European Flood Awareness System

EFAS *Bulletin*

April – May 2015

Issue 2015(3)

The European Flood Awareness System (EFAS) produces European overviews of ongoing and forecasted floods up to 15 days in advance and contributes to better protection of the European citizens, the environment, properties and cultural heritage. It has been developed at the European Commission's in house science service, the Joint Research Centre (JRC), in close collaboration with national hydrological and meteorological services and policy DG's of the European Commission.

EFAS has been transferred to operations under the European Commission's COPERNICUS Emergency Management Service led by DG ENTR in direct support to the EU's Emergency Response Coordination Centre (ERCC) of DG ECHO and the hydrological services in the Member States.

ECMWF has been awarded the contract for the EFAS Computational centre. It is responsible for providing daily operational EFAS forecasts and 24/7 support to the technical system.

A consortium of Swedish Meteorological and Hydrological Institute (SMHI), Rijkswaterstaat (RWS) and Slovak Hydro-Meteorological Institute (SHMU) has been awarded the contract for the EFAS Dissemination centre. They are responsible for analysing EFAS output and disseminating information to the partners and the MIC.

A Spanish consortium (REDIAM and ELIMCO) has been awarded the contract for the EFAS Hydrological data collection centre. They are responsible for collecting discharge and water level data across Europe.

The work related to the EFAS Meteorological data collection centre has been outsourced but onsite the JRC. Finally, the JRC is responsible for the overall project management related to EFAS and further development.

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EFAS news

Meetings

The 10th EFAS annual meeting was held at the Emergency Response Coordination Centre in Brussels, Belgium 28-29 April. A more detailed report from the meeting follows below.

The Global flood partnership held its 2nd annual meeting in Boulder, Colorado 4-6th May. At the meeting, Peter Salamon presented EFAS, Florian Pappenberger presented a poster on financial benefits of flood forecasts and Calum Baugh presented a poster on flash flood forecasting in EFAS. Florian and Calum also organised a workshop on how to use probabilistic forecasts to predict extreme weather events.

Fredrik Wetterhall visited the Ethiopian Directorate of Hydrology and Water Quality in Addis Abeba 11-14 May. A workshop was organised, where Fredrik explained the EFAS and GloFAS systems and held a tutorial on GloFAS.

On 15-16 May Eric Sprokkereef attended the annual meeting of the flood forecasting centres in the Rhine basin. The meeting that takes place every spring at the secretariat of the International Commission for the Protection of the Rhine in Koblenz/Germany and is attended by the forecasting and warning centers from Switzerland, France, Germany and The Netherlands. In this meeting the centers exchange information on model developments, available meteorological and hydrological data, warning procedures, probabilistic forecasting, verification of forecasting results, etc. Eric gave a short report about the technical developments, the number of alerts and watches in the past year, the new EFAS contracts and the upcoming EFAS annual meeting.

New partners

We welcome the Estonian Environmental Agency as new EFAS partner.

Upcoming workshop

On the 25th of June EDHIT organizes a workshop called “International Workshop on Forecasting Rainfall and lightning induced Hazards at European Scale” in Brussels. For more information, please go to: http://edhit.eu/workshop/

EFAS results

Meteorological situation for April- May 2015

April was on average normal or drier than normal in terms of precipitation for most parts of Europe (Figure 7 and Figure 8). The countries around the Gulf of Finland, the Northern part of Finland and Sweden experienced wetter than normal conditions. There were occasions of very heavy precipitation at locations in central and south-east Europe, but none of them led to any warnings.

May started with a number of flash-floods due to heavy precipitation on the Western parts of the Alps (Figure 9). Northern Europe including the British Isles were wetter than normal, whereas the central and Western Europe (apart from the Alpine regions) were drier (Figure 10). Eastern and south-eastern Europe did receive heavy precipitation in some parts which led to flash flood watches and flood alerts and watches. In late May there were reported floods in Northern Bulgaria and Western Romania, but they were not picked up by EFAS.

Summary of EFAS flood alerts for April - May 2015

EFAS Flood Alerts and Flood Watches sent in April - May 2015 are summarized in Table 1 and their location are shown in Figure 11 and Figure 12.

Summary of flash flood watches for April - May 2015

In April 2015, only 1 flash flood reporting point was detected by EPIC (Figure 13) having probability higher than 60% of exceeding the high threshold (5-year return period).

In May 2015, 45 flash flood reporting points were detected by EPIC (Figure 14), having probability higher than 60% of exceeding the high threshold (5-year return period). The forecast lead time of the predicted storm peaks is in the range 24 - 48 hours, with average lead time of 33 hours. Catchment size of flash flood alerts is in the range 55 - 2732 km^2, with average size of 559 km^2.
Based on these points EFAS Flash Flood watches have been sent to the corresponding EFAS partners as summarized in Table 2 and shown in Figure 13 and Figure 14.

Table 1: EFAS flood alerts sent in April-May 2015

Type	Forecast date	Issue date	Lead time*	River	Country
Watch	30/04/2015 00 UTC	30/04/2015	2	Rhone, above Saone	France
Alert	01/05/2015 00 UTC	01/05/2015	4	Vah	Slovakia
Watch	01/05/2015 12 UTC	02/05/2015	2	Loing	France
Watch	13/05/2015 12 UTC	14/05/2015	1	Po, below Oglio	Italy
Alert	17/05/2015 12 UTC	18/05/2015	4	Ipoly	Hungary
Alert	17/05/2015 12 UTC	18/05/2015	3	Hron	Slovakia

* Lead time [days] to the first forecasted exceedance of the 5-year simulated discharge threshold.

Table 2: EFAS flash flood watches sent in April-May 2015

Type	Forecast date	Issue date	Lead time*	River	Country
FF Watch	01/05/2015 00 UTC	01/05/201	24	France - Isere	France
FF Watch	01/05/2015 00 UTC	01/05/201	24	France - Isere	France
FF Watch	01/05/2015 00 UTC	01/05/201	24	France - Rhone, above Saone	France
FF Watch	21/05/2015 12 UTC	22/05/201	42	Slovenia - Sava, above Kupa	Slovenia
FF Watch	21/05/2015 12 UTC	22/05/201	42	Slovenia - Kupa	Slovenia
FF Watch	21/05/2015 12 UTC	22/05/201	42	Slovenia - Kupa	Slovenia
FF Watch	21/05/2015 12 UTC	22/05/201	36	Croatia - Kupa	Croatia
FF Watch	21/05/2015 12 UTC	22/05/201	36	Croatia - Kupa	Croatia
FF Watch	21/05/2015 12 UTC	22/05/201	36	Croatia - Kupa	Croatia
FF Watch	22/05/2015 00 UTC	22/05/201	30	Slovenia - Sava, above Kupa	Slovenia

* Lead time [hours] to the forecasted peak of the rain

EFAS 10th annual meeting

The 28-29th April saw the 10th anniversary of the Annual EFAS user meeting at the facilities of the European Response Coordination Centre (ERCC) in Brussels. The user community has during this time grown from 10 partners to our current over 40 regional hydro-meteorological partners across Europe. The meeting was kicked off by presentations and a panel discussion on "Europe's response to floods - achievements of a decade". A panel of experts from the COPERNICUS Emergency management Service (EMS), DG Environment, DG REGIO ,DG JRC and ECMWF. Francoise Villette (COPERNICUS EMS) said that she is “excited about what has happened in the field with the transition from research projects to operational". Over the last decade EFAS has developed into a mature service and now EFAS is one of the key components and the largest number of activations of the Copernicus Emergency Service is for floods.

Figure 1. The attendants of the 10th annual EFAS meeting.

The anniversary workshop was focusing on a special topic on the Balkan floods in 2014, which were predicted several days in advance by EFAS, who supported the coordination of EU civil protection actions and was even used to task satellites producing detailed maps of the disaster which are needed by staff on the ground. The national hydro-meteorological service of the Republic of Serbia independently confirmed the high quality of EFAS forecasts, which were used to coordinate activities by affected nations (through the International Sava River basin Commission).

During the meeting a plan for future developments was approved by the EFAS users ranging from improved flash flood forecasting, extending forecasts to the seasonal scale to advanced statistical pre-processing routines to derive total probabilities. The meeting showed that the EFAS user community is continuing to grow stronger and we are looking forward to the next 10 years of EFAS forecasts.

From EPIC to ERIC – Flash flood forecasting in EFAS

by Calum Baugh and Peter Salamon

Background

Predicting flash floods remains a major challenge despite recent notable advances in weather forecasting. Most operational early warning systems for extreme rainstorms and flash floods are still based on rainfall measurements from rain gauges and weather radars. As a result, warning lead times are bound to a few hours and warnings are usually issued when the event is already taking place. To address this issue an early warning system for heavy precipitation events in Europe was developed and implemented in the operational EFAS in 2012 with the aim to produce forecasts of extreme rainfall accumulations over short durations and within small-size catchments prone to flash flooding. The system arose from the research project IMPRINTS as well as direct requests of various EFAS partners. Currently the flash flood forecasts rely on the European Precipitation Index based on simulated Climatology (EPIC), which uses the COSMO-LEPS ensemble as the driving weather forecasts.

Despite its proven skill for predicting flash floods in Europe, EPIC has two shortcomings: 1) It assumes that flash floods are solely related to extreme accumulations of upstream precipitation, thus not accounting for the local geomorphological (slope, land use type) or hydrological (soil moisture) conditions; 2) It does not differentiate between solid (snow) and liquid (rain) precipitation. To address these issues an enhanced version of EPIC, the European Runoff Index based on Climatology (ERIC) was recently developed. ERIC[1] uses a dynamic and distributed runoff co-efficient which depends on the initial soil moisture to weigh each contribution of the upstream precipitation proportionally to the initial soil moisture.

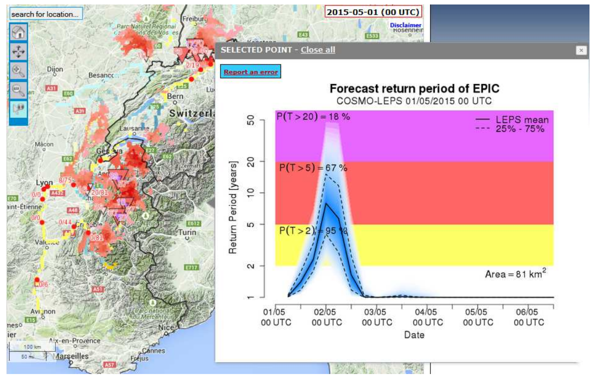


Figure 2. EPIC forecast for the French Alps issued 1 May 2015 00UTC.

Comparing ERIC and EPIC

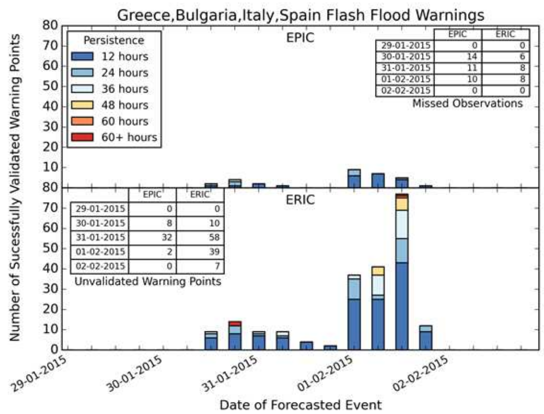
Pre-operational benchmarking was conducted for a series of observed flash flood events across Europe to test the performance of ERIC against EPIC. One such case study was the recent flash floods across southern Europe from the 30th January – 1st February 2015 where heavy rainfall hit northern Spain, southern Italy, Greece, Albania and went further into Bulgaria and Romania. Four flash flood watches were sent from EFAS prior to the event. Observed flood locations were pooled from a variety of sources including the European Severe Weather Database (ESWD-http://www.eswd.eu/) and media reporting. The event led to villages being evacuated in Greece, three deaths in Bulgaria and one death in Spain. Alert points generated from EPIC and ERIC were compared against these observations, a match between an EPIC/ERIC point and an observation was declared if they occurred on the same day, within 100 km and the same sub-catchment.

Results

Results from the analysis found that ERIC produced more hits but also more false alarms than EPIC (Figure 3). The persistence of warning points was greater for ERIC than EPIC, where the majority of warnings were persistent for 12-24 hours for the former with some

[1] Raynaud, D., Thielen, J., Salamon, P., Burek, P., Anquetin, S. and Alfieri, L. (2014), A dynamic runoff co-efficient to improve flash flood early warning in Europe: evaluation on the 2013 central European floods in Germany. Met. Apps. doi: 10.1002/met.1469

warning points showing a persistence of up to and over two days (Figure 3). When comparing the spatial distribution of the EPIC and ERIC alerts points there are some interesting differences. For example, on the 30th January only ERIC produced alerts in northern Spain (Figure 4). The precipitation intensity was not exceedingly high but it fell onto highly saturated soils, therefore the EPIC routine did not generate alerts. On the same day EPIC produced alerts in Montenegro, however these transpired to be false alerts (Figure 4). Although the precipitation intensity was high it fell as snow rather than rainfall because of the high altitude. Since ERIC is not affected by high intensity snow, ERIC did not produce warnings.



Missed Observations

	EPIC	ERIC
29-01-2015	0	0
30-01-2015	14	6
31-01-2015	11	8
01-02-2015	10	8
02-02-2015	0	0

Unvalidated Warning Points

	EPIC	ERIC
29-01-2015	0	0
30-01-2015	8	10
31-01-2015	32	58
01-02-2015	2	39
02-02-2015	0	7

Figure 3. The number of EPIC and ERIC warning points which were successfully matched against observations, colour-coded by their persistence. Note that false alerts are referred to as "unvalidated warning points".

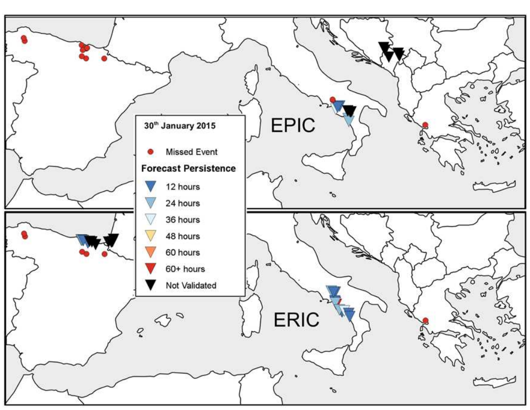


Figure 4. EPIC and ERIC flash flood warnings forecast to occur on 30th January 2015 plotted by their persistence as well as the location of observed flood locations which were missed by the forecasts.

Conclusions

ERIC produces a greater number of correct warning points than the current EPIC routine, however at the cost of more false alerts. Further testing is needed to calibrate suitable probability thresholds to minimise the number of false alerts. Currently the ERIC routine is implemented in the EFAS test system with plans to make it operational later this year. During this time the display of the warnings within the web interface will be further developed. Progress on this will be reported in upcoming bulletins.

Hydrological Ensemble forecasting – financial investment vs return

by Hannah Cloke, Fredrik Wetterhall and Florian Pappenberger

Within the HEPEX community we all understand very well that hydrological (ensemble) forecasting is hard work. Massive effort goes into developing the systems, huge resources go into running them and there is much sweat over making decisions. Entire PhDs, or indeed careers, are spent on getting a system to work or to be used effectively. In most cases there are still mountains to climb before we reach our current goals.

To motivate spending resources in the public and private sector it is beneficial to provide evidence of the benefits of our forecasts in terms of 'hard cash'. Usually we are asked to do this in terms of financial, economic or monetary return on investments in a system. This could lead us down the tricky ethical path of specifying the value human lives or to account for psychological impacts after a flood event. However another option is to remain on more solid ground and just account for the direct monetary benefit. Such studies include assumptions on how many people react to a flood event as a percentage of the population and what actions they are taking. These percentages and actions are usually taken from post-flood event surveys. These assumptions cover for example rational response to warnings, such as always moving your (very heavy) TV upstairs when a flood alert is received, although the effect of false alarms and the pull of the prospect of insurance claims can mean that response to warnings doesn't follow these assumptions.

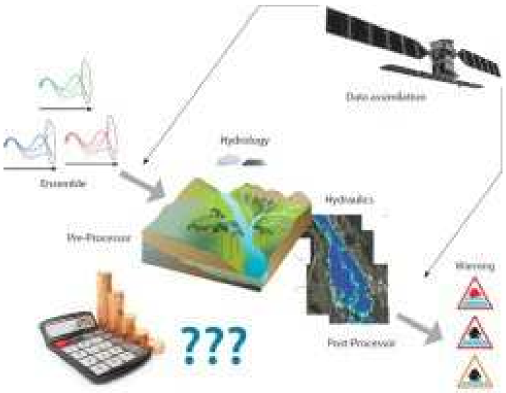


Figure 5. How much money should be spent on forecasts?

Despite these caveats it is possible to calculate the potential monetary value of a forecast system by combining forecasting system performance with the percentage of response to warnings, given the investments and running costs of the system. For early warning of floods the results are surprising. Within the setting of such a theoretical study (Pappenberger et al., 2015), the benefits are of the order of 400 Euro for every 1 Euro invested. Indeed, it is near impossible not to have a positive return from an early flood warning system – so we should keep developing, forecasting, operating or whatever else you do in hydrological ensemble forecasting – it is worth it!

Verification

The verification scores for EFAS have previously denoted the overall performance of the system. In this issue we take a closer look at the performance of EFAS in terms of issued flood alerts, flood watches and flash flood watches (Figure 6). In the figure is also shown the number of reported floods in Europe from EM-database (http://www.emdat.be/database).

A few interesting features can be detected. Firstly, the number of alerts and warnings have dramatically increased in 2013 and 2014. Not surprisingly since the two major flood events occurred during this period, which is also reflected in the number of issued alerts and watches. Secondly, in comparison with the number of reported events it seems like the system has increased in activity over the years. This can be due to the fact that the number of EFAS members have grown over the years, or that the system since it became operational has issued more warnings and alerts.

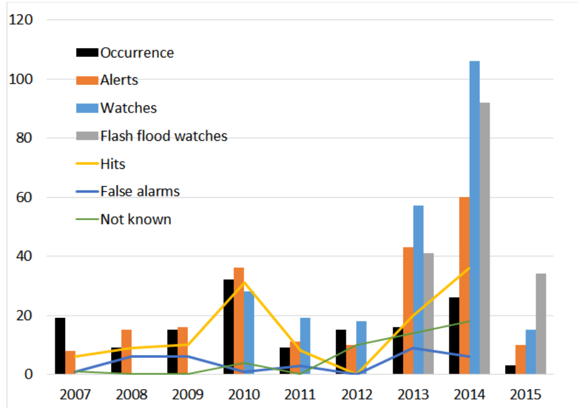


Figure 6. EFAS performance in terms of issued warnings 2007-2015. The bars denote the flood watches, alerts and flash flood watches over the period 2007-2015. The black bar shows the number of flood events. The lines show the number of hits, false alarms and not knowns from the issued alerts.

However, from the EM-database you can also extract information on the number of casualties, affected people and economic loss for the events. The variable that has highest correlation with the number of issued flood alerts is the number of affected people (0.89), whereas the number of events has a correlation of 0.65. The EM-database surely has its issues, and the way an event is classified will always be subjected. The number of people affected is a better measure of the extent of the flood, and this is what is reflected in the number of alerts.

Recent team publications

Kauffeldt, A., Halldin, S., Pappenberger, F., Wetterhall, F, Xu, C.-Y., Cloke, H.L., 2015, Imbalanced land-surface water budgets in a numerical weather prediction system, Geophysical Research Letters, doi: 10.1002/2015GL064230.

Pappenberger, F., Cloke, H. L., Parker, D. J., Wetterhall, F., Richardson, D. S., Thielen, J., 2015, The monetary benefit of early flood warnings in Europe, Environmental Science & Policy, 51, 278-291.

Appendix - figures

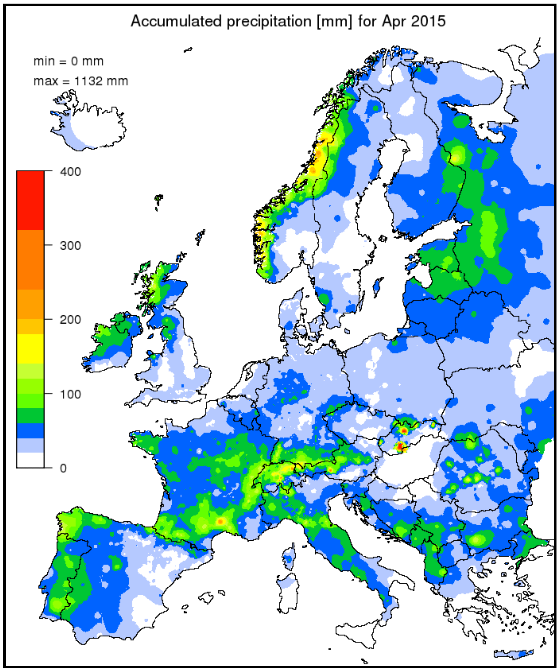


Figure 7: Accumulated precipitation [mm] for April 2015.

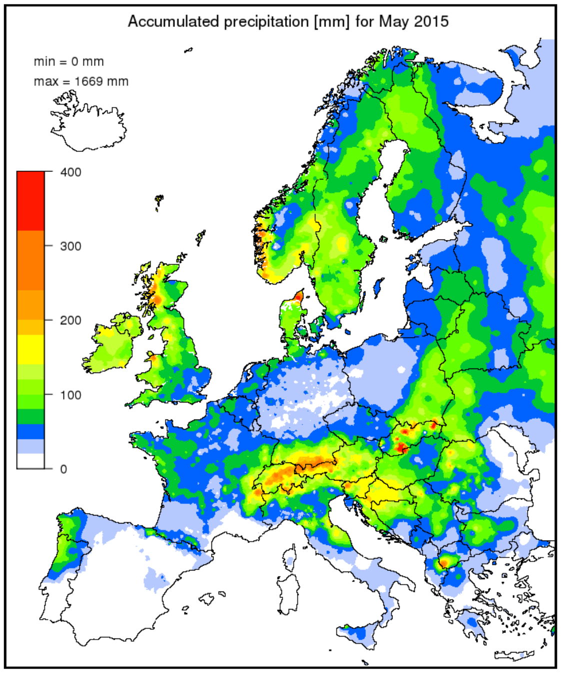


Figure 9: Accumulated precipitation [mm] for May 2015.

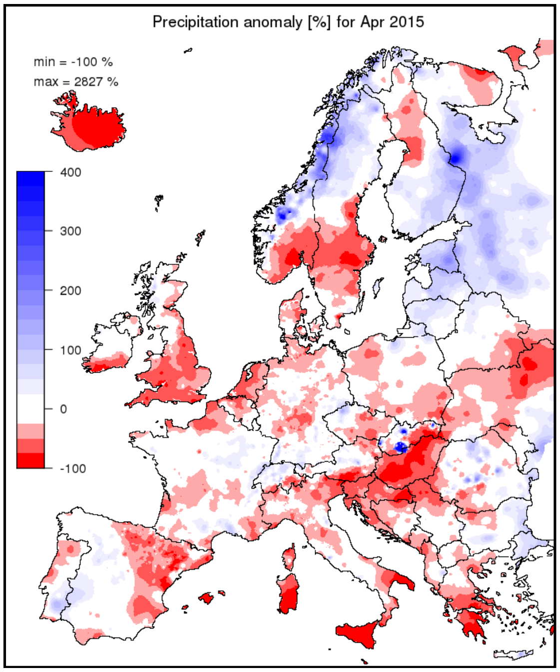


Figure 8: Precipitation anomaly [%] for April 2015, relatively to a long term average (1990-2011). Blue (red) denotes wetter (drier) conditions than normal.

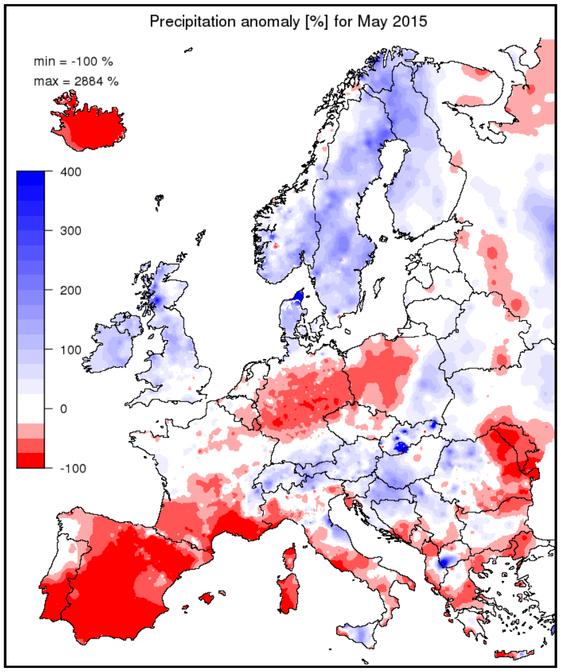


Figure 10: Precipitation anomaly [%] for May 2015, relatively to a long term average (1990-2011). Blue (red) denotes wetter (drier) conditions than normal.

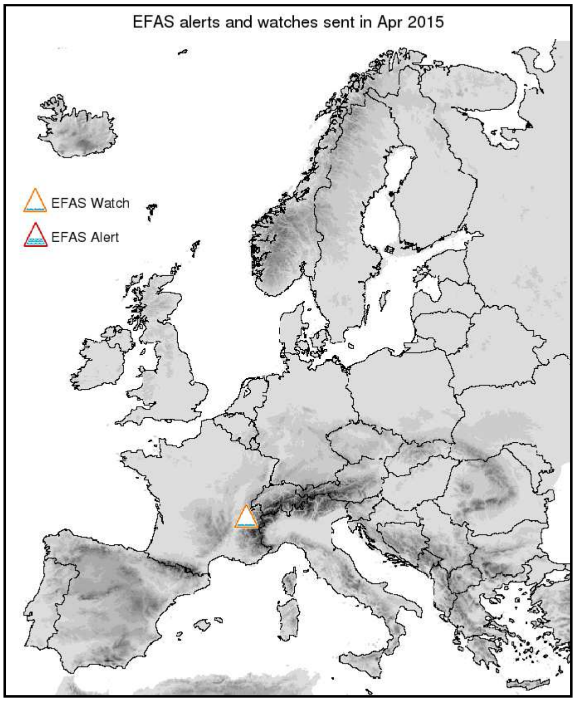


Figure 11: EFAS flood alerts and watches for April 2015.

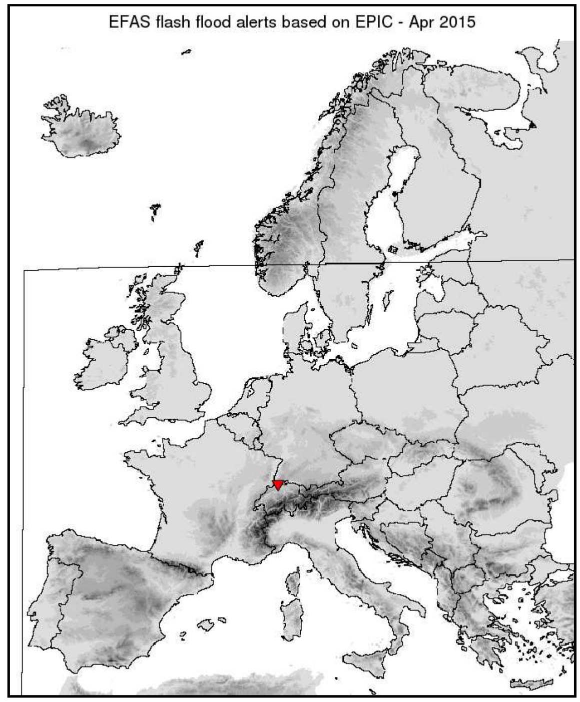


Figure 13: Flash flood reporting points for April 2015.

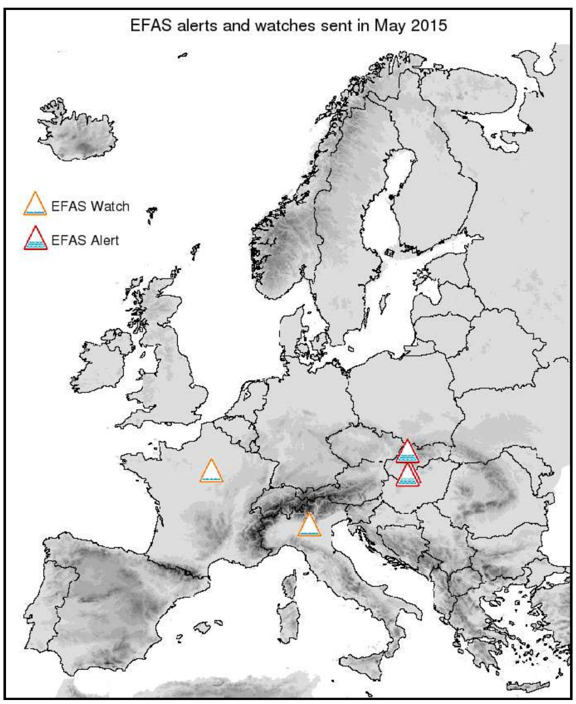


Figure 12: EFAS flood alerts and watches for May 2015.

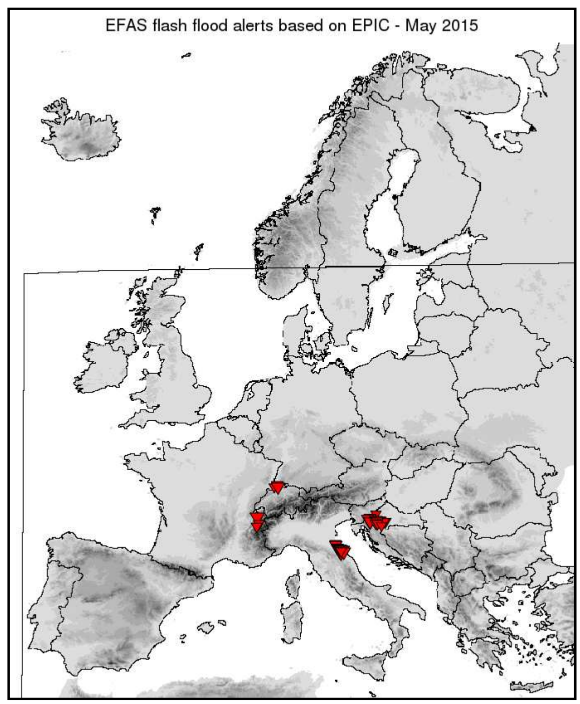


Figure 14. Flash flood reporting points for May 2015.

Acknowledgements

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- The EFAS Operational Centres