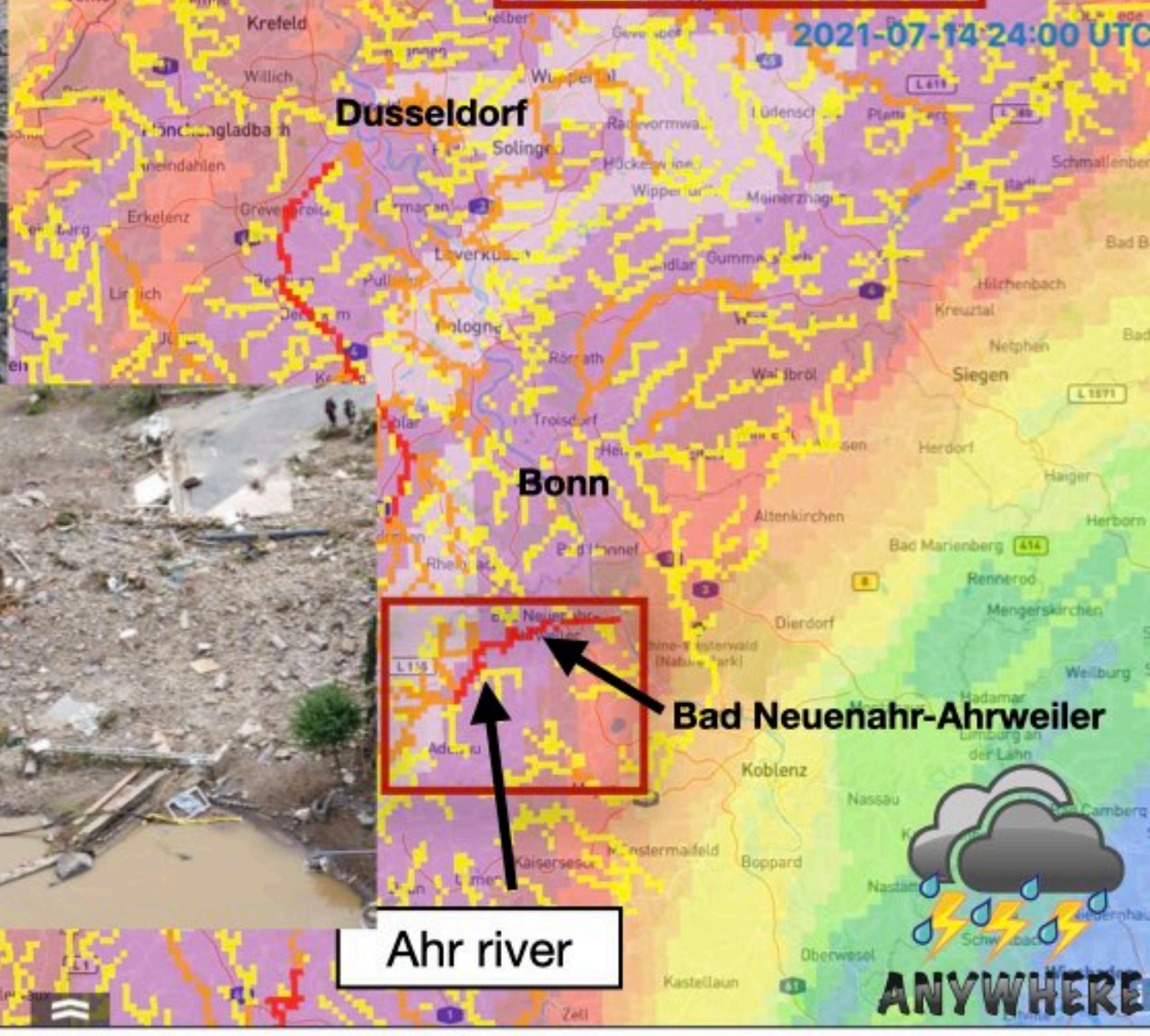
1



Ahr river: Continuous rain for about 12 hours
Ahrweiler district: At least, 140 dead, many missing
Schuld district: More than 25 houses in the risk of collapsing/Severe power/communication line failure



Bad Neuenahr-Ahrweiler







Johannes Schneider

Street View - jun 2015



Google

Fecha de la imagen: jun 2015 Las imágenes pueden estar protegidas por derechos de autor. Pícoso España Términos Privacidad Notificar un problema



H2020-DRS-I-2015-700099

ANYWHERE 

Is it good enough to support emergency management?

How it compares with a full hydrological model ?



COMPARISON OF ERICHA FF-EWS WITH A HYDROLOGICAL MODEL

Flash flood early warnings at regional scale

Radar rainfall
QPE+QPF



***Rainfall-Runoff
Hydrological model***
simulated streamflow

flow
thresholds



hazard level
return period T

- Hard work to calibrate model
- Regionalisation of thresholds
- Computer demanding



COMPARISON OF ERICHA FF-EWS with an Hydrological model

Flash flood early warnings at regional scale

Radar rainfall
QPE+QPE

**Rainfall-Runoff
Hydrological model**
simulated streamflow
flow
thresholds

ERICHA
**basin-aggregated
rainfall indicator**
(basin-aggregated)
rainfall
thresholds

hazard level
return period T

comparison
over Liguria region
some control points

hazard level
return period T

Hydrological Model
(Flood-PROOFS)

ERICHA





Basics of the comparison

Settepani radar data (1386 amsl)

Only QPEs (not QPFs)

10-min accumulations (1x1 km²)

Rainfall thresholds (Rainfall Return Periods)

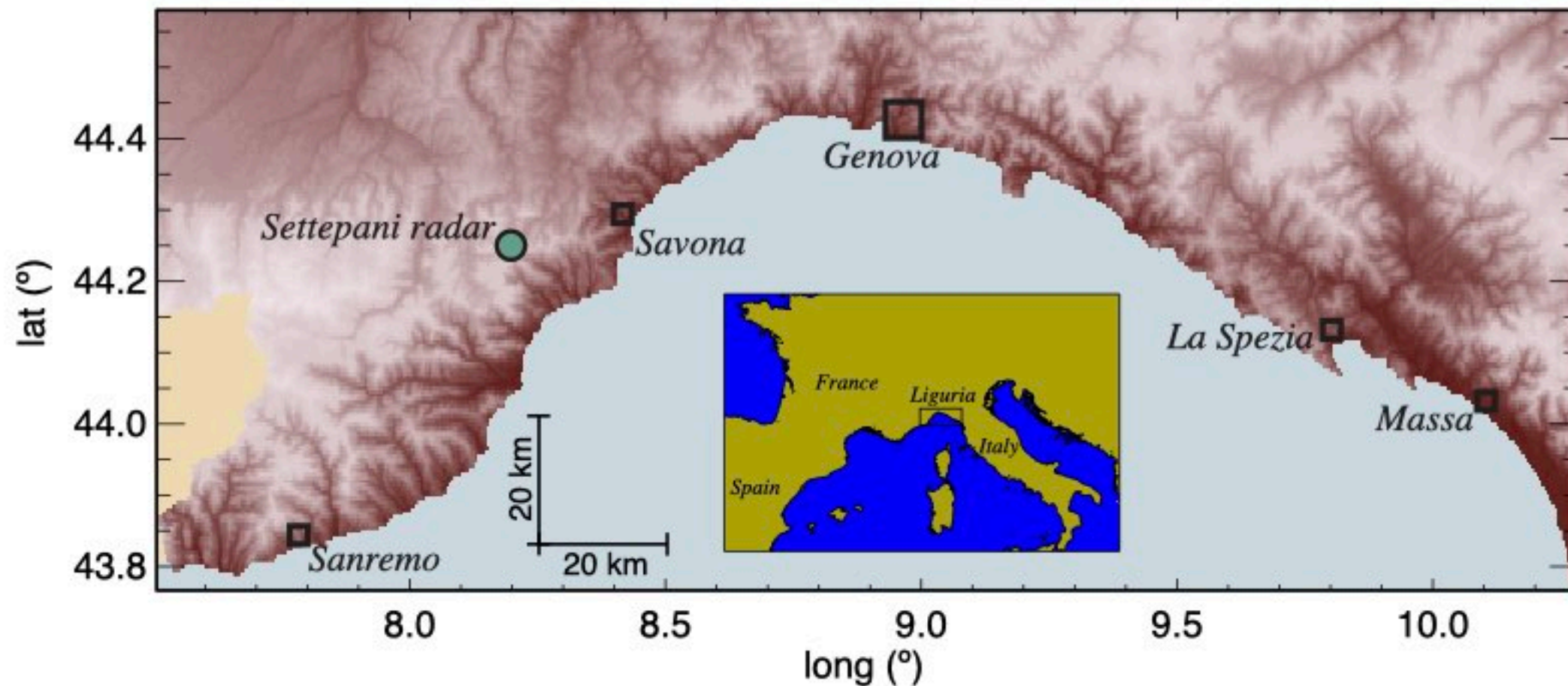
Rainfall depth-duration-frequency curves for Liguria

Regional analysis (Boni et. al., 2007)

Flow thresholds (Flows Return Periods)

Flow-frequency information over the same region

Regional analysis (Boni et. al., 2007), using the same IDF information



Mediterranean flash flood prone environment

Many catchments with $A < 100 \text{ km}^2$

Grid about 500 m resolution (559x167)

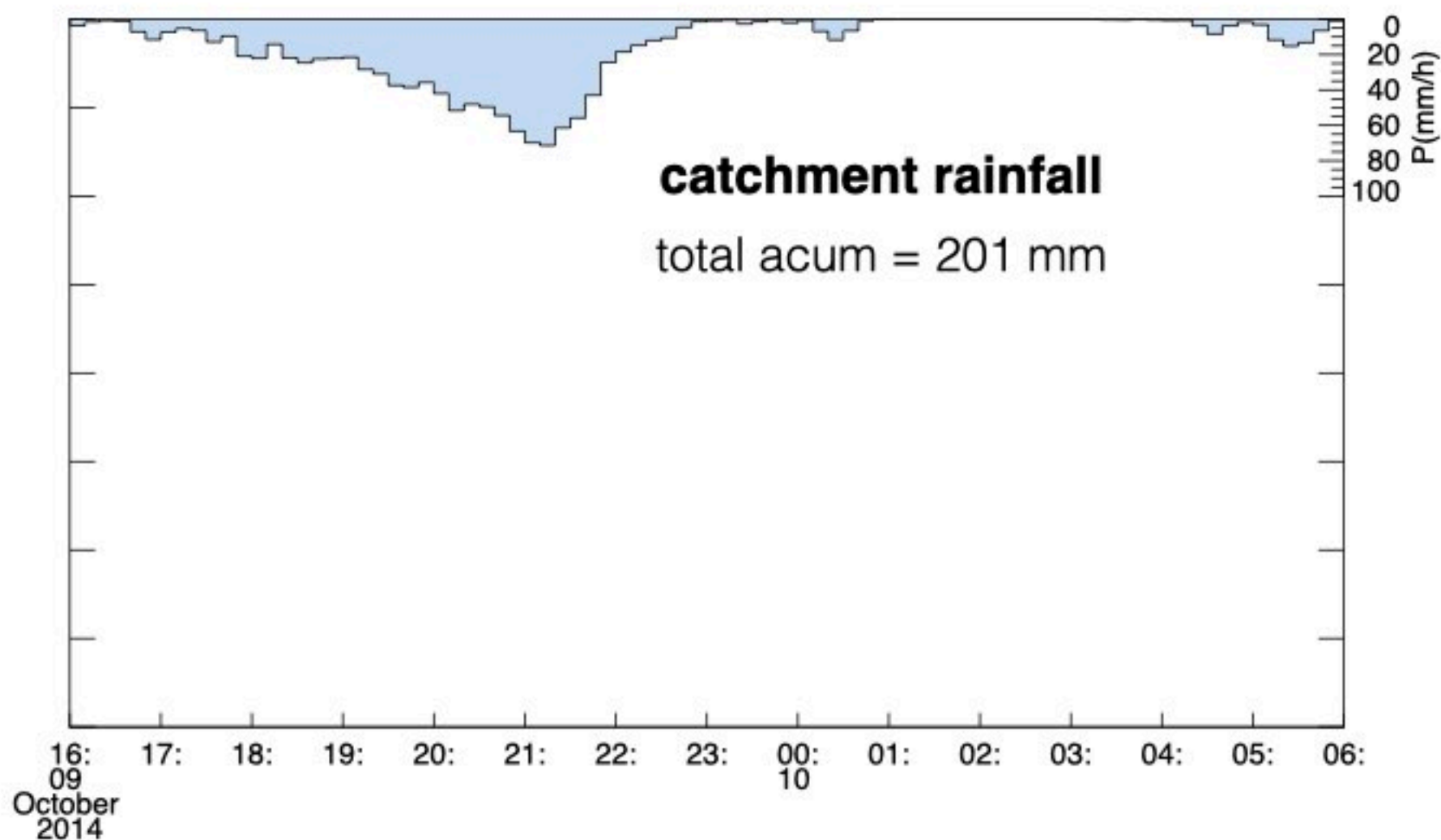
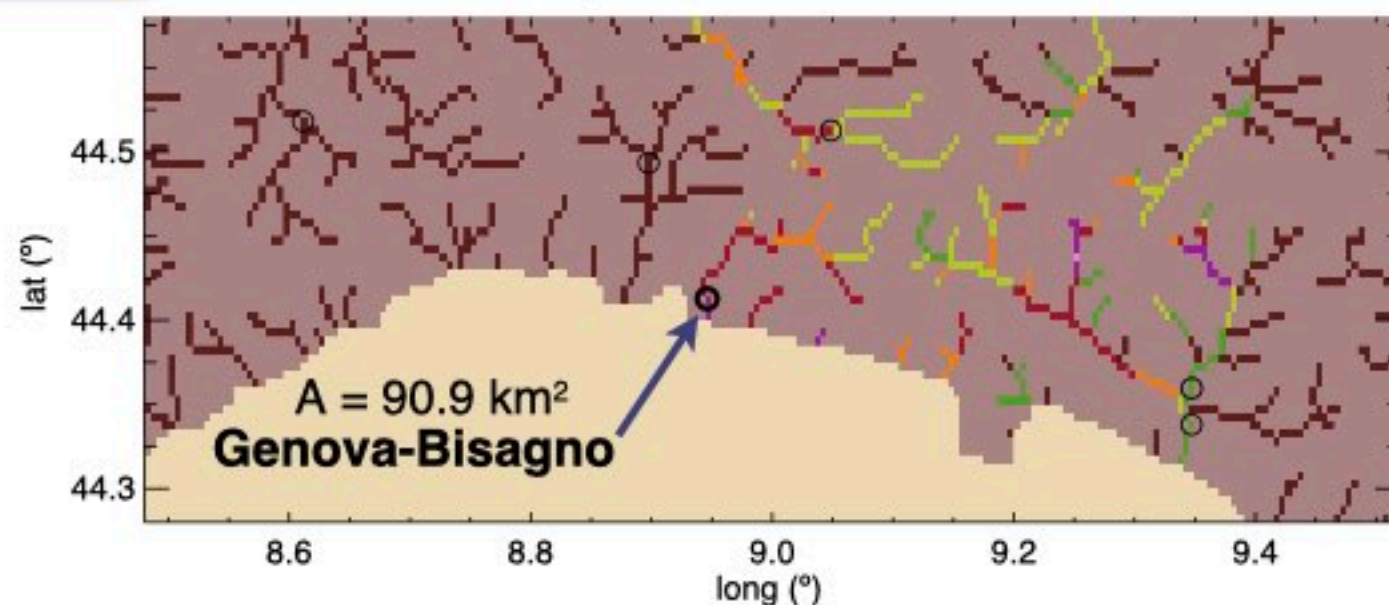
Genova (Italy) on 10th of October 2014



after > 300 mm of accumulated rain in few hours

9th-10th October

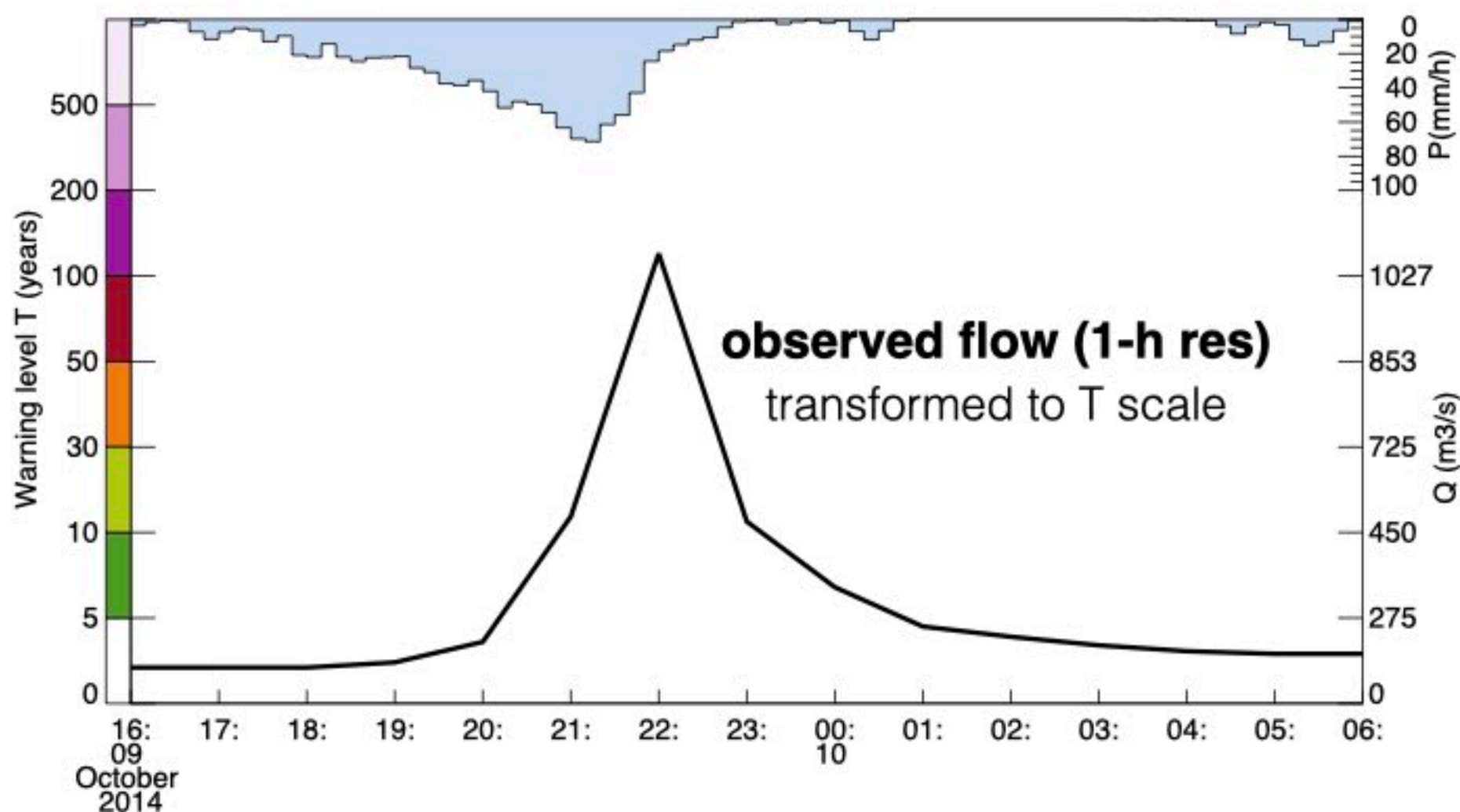
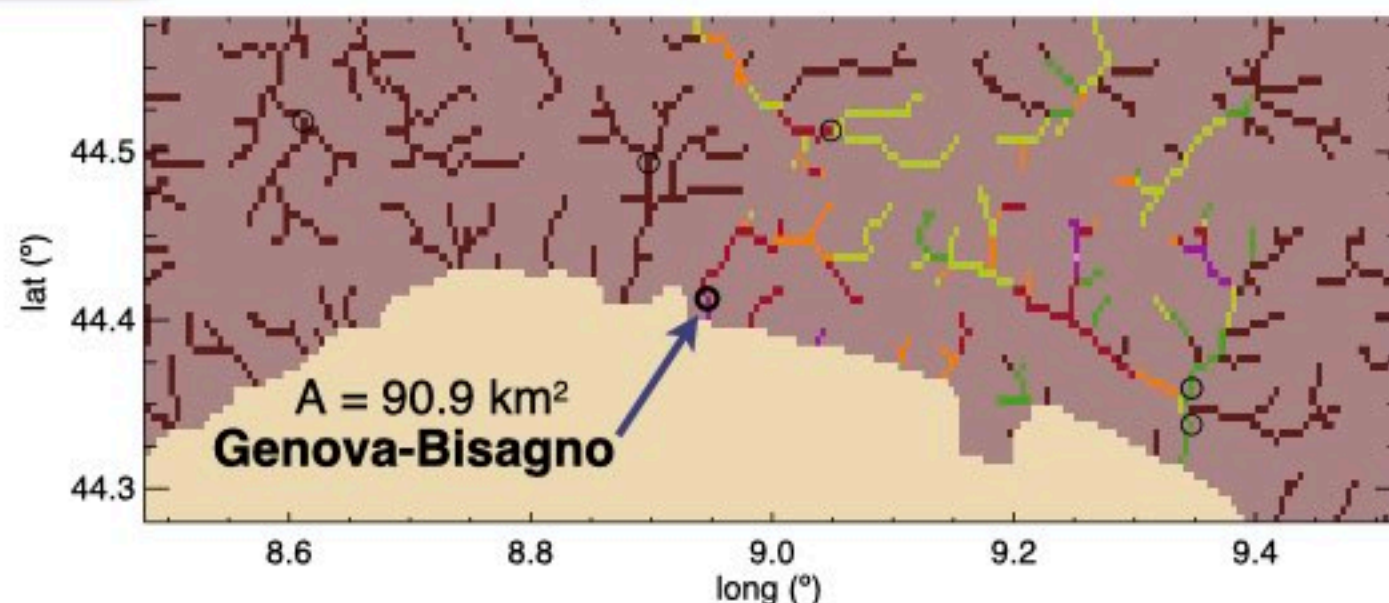
Control points: time series



Comparison of two early warning systems for regional flash flood hazard forecasting.
Journal of Hydrology, 572: 603-619. May 2019

9th-10th October

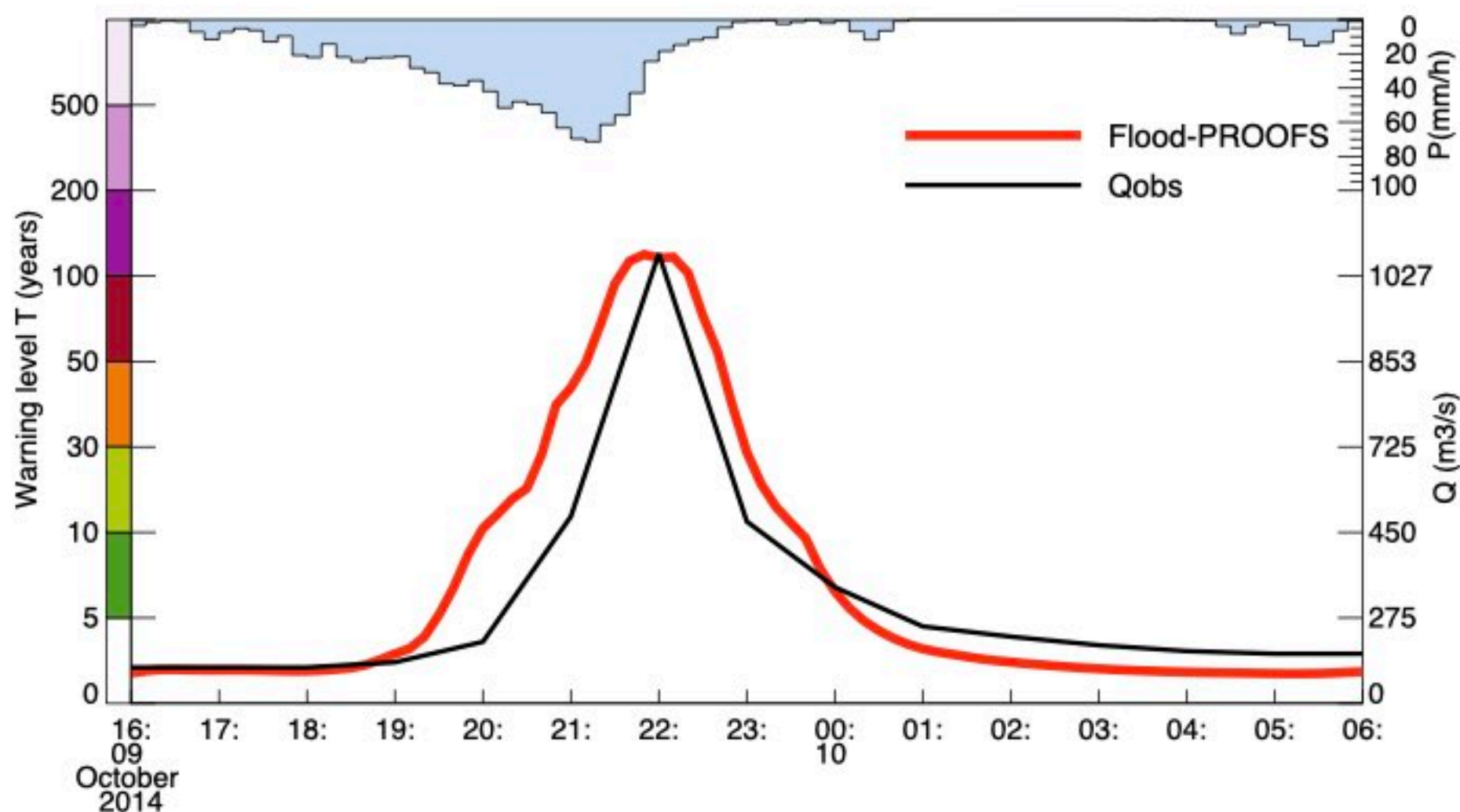
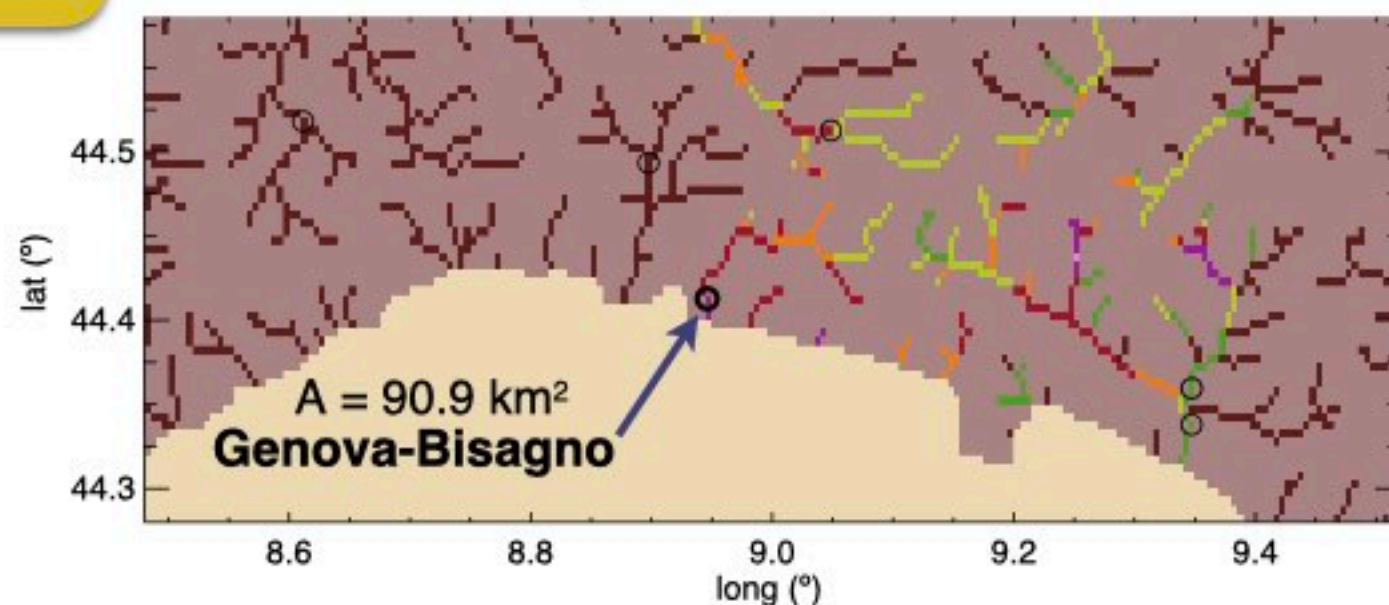
Control points: time series



Comparison of two early warning systems for regional flash flood hazard forecasting.
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9th October

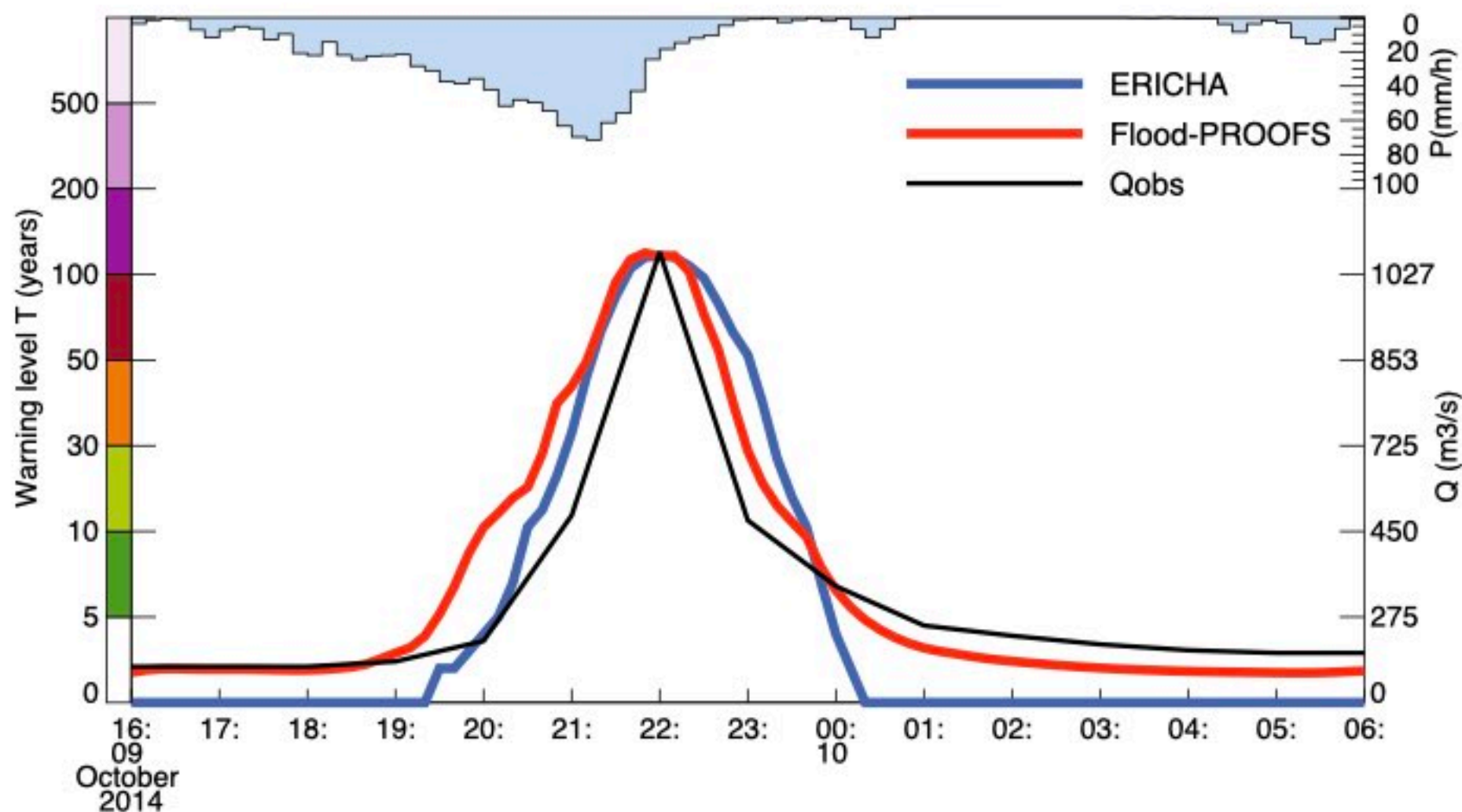
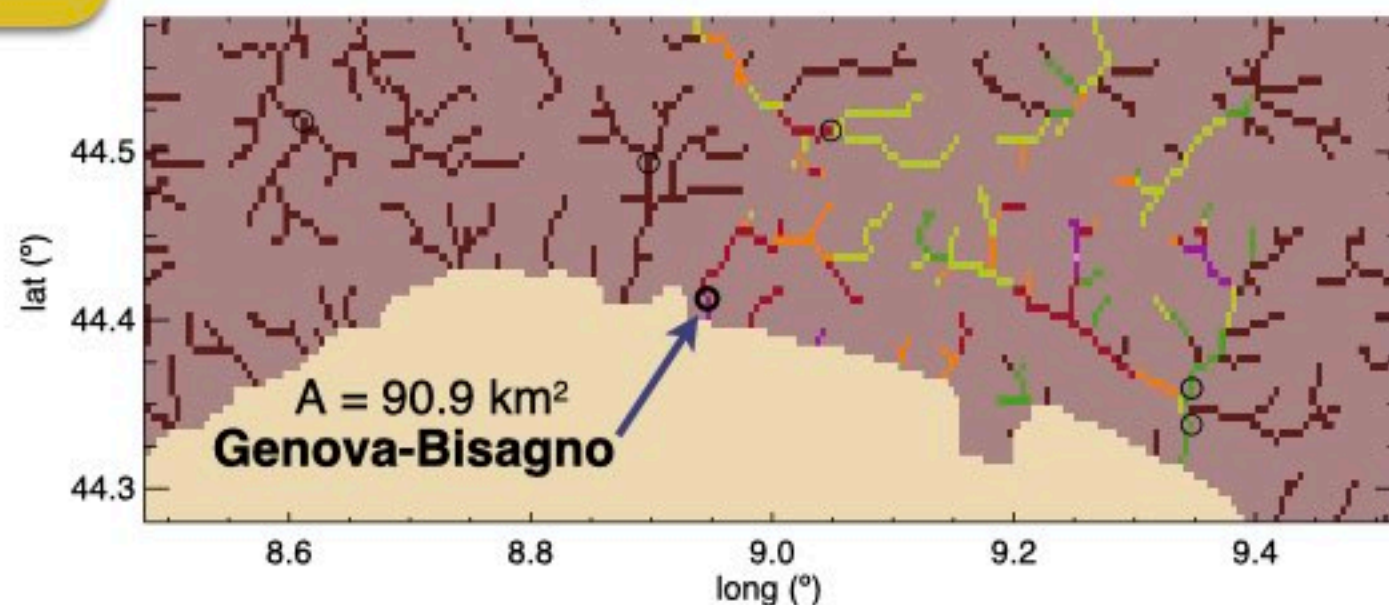
Control points: time series



Comparison of two early warning systems for regional flash flood hazard forecasting.
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9th October

Control points: time series



Comparison of two early warning systems for regional flash flood hazard forecasting.
Journal of Hydrology, 572: 603-619. May 2019



Conclusions



Radar data **CAN BE USED** directly to compute an FF-EWS indicator for warning purposes with **very good results for events over 10 year return period of probability.**

ERICHA hazard level is **as efficient as the full hydrological model FloodPROOFS for high-impact floods ($T > 20$ years)**, confirming the GRADEX concept.

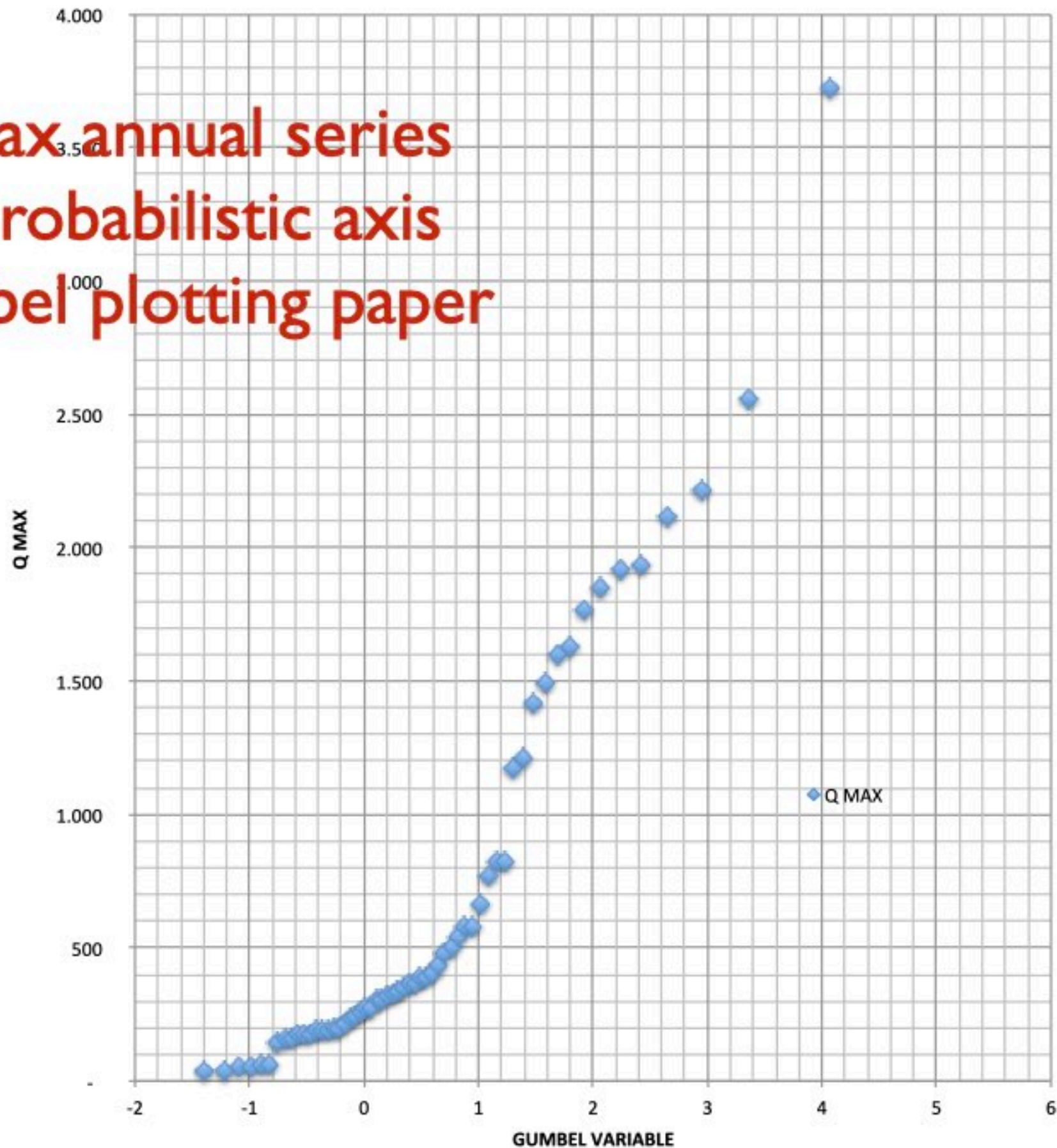
The ERICHA index can provide a good approximation of the hazard level (**even compared to flow observations**)

ERICHA index based on radar data. It is easy and fast to implement over regional domains
(need to define the rainfall thresholds from IDF curves)

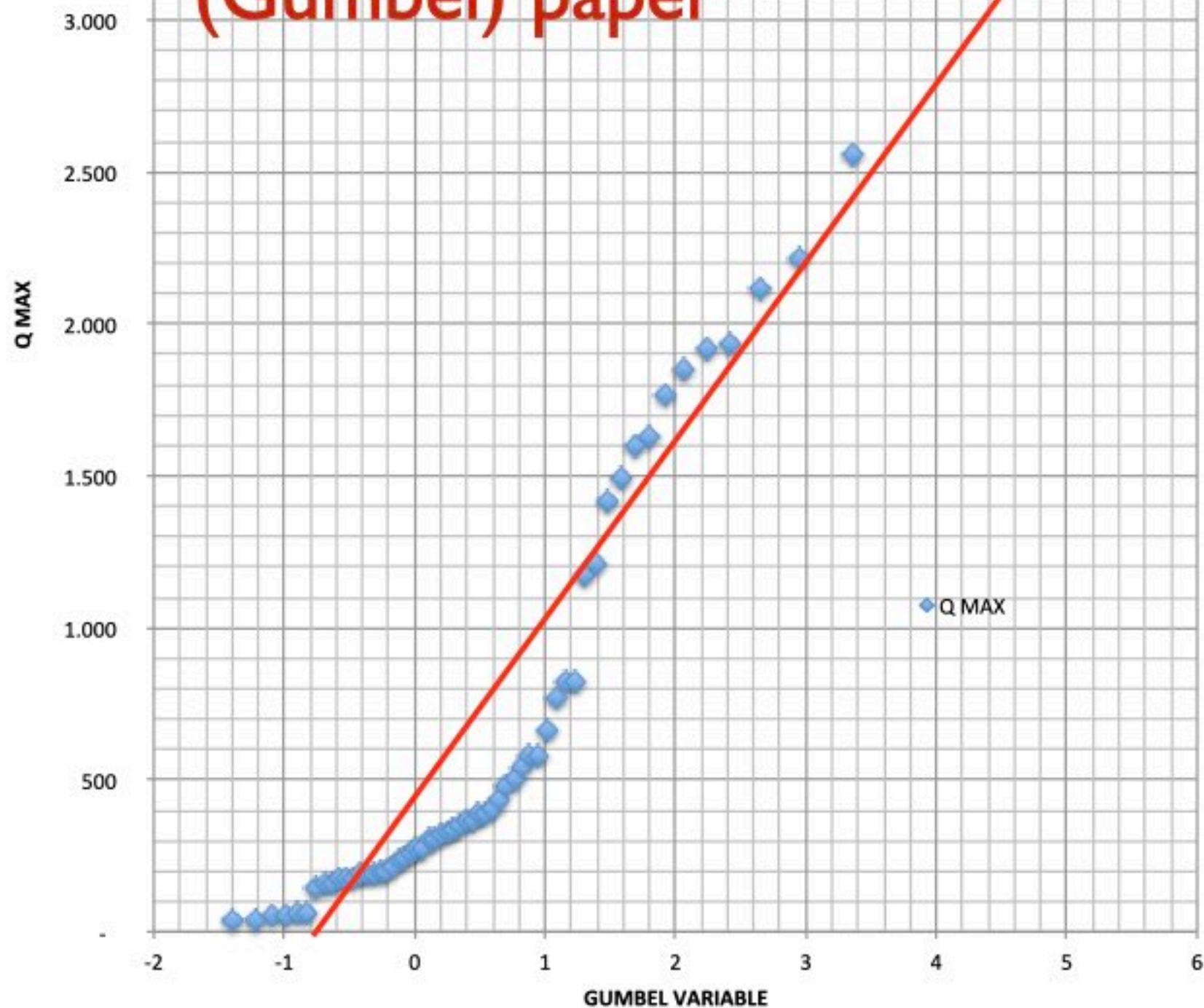
It is integrated in the A4EU multi-hazard platform and has been **operationally tested in 7 Pilot Sites in the ANYWHERE project**

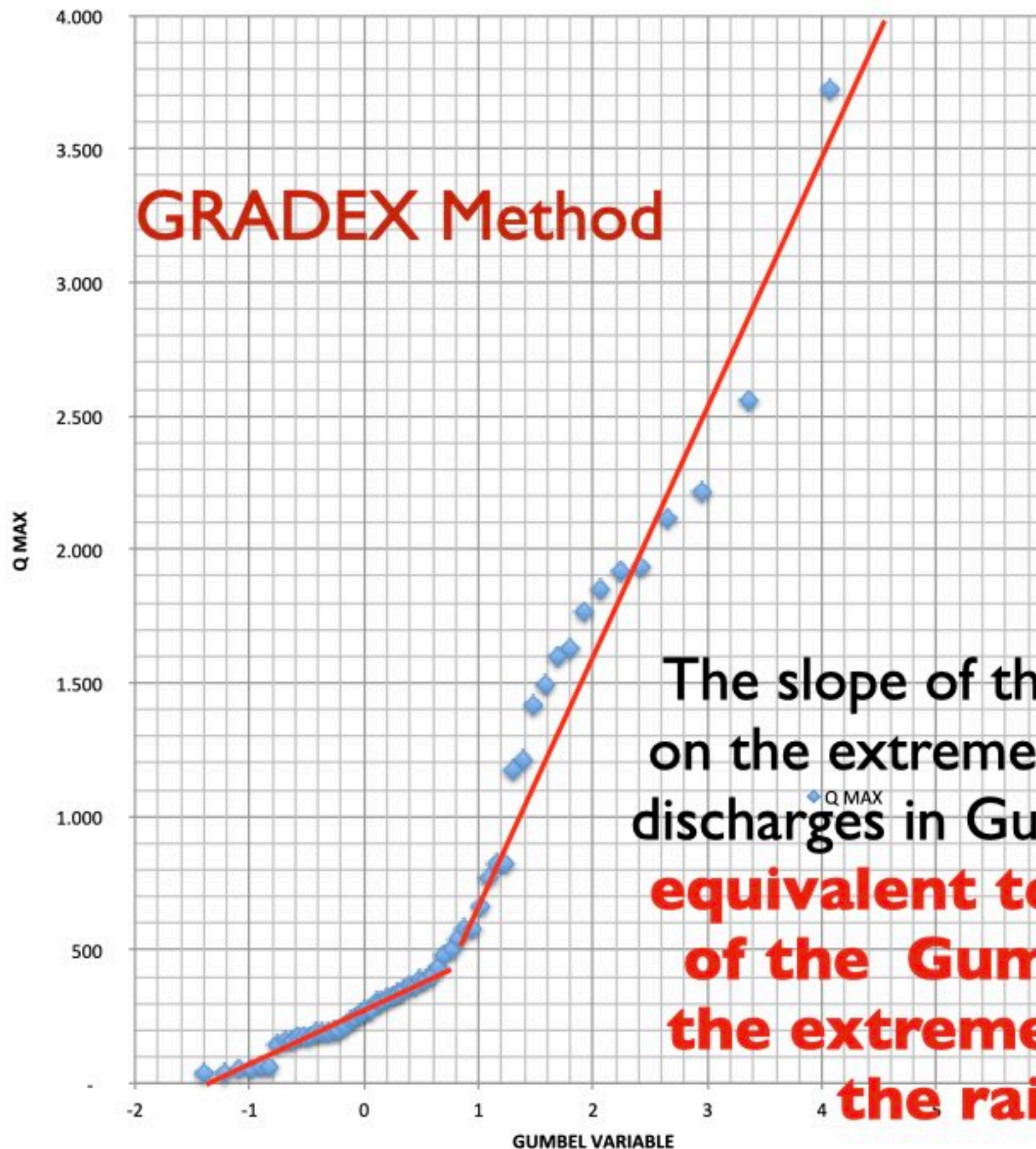
ANYWHERE 

Qmax annual series in probabilistic axis Gumbel plotting paper



Gumbel Fit in probabilistic (Gumbel) paper





The slope of the Gumbel fit on the extreme values of the discharges in Gumbel paper, **is equivalent to the slope of the Gumbel fit on the extreme values of the rainfall**



This presentation is dedicated to Daniel Duband.

To acknowledge his key contributions to **Hydrometeorology** from *Electricity de France* since the 1960's, including the **DPFT**, and specially the **GRADEX** concept (Guillot et Duband, 1967).

We are proud to recognize that our work would have been much more difficult without his enlightening.

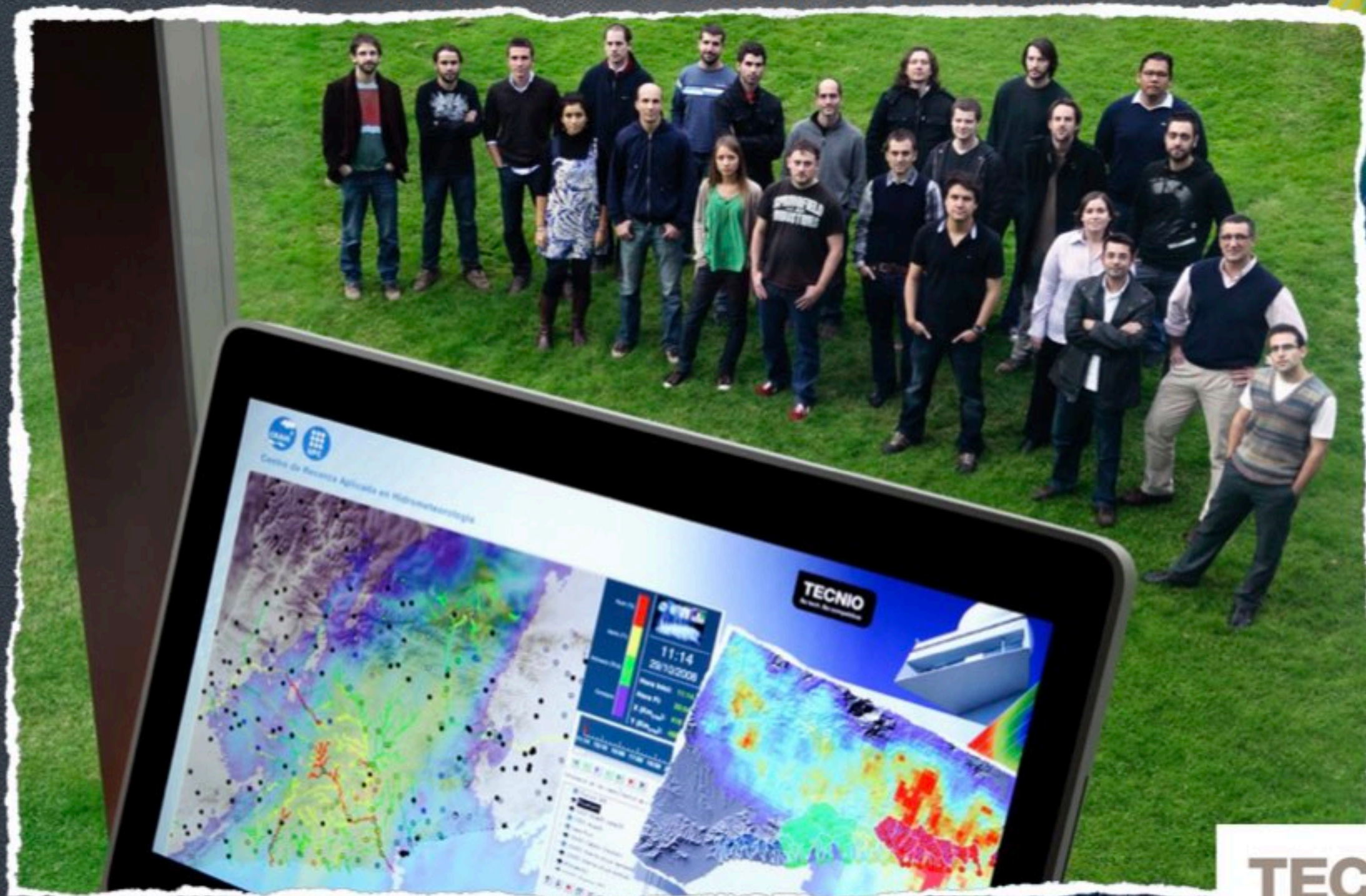
Daniel Duband passed away on July 2011. At that moment he was

Scientific Advisor of the EU project



Centre de Recerca Aplicada en Hidrometeorologia

UNIVERSITAT POLITÈCNICA DE CATALUNYA



GRACIES!

TECNIO
Be tech. Be competitive