European Commission

The European Flood Awareness System

EFAS

European Flood Awareness System

Peter Salamon

Climate Risk Management Unit

Joint Research Centre

European Commission

Copernicus
Europe's eyes on Earth

Joint Research Centre

The objective of this course

- General background and basic set up of EFAS
- Use of ensemble predictions in flood forecasting
- Basic concepts of EFAS
- Communication and visualization of uncertain results for decision making
- Hands on with EFAS!

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European Flood Awareness System

Basic set up and background

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Background - Why did we start with EFAS?

Elbe and Danube floods in 2002 were a wake-up call for the European Commission to start different activities on floods and disasters.

JRC expanded the research project EFFS (1999-2003) to an operational stage to increase preparedness for floods and to improve international aid management

EFAS development is done in collaboration with national hydro-met services and research organizations

EFAS main objectives

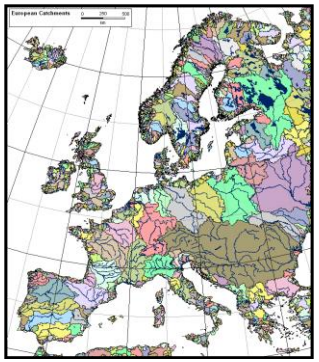
Added value

- -Catchment based information
- -Lead times up to 10 days
- -Probabilistic information
- - knowledge exchange platform

National hydro-met services

Novel information

- Comparable information across Europe
- Tool for international aid assistance during crisis



EC Emergency Response and Coordination Center

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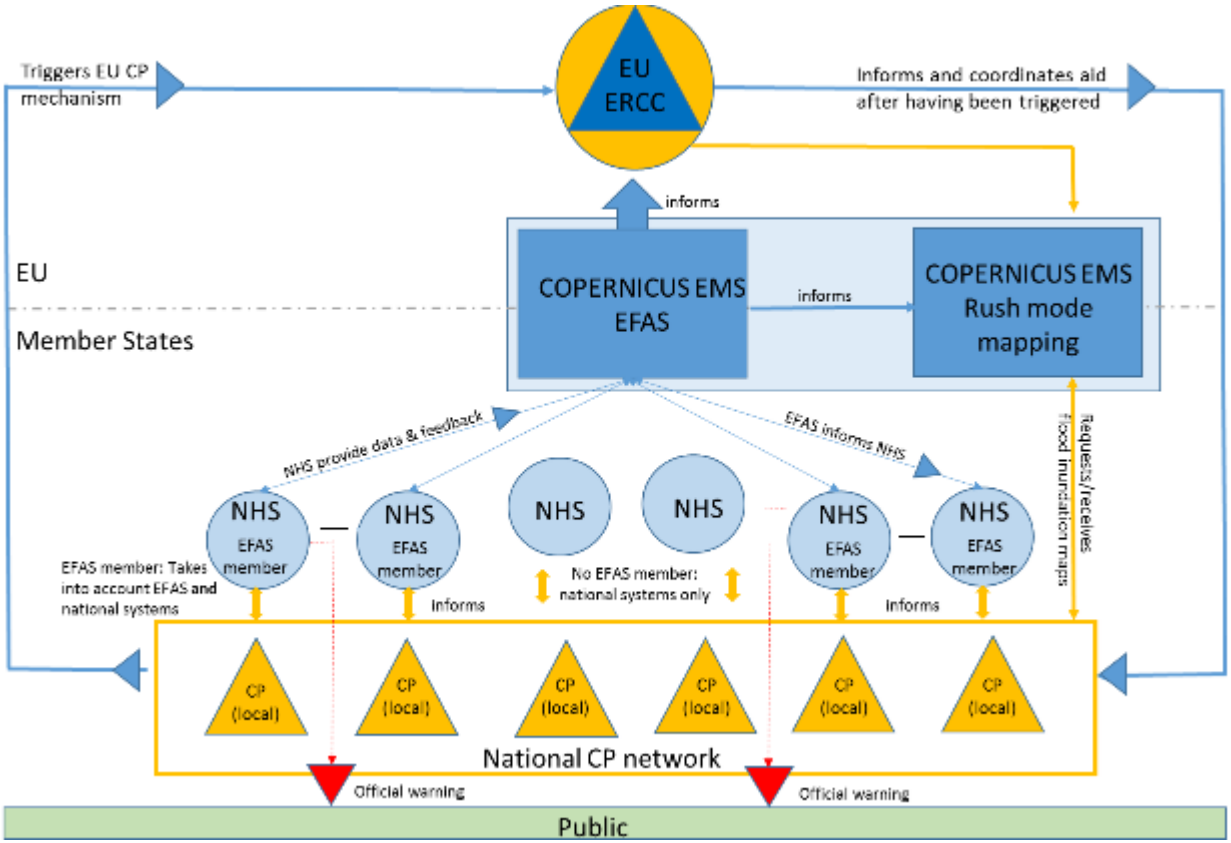
Role of EFAS in relation to national services



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EFAS partner network

Who can become EFAS partner?

National/regional authorities in charge of flood forecasting.

Third parties if agreed by the national EFAS partner

EFAS is free and not limited to EU MS

- **More than 50 national/regional authorities as EFAS partners plus ERCC**
- **First European operational flood forecasting network**
- **Annual partner meetings**

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Structure of operational EFAS

Since 2012 four operational EFAS Centers are in place:

- **EFAS computational center (ECMWF)**
- **EFAS dissemination center (SE, *SK*, NL)**
- **EFAS hydrological data collection center (ES)**
- **EFAS meteorological data collection center**

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EFAS computational center (ECMWF)

- **Flood forecast simulations**
- **Guarantee a 24/7 service for the availability of EFAS forecasts**
- **Responsible for the implementation of new developments**
- **Maintain EFAS web site**

ECMWF

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EFAS Hydro- and Meteo Data Collection

- **Collect hydro – and meteo data (real time and historic) necessary for EFAS**
- **Contacting and managing the data providers**
- **License conditions will be negotiated by the JRC**

JUNTA DE ANDALUCIA
CONSEJERIA DE MEDIO AMBIENTE
REGIONAL MINISTRY OF ENVIRONMENT

Agencia de Medio Ambiente y Agua
CONSEJERÍA DE MEDIO AMBIENTE

Rediam

ELIMCO SISTEMAS

KISTERS
Pioneering Technologies.

DWD

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EFAS Dissemination Center

- **Daily analysis of EFAS forecasts**
- **Sending of EFAS warnings to national partners and the ERCC**
- **Maintenance of EFAS partner network**
- **Organization of the annual meetings**
- **Represent EFAS in workshops and conferences**

SMHI

SHMÚ

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Concepts and methodologies

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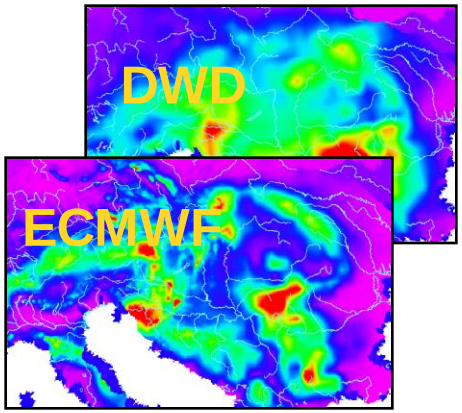
Weather forecasts in EFAS

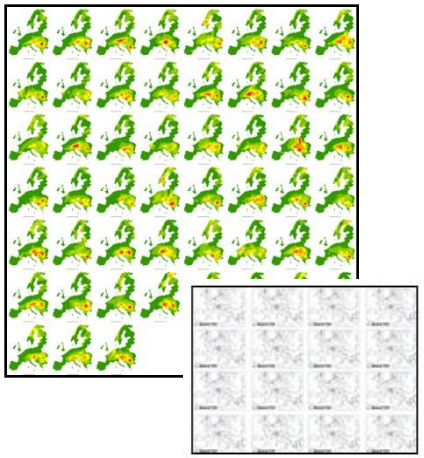
Deterministic

- DWD – 7 days, ~ 7 km (Day 1 – 3), ~ 30 km (day 4 - 7), twice daily
- ECMWF, 10 days, ~16 km, twice daily



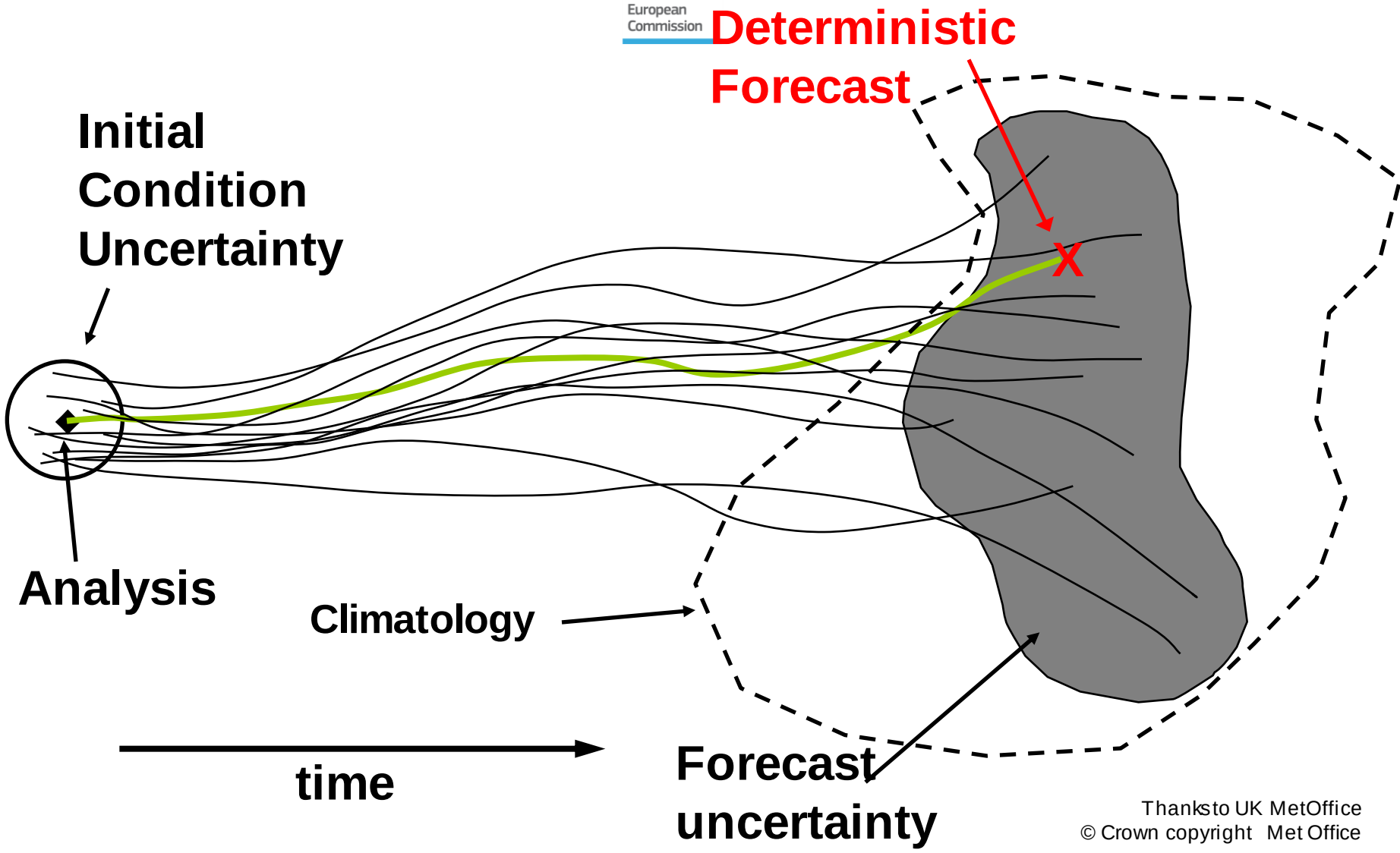
Ensembles

- ECMWF VAREPS – 10 days , ~ 30 km, 51 members, twice daily
- COSMO-LEPS - 5 days, ~ 7 km, 16 members



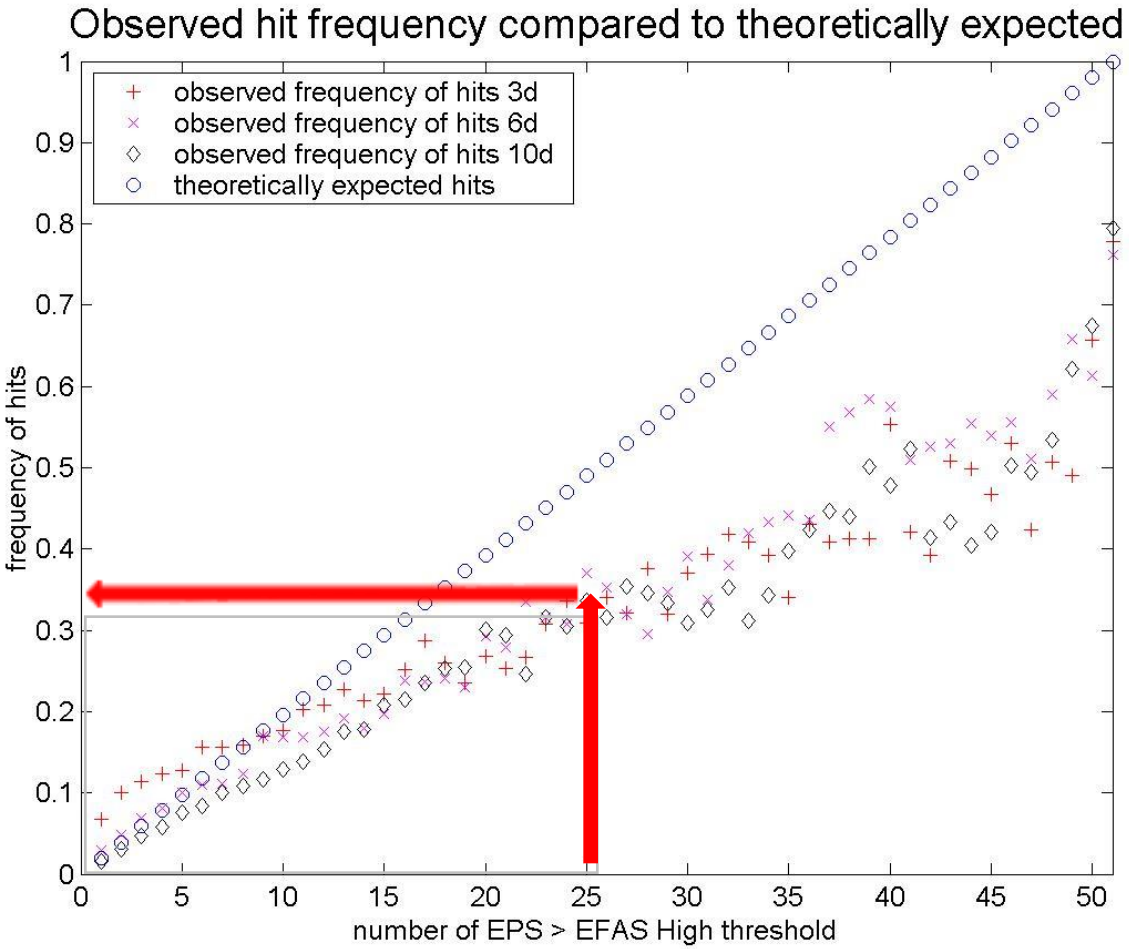
- A total of 138 forecasts are produced daily! (69 at 12:00 and 00:00UTC)

Ensembles - concepts



Thanksto UK MetOffice

Reliability diagrams

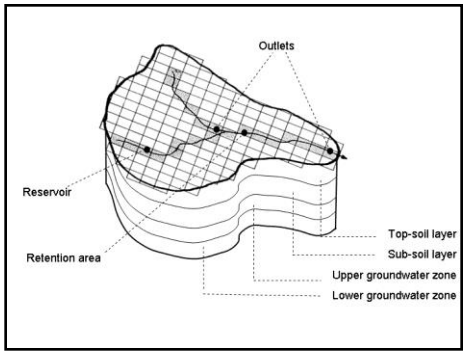


EFAS analysis 2005/2006

Indicates that the forecasts are not fully reliable and that there is a bias.

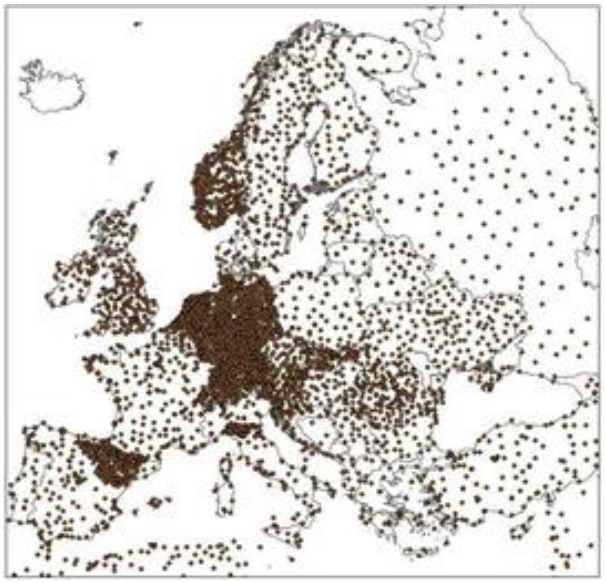
EFAS technical set up:

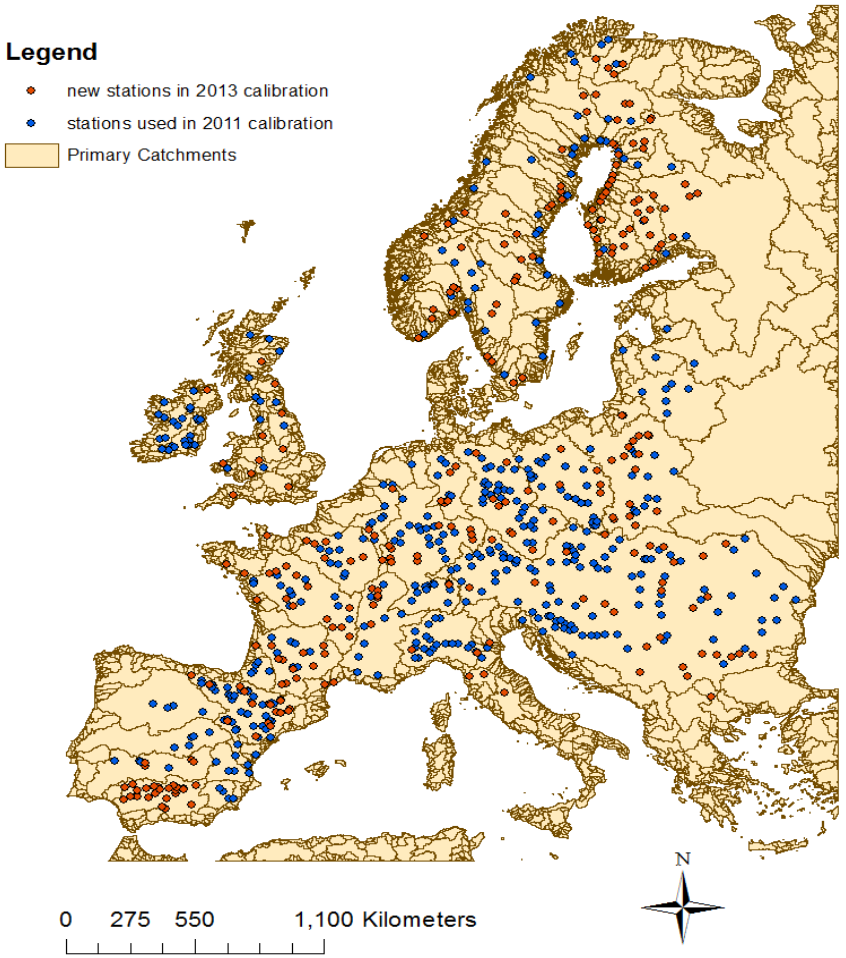
- Distributed hydrological model (LISFLOOD)
- Spatial extent: **Europe**
- Grid Resolution **5 km x 5 km**
- Temporal resolution: **6 hourly with exception ECMWF EPS (daily)**



EFAS technical set up:

- 693 sub-catchments calibrated
- More than 6000 near real time meteorological observations



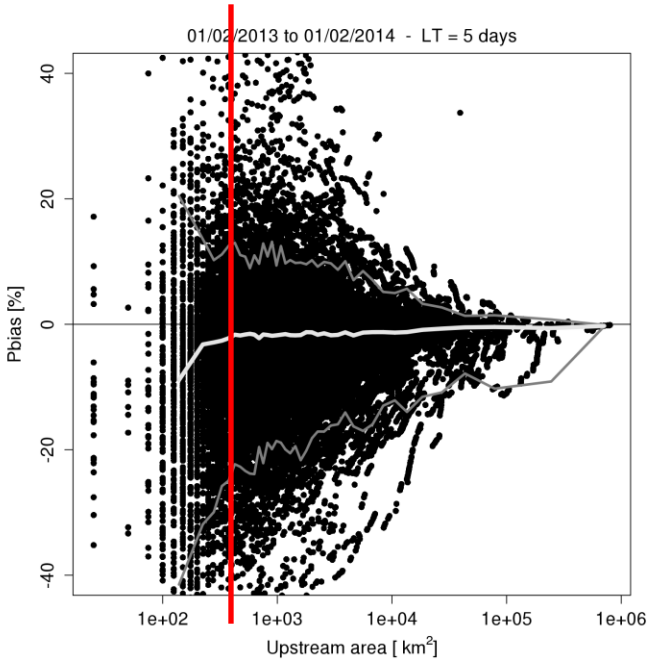


EFAS calibration update:

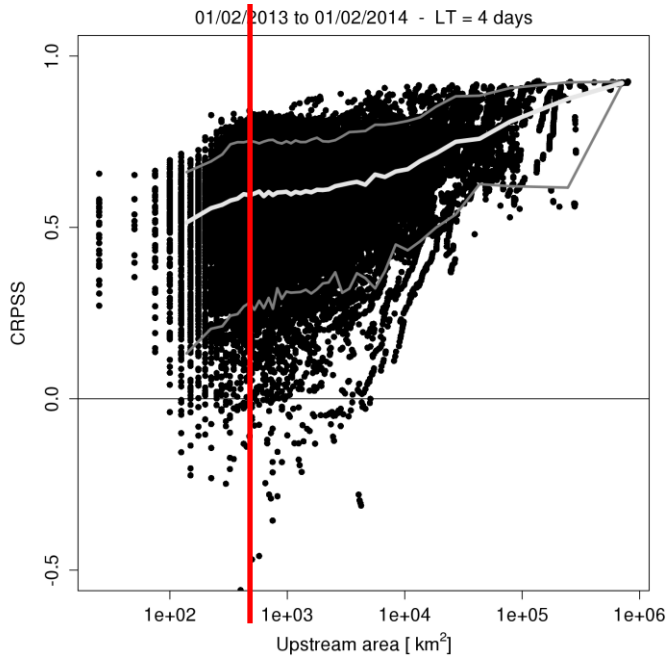
- EFAS calibration is updated every 2-3 years
- Expanded model domain
- Updated/ improved hydrological model
- Include all major Spanish reservoirs to cover more than 90% of the total reservoir storage capacity
- Release foreseen end of 2016!

EFAS limits

- More EFAS verification skill scores available in the EFAS Bulletin



Significant drop in bias for upstream areas below approx. 600km2



Significant drop in CRPSS for upstream areas below approx. 700km2

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Flood Thresholds

In national institutions critical levels are often linked to "local" phenomena:

- Bridges overtopped
- Roads flooded
- Bankfull conditions reached

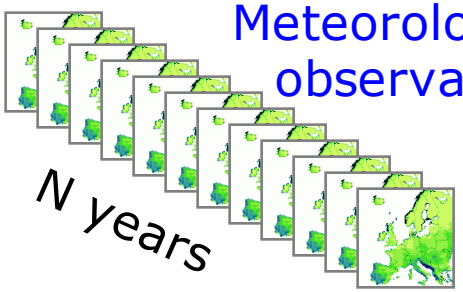
River Blackwater

Stage 1 - likely flooding to Longsfields Bridge and environs.
Stage 2 - likely flooding to the Park Rd, Mallow and Environs.
Stage 3 - the likelihood of serious flooding in Mallow.

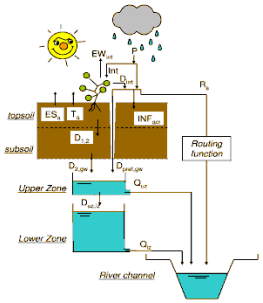
For EFAS this kind of information is not available: need to construct critical levels differently

Employing model climatology to derive return period statistics

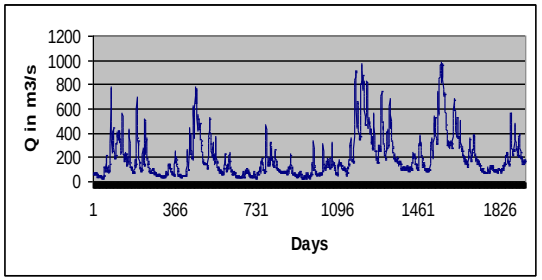
Meteorological observations



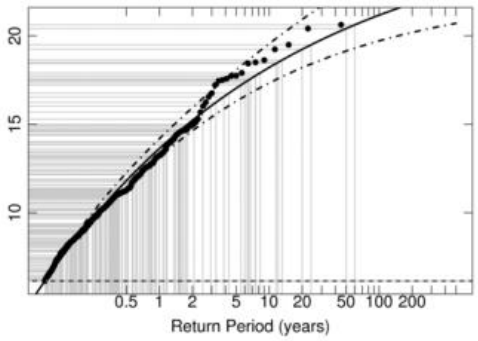
LISFLOOD



Discharge time series



Return period statistics

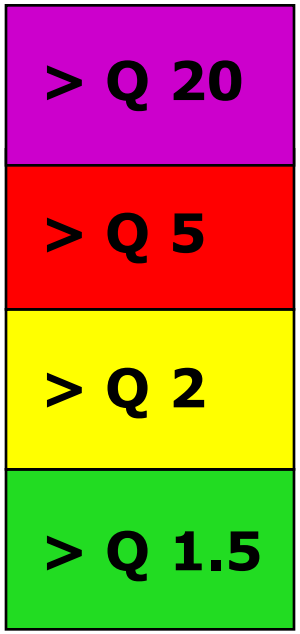


Thresholds

- Q20
- Q5
- Q2
- Q1.5

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

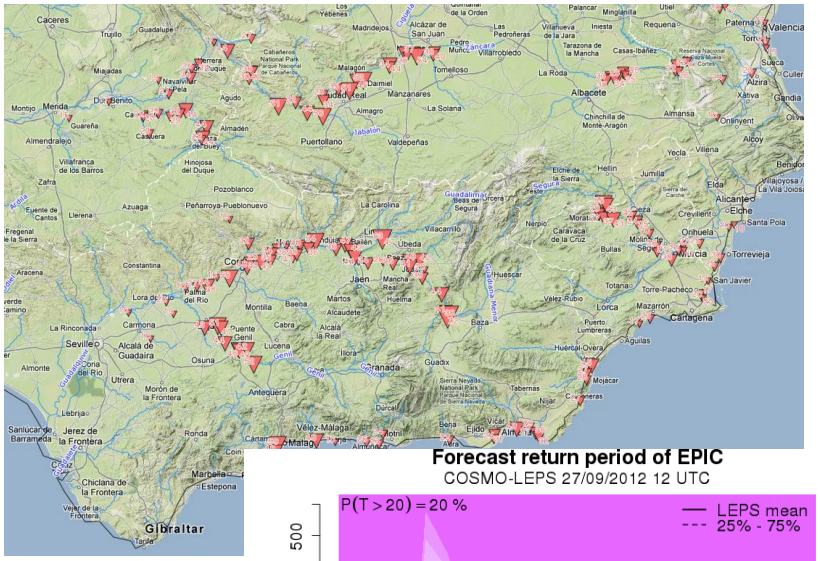
EFAS Thresholds - Meaning

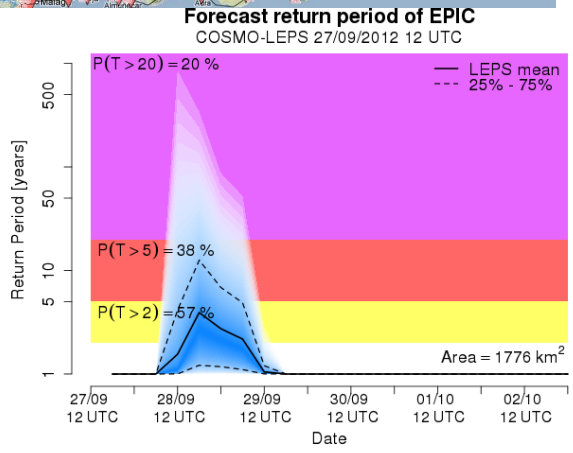


- Approach eliminates systematic bias (e.g., systematic influence of reservoirs not included
- Easily understandable
- Can be more easily linked to national levels

Flash floods – a specific problem

Problem: Temporal and spatial resolution in EFAS are not high enough for an efficient flash flood warning.

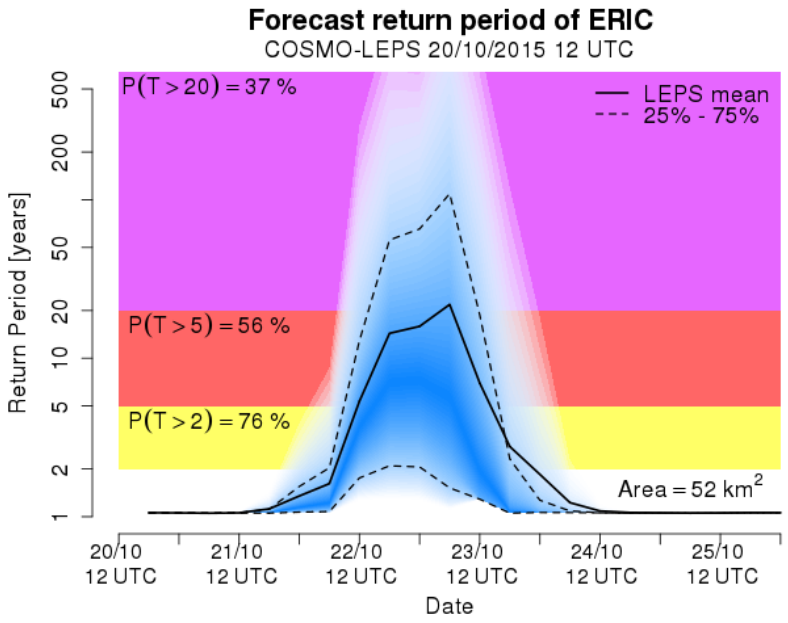




- Extremely difficult to predict
- Many flash flood EWS are rain gauge or radar based
- Warning lead times are thus very short (hours)

The European Runoff Index Climatology (ERIC)

Using high resolution numerical weather predictions to build an indicator for upcoming extreme precipitation events and possible associated flash floods



Landslide susceptibility of the affected areas

Very high	High	Moderate
52%	27%	21%

- Based on EPIC
- Uses high resolution NWP (COSMO-LEPS)
- compares **accumulated upstream precipitation** taking into account hydrological conditions (soil moisture/runoff relation)
- Lead times up to 72 hours
- Area > 25km2

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Communication

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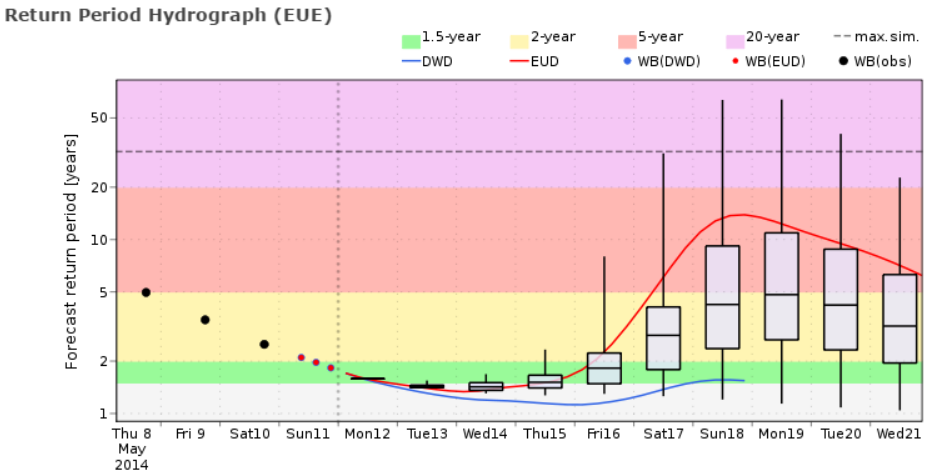
EFAS web interface – Communication

Easy and fast access to flood forecast for end users:

- Password protected Web Interface for partners only
- Updates twice a day
- Easy understandable hotspot maps, flood probability maps, flood threshold exceedances
- Hydrologically relevant meteorological information (upstream rainfall, snowmelt, rainfall probabilities, etc)

Visualization of uncertain results



Return period hydrograph using box-plot diagrams and thresholds

Overview of DWD, EUD, EUE > HAL, EUE > SAL

Forecast Type	13	14	15	16	17	18	19	20	21	22
DWD		↓	↓	↑	↑	*	↓			
EUD		↓	↑	↑	↑	*	↓	↓	↓	↓
EUE > HAL				14	61	90	90	88	82	69
EUE > SAL					22	47	47	37	31	14
COS > HAL				25	69					
COS > SAL				12	37					

EFAS threshold exceedance box diagrams

Visualizing uncertain results

Forecast consistency

Overview of DWD, EUD, EUE > HAL, EUE > SAL

Forecast Type	14	15	16	17	18	19	20	21	22	23
DWD		↑	↑	↑	*	↓	↓			
EUD		↑	↑	↑	*	↓	↓	↓	↓	↓
EUE > HAL			4	98	100	100	100	100	96	94
EUE > SAL				35	92	92	86	55	31	8
COS > HAL			62	100	100					
COS > SAL			37	87	94					

Consistent between DWD, ECWMF determinstic and EPS

Overview of DWD, EUD, EUE > HAL, EUE > SAL

Forecast Type	28	29	30	1	2	3	4	5	6	7
DWD		↑	↑	*	↓	↓	↓			
EUD		↑	↑	*	↑	↓	↓	↓	↓	↓
EUE > HAL										
EUE > SAL										
COS > HAL			19	75	62					
COS > SAL			6	25						

No consistency

Visualization of uncertain results

Forecast persistence

EUE > HAL

Forecast Day	10	11	12	13	14	15	16	17	18	19	20	21	22
2014-05-10 00:00							16	33	35	35			
2014-05-10 12:00					2	6	14	27	37	33			
2014-05-11 00:00						4	27	43	53	53	39		
2014-05-11 12:00						10	35	49	55	43	39		
2014-05-12 00:00							6	22	41	49	41	31	
2014-05-12 12:00						2	18	47	59	57	51	41	
2014-05-13 00:00							14	61	90	90	88	82	69

Previous forecasts

Today's forecast

EUE > HAL

Forecast Day	18	19	20	21	22	23	24	25	26	27	28	29	30
2014-10-18 00:00						12	10	6					
2014-10-18 12:00													
2014-10-19 00:00						2							
2014-10-19 12:00					8	6							
2014-10-20 00:00						39	35	6	4	2			
2014-10-20 12:00					27	20	8	12	4	2			
2014-10-21 00:00						31	31	16	6				2

No forecast persistence

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Visualization of uncertain results

Overview of DWD, EUD, EUE > HAL, EUE > SAL

Forecast Type	13	14	15	16	17	18	19	20	21	22
DWD		↓	↓	↑	↑	*	↓			
EUD		↓	↑	↑	↑	*	↓	↓	↓	↓
EUE > HAL				14	61	90	90	88	82	69
EUE > SAL					22	47	47	37	31	14
COS > HAL				25	69					
COS > SAL				12	37					

Consistence between forecasts

EUE > HAL

Forecast Day	10	11	12	13	14	15	16	17	18	19	20	21	22
2014-05-10 00:00							16	33	35	35			
2014-05-10 12:00					2	6	14	27	37	33			
2014-05-11 00:00						4	27	43	53	53	39		
2014-05-11 12:00						10	35	49	55	43	39		
2014-05-12 00:00							6	22	41	49	41	31	
2014-05-12 12:00						2	18	47	59	57	51	41	
2014-05-13 00:00							14	61	90	90	88	82	69

Persistence of results from forecast to forecast

Reduction of false alarms

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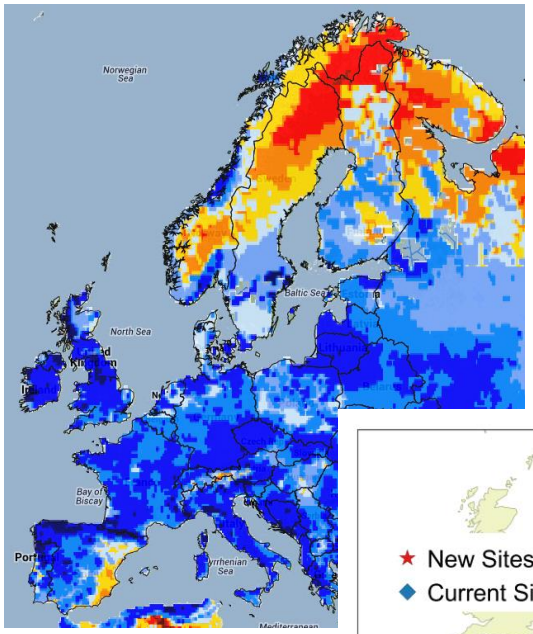
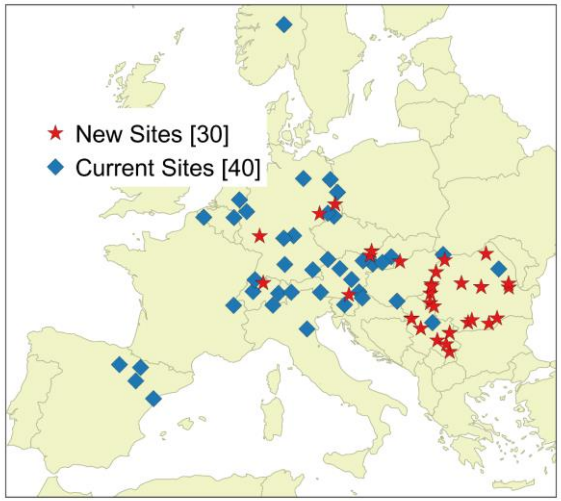
EFAS web services





EFAS Web Map Server Time:

- Password protected
- Updates twice a day
- Contains most of the maps visible in the EFAS web interface

EFAS Sensor Observation Service:

- Password protected
- Updates twice a day
- Only available for a limited set of stations

EFAS alerts:

Two types (previous three):

- **EFAS Flood Notification (previous EFAS Flood Alerts and Watches)**
- **EFAS Flash Flood Notification (previous EFAS Flash Flood Watches)**

Who receives EFAS alerts:

- **National EFAS partner (including ALL downstream authorities)**
- **Emergency Response and Coordination Center**

EFAS alerts:

Criteria for sending out EFAS Flood Notifications:

- more than 2 days ahead
- Minimum drainage area 2000 km2
- Exceeding 30% probability above 5yr RP at least three consecutive times
- Basin has an EFAS partner
- An informal EFAS flood notification can be sent if any of the above is not met but the forecaster still considers it to be necessary

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EFAS Flood Notification – Type: Formal*

Country: **Norway**
River: **Vorma (Glomma basin)**
Predicted start of event: **25-06-2015**
Earliest predicted peak: **28-06-2015**
Probability to exceed a 5-year return period magnitude: **67%**
Probability to exceed a 20-year return period magnitude: **33%**
Comment: **-**
Forecast date: **18-06-2015 00 UTC**

This is the only notification you will receive for this event! Please follow the evolution of the event on EFAS.

EFAS forecaster on duty:
Gustav Carlsson, Swedish Meteorological and Hydrological Institute (SMHI)
tel: 0046-11-4958074 email: gustav.carlsson@smhi.se

** Formal = previous EFAS Flood Alert, Informal = previous EFAS Flood Watch.*
The conditions for an EFAS Flood Notification of Type: Formal/Informal can be found here.

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EFAS alerts:

Criteria for sending out EFAS Flash Flood Notifications:

- Catchment has an EFAS partner
- Probability of exceeding the 20 year return period ERIC threshold is equal/greater than 35%
- Start of the event has a lead time < 72 hours

European Commission

EFAS Flash Flood Notification*

Country: **Spain**
Region: **Navarra Region**
Earliest predicted peak: **26-02-2015 06:00**
Landslide susceptibility for the affected area: very high **52%** - high **9%** - moderate **31%**
Forecast date: **24-02-2015 00UTC**

This is the only notification you will receive for this event! Please follow the evolution of the event on EFAS.

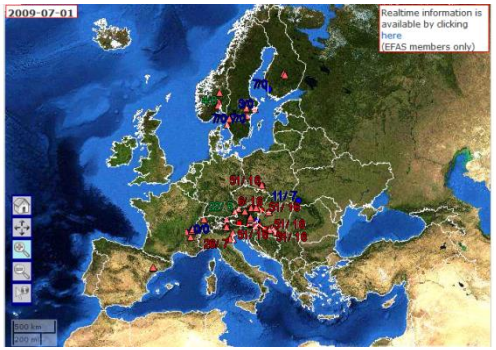
* *indicating a high probability of extreme precipitation and potential flash flooding*

EFAS forecaster on duty:
Hendrik Buiteveld
Tel: +31 653649418 email: hendrik.buiteveld@rws.nl
Rijkswaterstaat Water Management Centre for the Netherlands

Decision making in EFAS

EFAS dissemination Centre

www.efas.eu



Partner

- **Daily analysis of full information**
- **Sends EFAS warnings to EFAS partner**
- **Only 1 alert to partner to draw attention to probability of flooding**

- **Can decide to analyse EFAS daily or wait for EFAS warning**
- **EFAS warning should trigger further investigation with local system, meteorological office, observations**
- **Partner free to use EFAS information or not**

For more info:

www.efas.eu