



The wettest summer – heavy rainfall events of 2007  
and other large scale flooding events

# Development of the European Flood Awareness System

Christel Prudhomme



With contributions the Environmental forecasts team and  
colleagues from the JRC

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**414mm** rainfall (average England Wales) from May to July 2007  
**Wettest** summer since records began 1766

**4X** average June rainfall in parts North York moors and South Pennines

**30,000** people had to leave their home in hull

**40,000** people lost power in Sheffield (substation inundated)

**> 55,000** homes and businesses affected across the country

**7,000** people were rescued

**800** properties flooded in Tewkesbury

**13** people died

**£4bn** losses, including ~ £3bn insurable



UK RAINFALL  
% of monthly



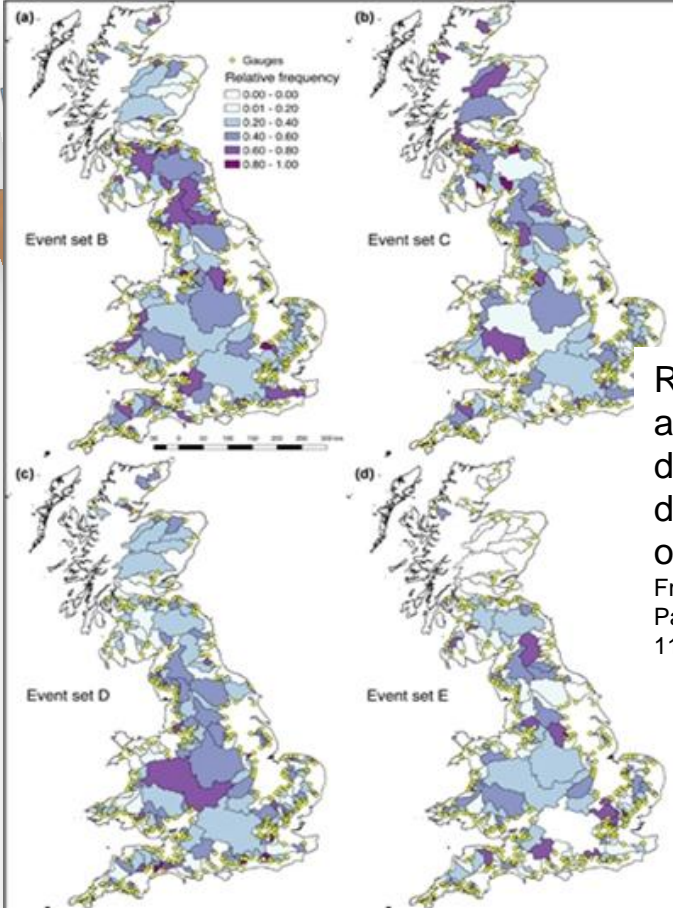
and July

Environment Agency

Source: Environment Agency



...not a unique event....



# CHRISTMAS WEATHER ALERT: Britain to face the WORST Xmas floods for 50 years

MS threaten to batter Britain for the next fortnight as forecasters predict heavy rain and high winds. The weather could lead to flooding in some areas for two years.

IAN RAO  
PUBLISHED: 00:00, Fri, Dec 11, 2015 | UPDATED: 20:31, Fri, Dec 11, 2015

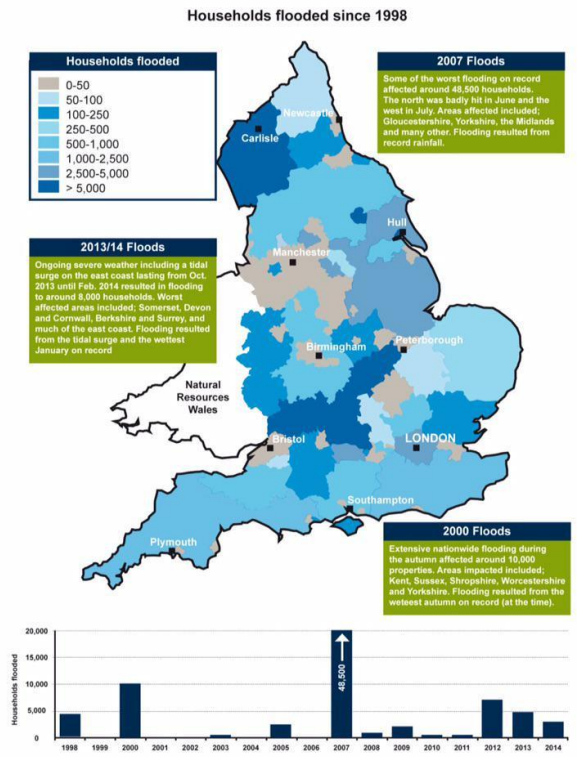
Relative frequency for peak flow annual maxima to occur together; derived from observations; the darker the colour, the most occurrence.

From Paolo De Luca et al 2017 Environ. Res. Lett. 12 114009 doi:10.1088/1748-9326/aa868e



has been battered by floods

Figure A1 Households flooded since 1998



John Curtin. executive Director of Flood & Coastal Risk Management, Environment Agency



... and not unique in Europe...



European  
Commission

**BBC NEWS**  
You are in: World: Europe  
Thursday, 15 August, 2002, 16:46 GMT 17:46 UK

## Floods wreak havoc in Germany

Some parts of Dresden can barely be seen

A dam has burst in south-eastern Germany as flood waters sweep northwards from the Czech Republic, spreading chaos in Europe's worst floods for more than a century.

The dam at Bitterfeld collapsed around midday, sending the Mulde River cascading towards the town, whose 16,000 inhabitants are being urgently evacuated.

A large chemical plant at Bitterfeld is unlikely to be flooded, the authorities say, but there are fears of environmental damage after a chlorine gas leak from a Czech plant near the German border.

Click here to see a map of the region

The swollen Elbe is surging towards Dresden,

**WATCH/LISTEN ON THIS STORY**  
REAL MEDIA  
The BBC's Gavin Hewitt  
"Tens of thousands have been evacuated"  
The BBC's Tristana Moore  
"Flood waters are threatening to engulf whole towns"

**FLOOD IMPACT**

- European havoc
  - Flood lessons
  - In pictures
  - Art saved
  - Slovakia's relief
- Germany ravaged
  - Footing the bill
  - Dresden's treasures
- Prague drama
  - Czechs warned
  - Flight before the flood
  - A seal's odyssey
- Freak phenomenon?
  - What's behind storms
  - The El Nino factor
  - Flash floods

**FORUM**  
The BBC's Michael Fish took your questions

**TALKING POINT**  
Are you affected?

**The Guardian**  
Sign in

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Contribute → Subscribe →

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Environment Climate change Wildlife Energy Pollution More

## Death toll from floods nears 100

Susie Steiner  
Mon 19 Aug 2002 14.27 BST

The towns of Bitterfeld and Wittenberg in Germany suffered continued flooding this morning as the rivers Elbe and Mulde burst their banks.

In the eastern town of Wittenberg seven dykes burst along the Elbe in the early hours of this morning. "Vast amounts of water are flooding into the city," a spokesman for Wittenberg rescue workers told Reuters. "We are evacuating nearby areas."





... with devastating impacts...



**3 large rivers:** Vltava, Elbe, Danube  
**9 countries:** Czech Republic, Slovakia, Italy, Germany, Romania, Hungary, Austria, Poland, Ukraine

**July 1997**

~25bn€ Losses

Millions €

106 killed

**3 countries:** Czech Republic, Poland, Germany

~4.5bn€ Losses

54 killed



## Flooding in central Europe, August 2002

**June 2009**

**9 countries:** Czech Republic, Poland, Slovakia, Austria, Hungary, Germany, Romania, Serbia, Turkey

33 killed

Ten dead in Czech floods, central Europe on alert



SOURCE: MUNICH RE., FEDERATION.

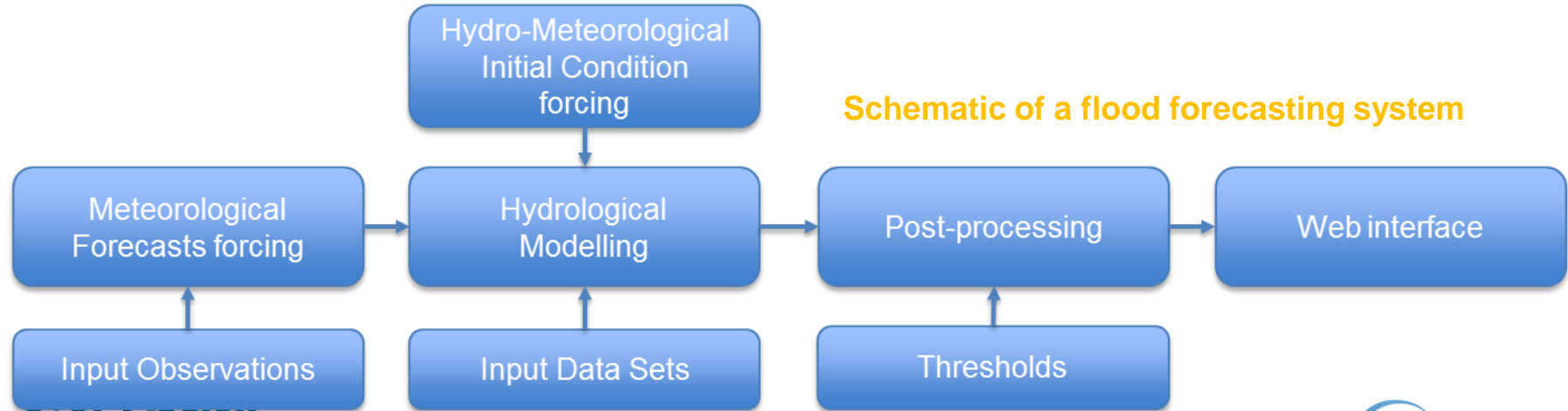


## Impacts

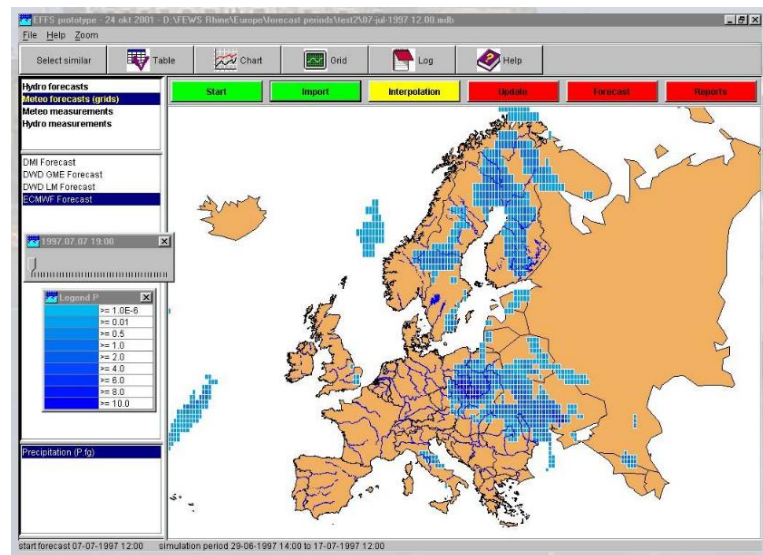
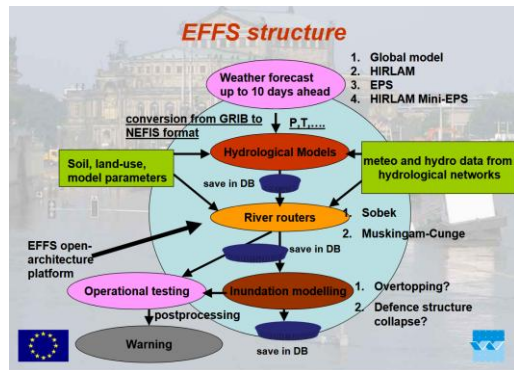
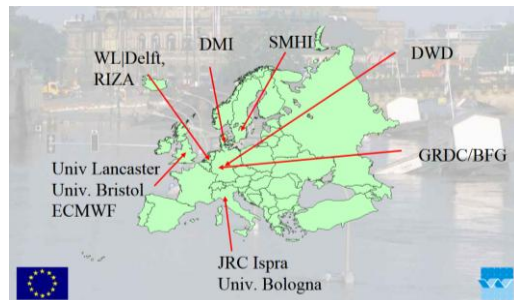
- National and international economic disruption
- Devastating impacts to thousands of citizens
- Prioritisation of response required
- Emergency and rescue services stretched

## Knowledge

- Fragmented information
- Inconsistent forecasts across agencies/ nations
- Variable quality of information
- Difficult large-scale planning and organisation of aid



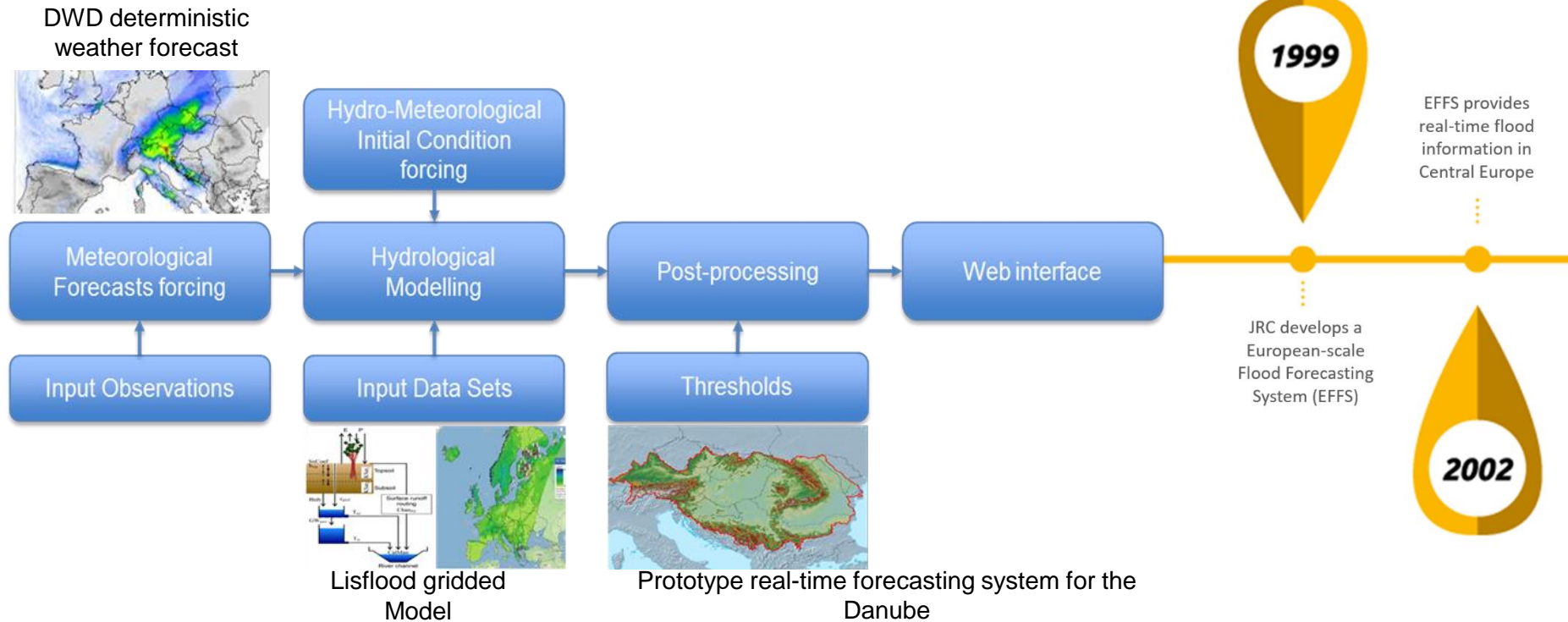
# The European Flood Forecasting System EFFS (FP5 project)



EFFS Prototype



JRC develops a European-scale Flood Forecasting System (EFFS)

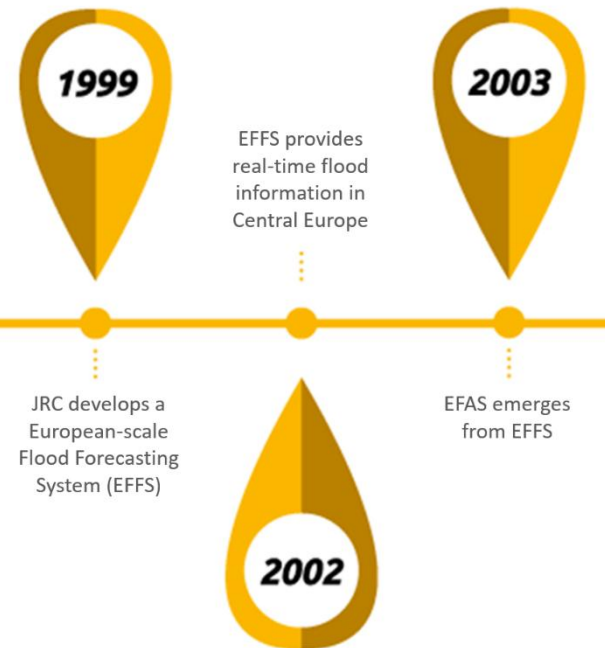
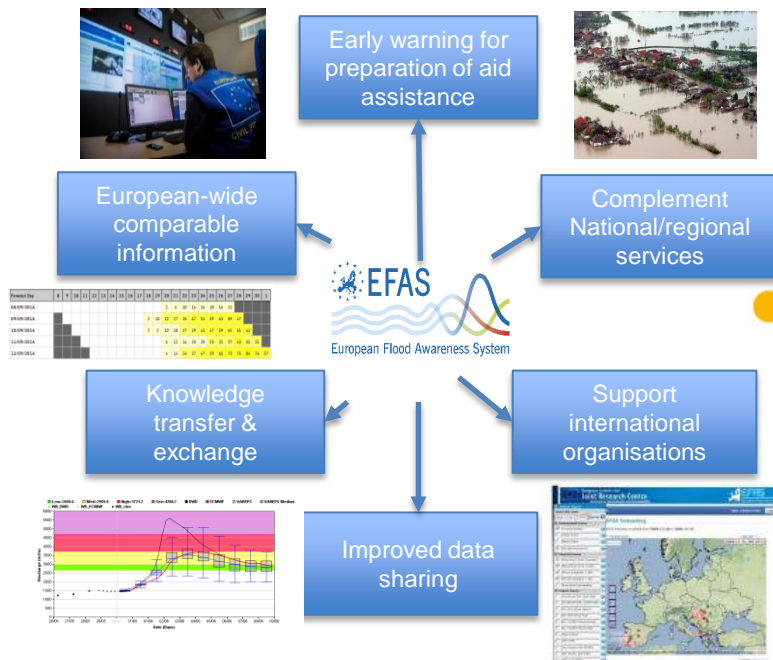




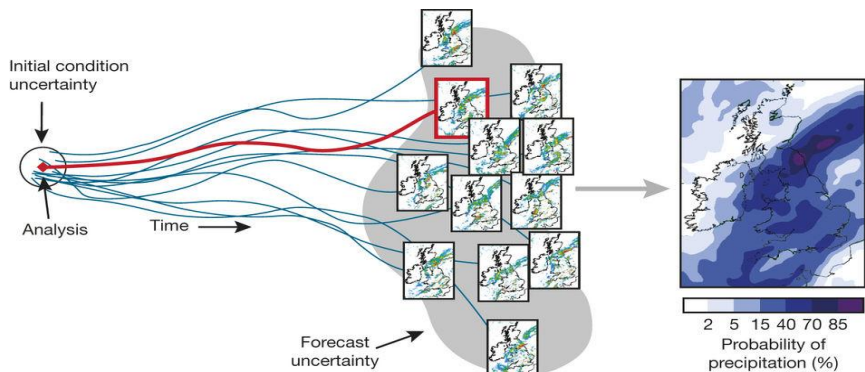
# EFFS becomes EFAS, funded by European Commission



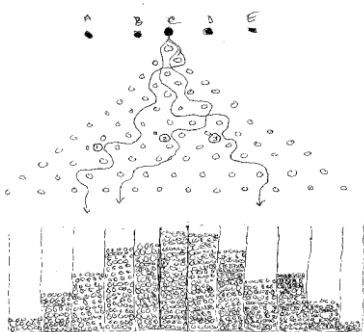
Experts from Austria, Czech Republic, Germany, Hungary, and Slovakia at JRC to co-develop EFAS



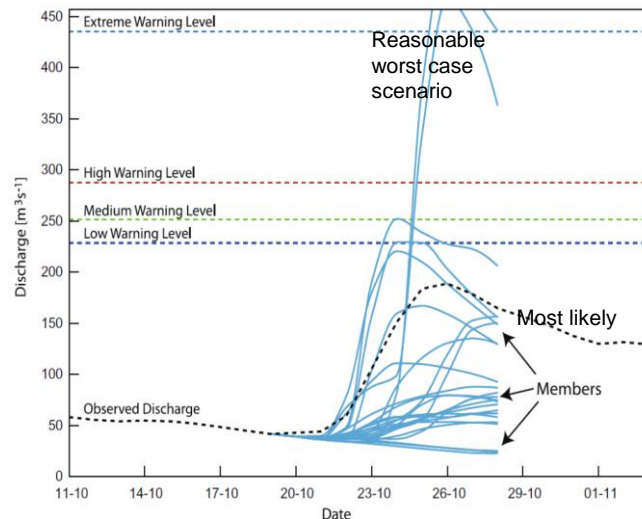
# Uncertainty in weather forecasting: the ensemble approach



Source: Bauer et al., Nature, 10.1038/nature14956



Source: <http://www.meteor.iastate.edu/gccourse>



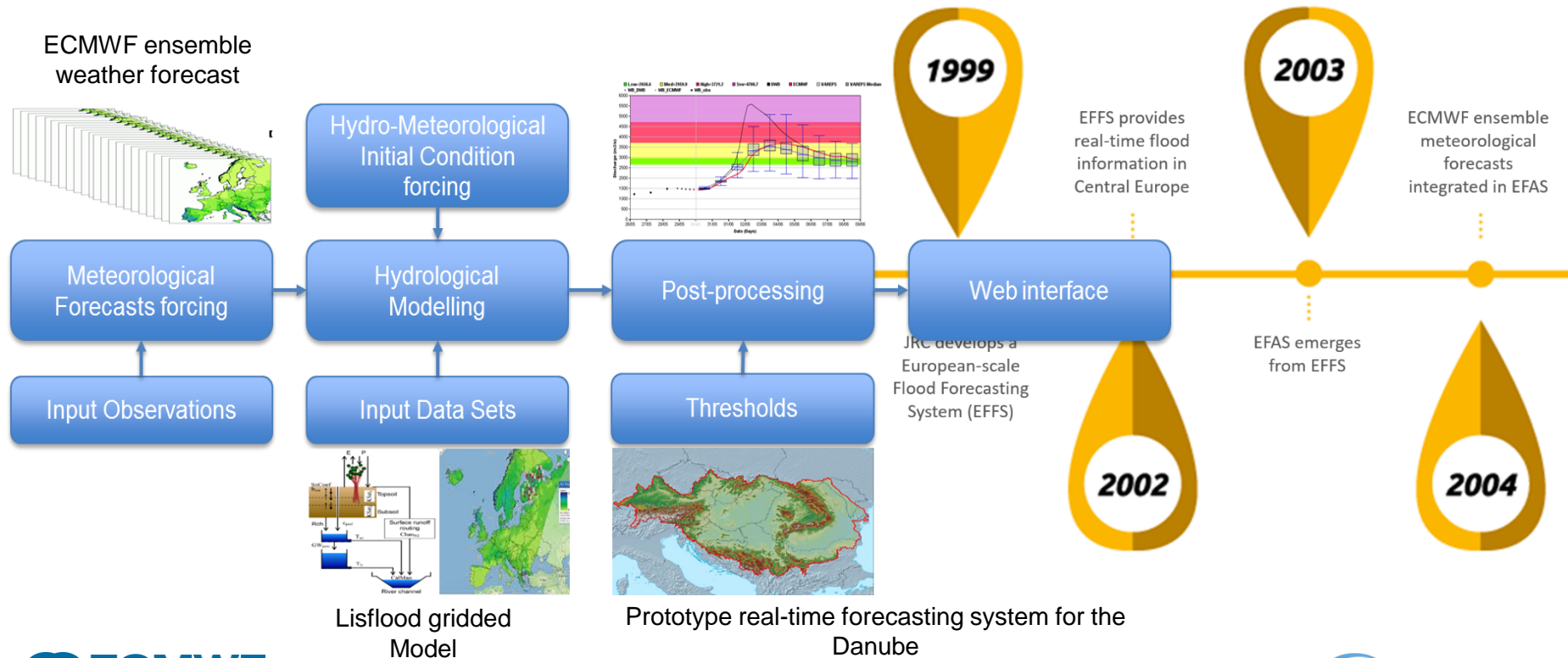
**Ensemble  
Forecast  
Hydrograph**

Source: Cloke & Pappenberger (2009) Ensemble Flood Forecasting. Journal of Hydrology





# ECMWF ensemble forecasts prototyped in EFAS



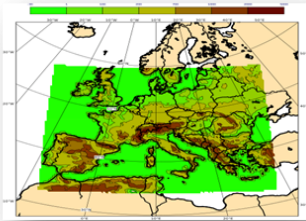


# EFAS gets pre-operational



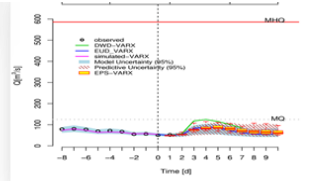
EFAS partners – June 2006

Cosmo-LEPS ensemble forecasts  
~7-km – 2009

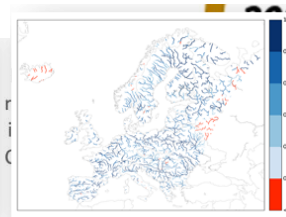


Hydro-Meteorological  
Initial Condition  
forcing

Statistical correction where  
real-time observed  
discharge is provided -  
2009



Bulletin  
Skill scores – 2009



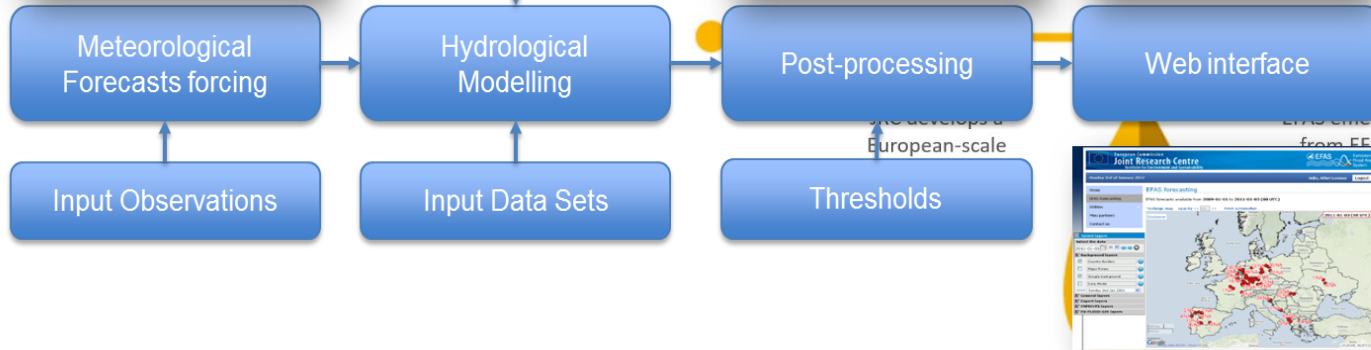
ECMWF ensemble  
meteorological  
forecasts  
integrated in EFAS

2005  
2010

Operational EFAS  
test system & EFAS  
partner network  
established

2004

Web interface – 2007





# EFAS becomes a Copernicus Emergency Management Service



Meteorological Data  
Collection Centre



Hydrological Data  
Collection Centre

1999



Hydro-Meteorological  
Initial Condition  
forcing

EFAS provides  
real-time flood  
information in

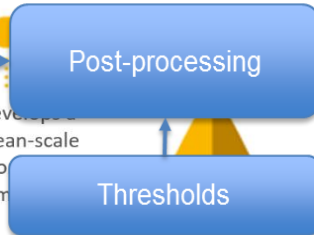
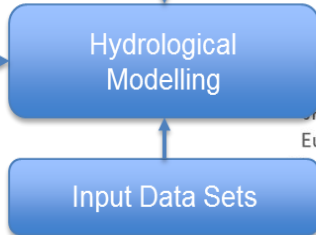
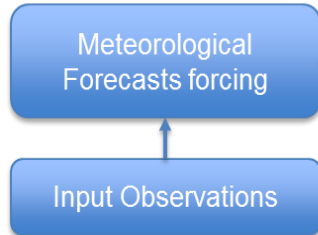


Dissemination Centre



2005  
2010

EFAS part of  
CEMS & EFAS  
consortium  
created



Computational Centre

2002

2004

2011



Emergency  
Management



EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS



Project Management



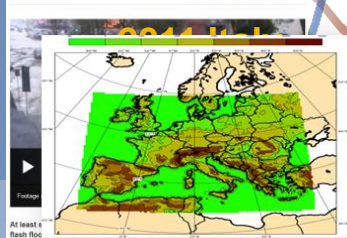




# EFAS is fully operational; EPIC Flash Flood layer added



Italy floods: Six killed in port city Genoa  
4 November 2011



Meteorological  
Forecasts forcing

Spain  
Input Observations

The Telegraph

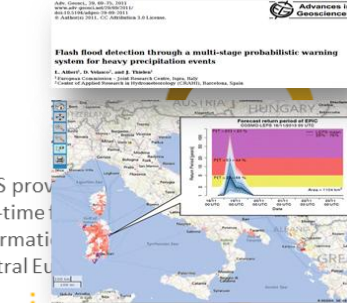
2012 Wales  
Weather: Britain on flood alert as a month's worth of rain falls in 24 hours



1999  
Hydro-Meteorological  
Initial Condition  
forcing

Hydrological  
Modelling

JRC develops a  
Input Data Sets



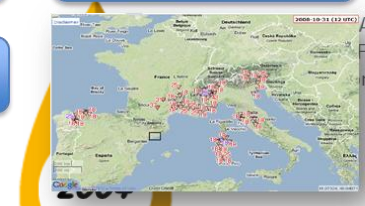
Post-processing

EFAS emerges  
Thresholds

2002

ECMWF ensemble  
meteorological  
forecasts  
integrated in EFAS

Web interface



Flash Flood Layer

2005  
2010

EFAS part of  
CEMS & EFAS  
consortium  
created

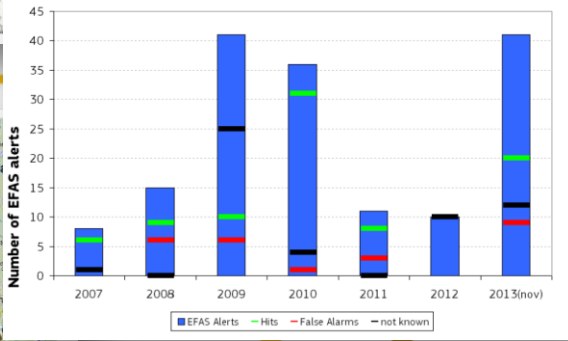
2011

2012

EFAS becomes fully  
operational  
EPIC Flash Flood  
layer



EFAS  
& EFAS  
work  
ed

**2013**



# Sharing EFAS forecasts to EFAS partners



Joint Research Centre Data Catalogue  
Opening access to JRC data

Home Datasets Collections Science Areas

/ Collections / CEMS-EFAS

**CEMS-EFAS**

European Flood Awareness System

Description  
The European Flood Awareness System (EFAS) is part of the Copernicus Emergency Management Service (Copernicus EMS). It provides complementary flood early warning information to its partners, the national/regional hydrological services and the European Response and Coordination. [Show more](#)

Joint Research Centre Data Catalogue  
Opening access to JRC data

Home Datasets Collections Science Areas

/ EFAS flood probabilities / EFAS Sensor Observation ...

**EFAS Sensor Observation Service (SOS)**

EFAS partners have the possibility to access and download selected products from the operational EFAS by using this password-protected OGDC service.

Conditions for use and access

Use conditions: Licence not available  
Access conditions: Access restrictions: Authorisation required

Access information

Access URL: [http://repositorio.ecmwf.int/2018/sos-webapp\\_efas/using/Service-SOS&request=GetCapabilities](http://repositorio.ecmwf.int/2018/sos-webapp_efas/using/Service-SOS&request=GetCapabilities)  
Format: SOS

Joint Research Centre Data Catalogue  
Opening access to JRC data

Home Datasets Collections Science Areas

/ EFAS flood probabilities / EFAS WMS-T (Web Map Service ...

**EFAS WMS-T (Web Map Service Time)**

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Conditions for use and access

Use conditions: Licence not available  
Access conditions: Access restrictions: Authorisation required

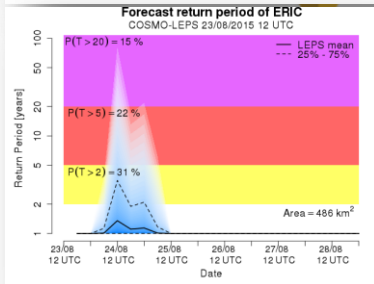
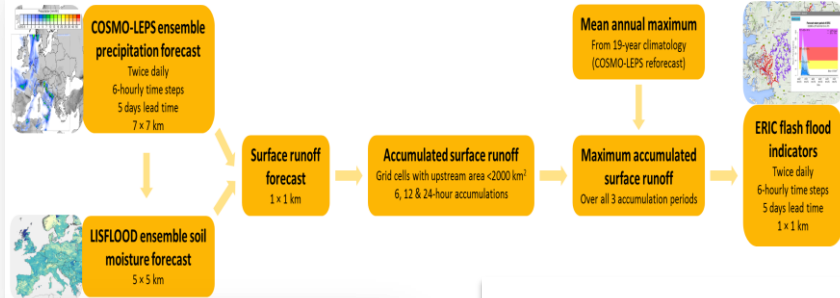
Access information

Access URL: [http://res-ows.jrc.ec.europa.eu/efas\\_jrc\\_new/](http://res-ows.jrc.ec.europa.eu/efas_jrc_new/)  
Format: wms





# Improved Flash Flood Indicator; Notification system



**Formal Notifications (leadtime; persistence;  
Severity; location; surface area)**

**Informal Notifications (location; surface area)**

**Flash flood Notifications (leadtime; severity;  
location)**

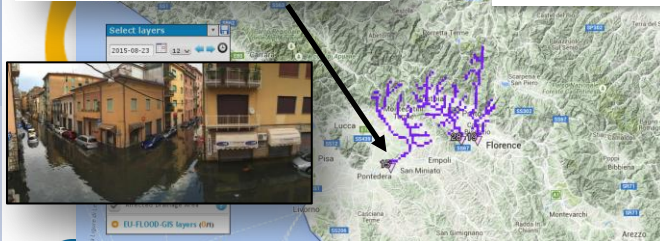
**Notifications to restricted users only**



EFAS stress tested  
during June 2013  
central European  
flood



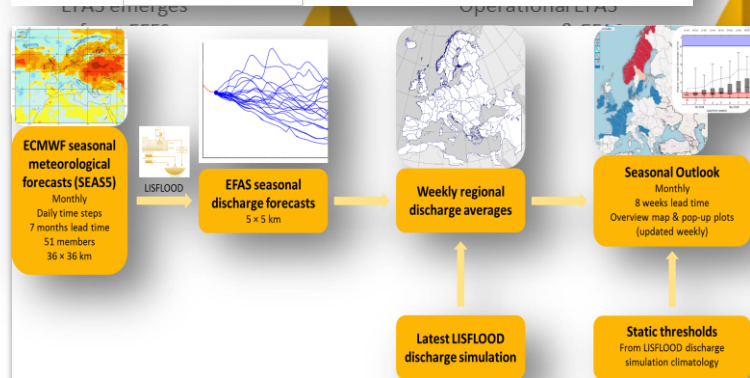
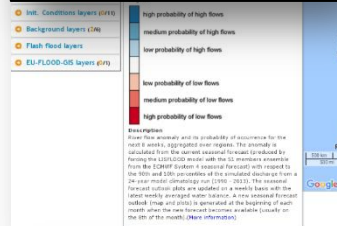
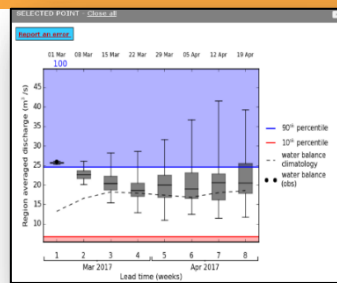
EFAS SOS and  
WMS  
services







# EFAS Seasonal – hydrological outlooks up to 8 weeks ahead



EFAS becomes fully operational

EFAS stress tested during June 2013 central European flooding



EFAS SOS and WMS services

ERIC replaces EPIC Formal and information notifications created



EFAS Seasonal – hydrological outlook



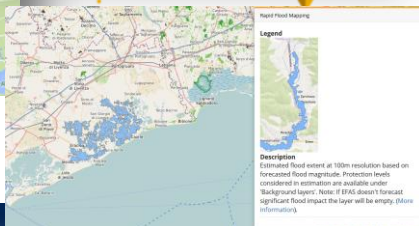
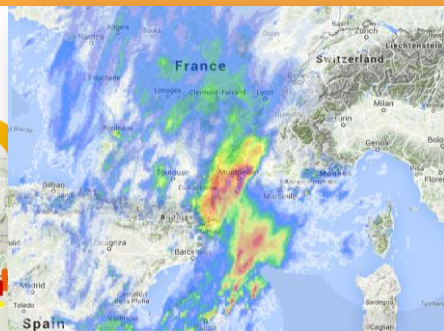
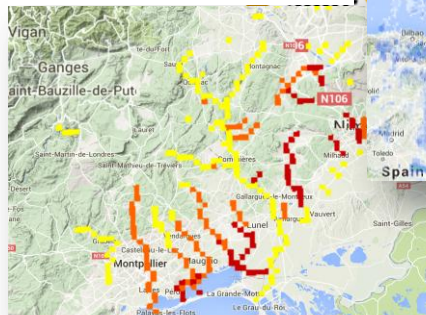




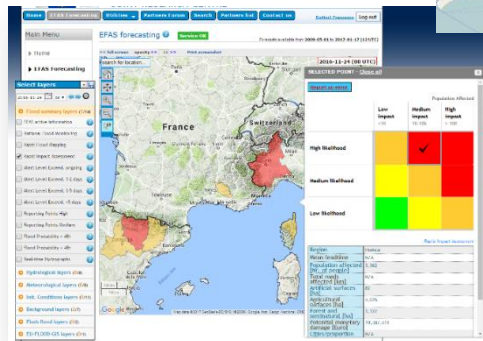
# ERICHA Nowcasting and Impact forecasting



ERICHA  
Radar-based forecast  
15mn up to 3 hours

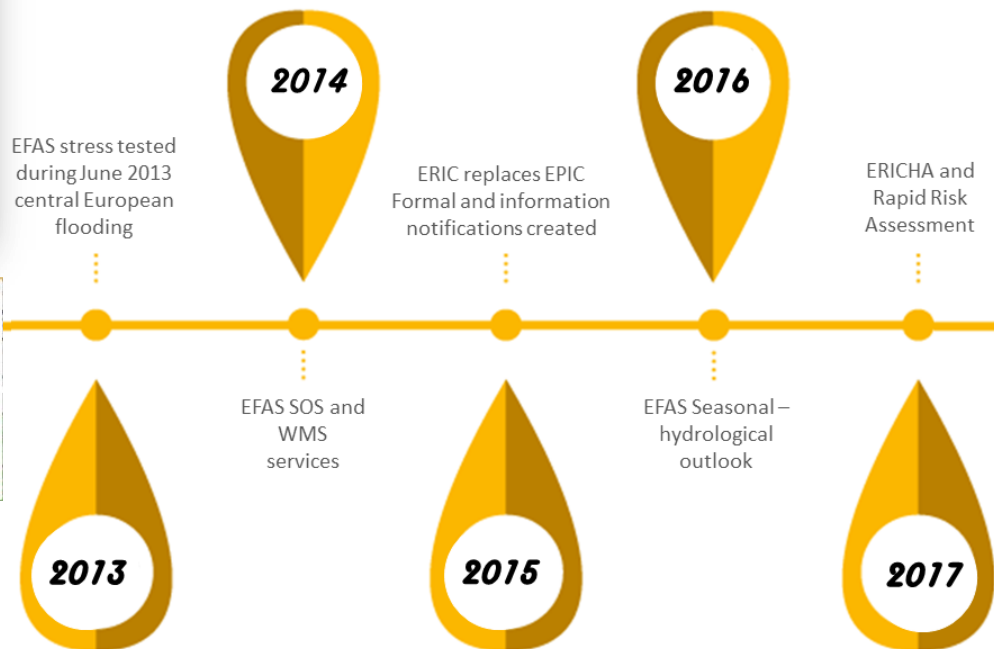


Impact mapping for rapid  
risk assessment



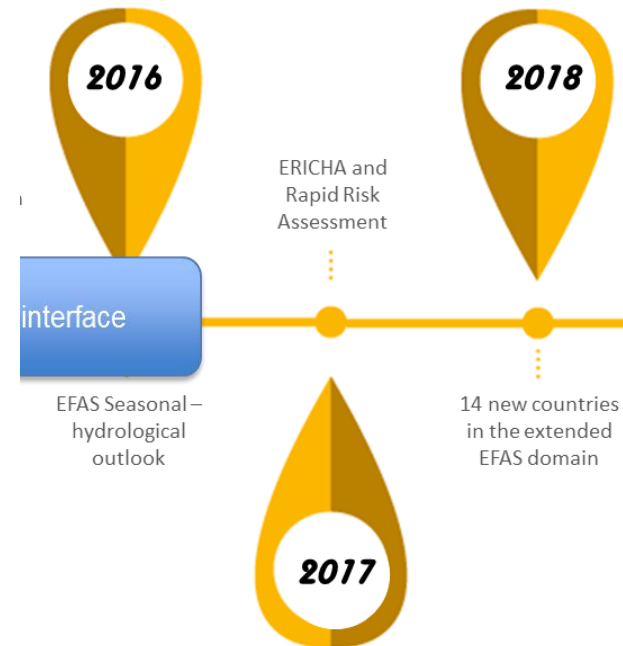
Max Median Severity  
+  
Inundation catalogue  
+  
Population  
Infrastructure  
Land cover

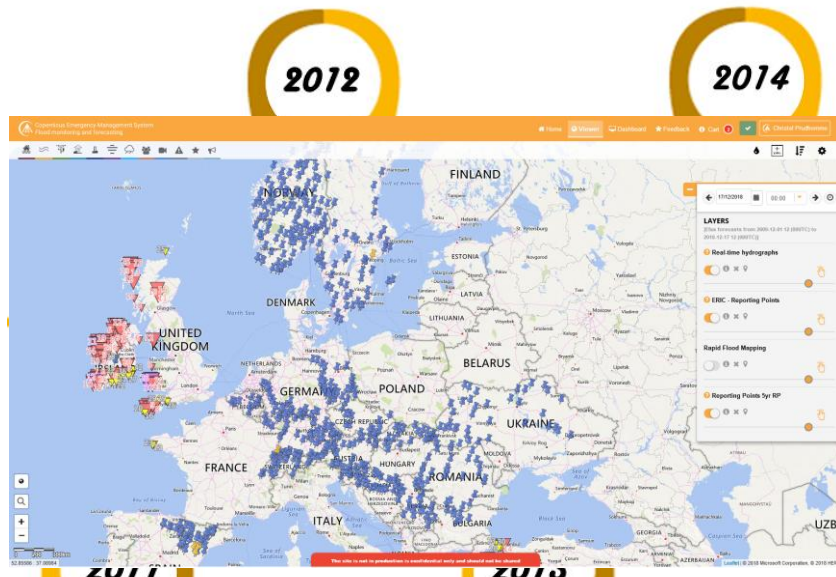
EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS





# EFAS extended domain





**2012**

**2014**

**2016**

**2018**

ERIC replaces EPIC  
normal and information  
notifications created

ERCHA and  
Rapid Risk  
Assessment

EFAS Seasonal –  
hydrological  
outlook

14 new countries  
in the extended  
EFAS domain

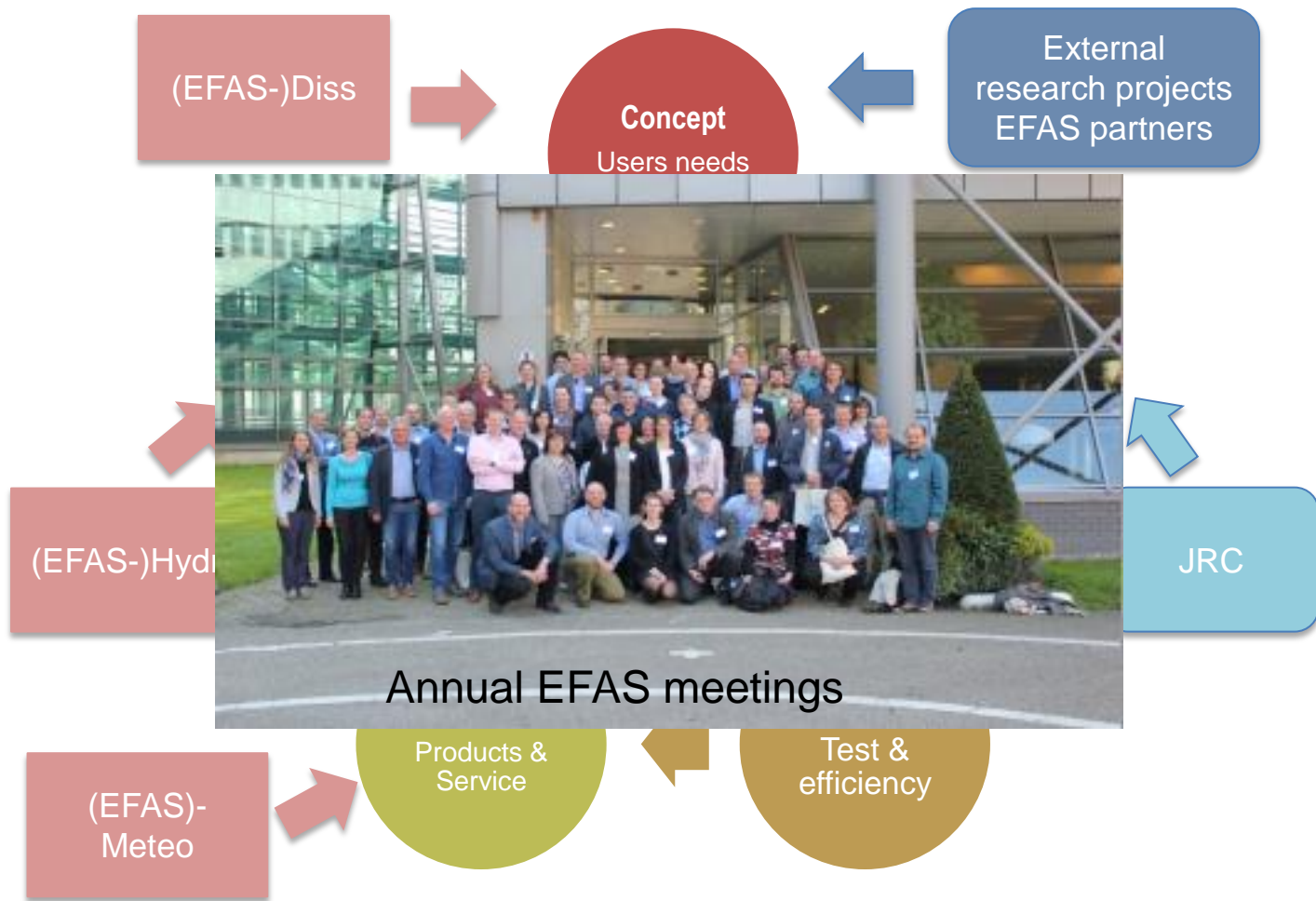
**2015**

**2017**

**2019...**

New web interactive interface and easier  
access to forecasts to registered users









**Only possible through  
collaboration and sharing**

**Thank you**

Christel.Prudhomme@ecmwf.int