ECMWF

European Flood Awareness System

EFAS *Bulletin*

October – November 2013

Issue 2013(6)

Copernicus The European Earth Observation Programme

European Commission

ELIMCO SISTEMAS

Junta de Andalucía

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The European Flood Awareness System (EFAS) produces European overviews of ongoing and forecasted floods up to 10 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), since 2002, in close collaboration with national hydrological and meteorological services, the Monitoring and Information Centre (MIC) of the European Civil Protection Mechanism, and other research institutes.

Since 2011, EFAS is part of the initial operations of the Copernicus (formerly GMES) Emergency Management Service, (GIO EMS) and was transferred to operational service in 2012 through public tender procurement.

As a result of the procurement procedure,

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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Cover image: Storm surge in winter, Shore Drive, Winthrop
Courtesy of the Boston Public Library, Leslie Jones Collection.

EFAS news

New features/model updates

An update of the EFAS web interface was released on the 10th October 2013. New features include:

- EFAS Flash Flood Watches are now prepared and sent in a semi-automated way via the EFAS web-interface in a similar manner as is done for EFAS Flood Alerts/Watches. This will speed up the issuing of Flash Flood Watches and reduce the likelihood of typos and errors in the email content.

- Flash flood reporting points (triangles) with a probability equal or higher than 60% of exceeding the 5-year return period threshold will be darker red than those below this probability. The change was introduced to help locate points above the flood warning threshold.

- All German stations are now included in the "Ongoing Floods" layer based on the data from the www.hochwasserzentralen.de webpage.

- Icons of the real time hydrographs are now coloured with orange when the probability P of exceeding the average yearly maximum discharge (MHQ) is $0<P(Q\geq MHQ)\leq 10\%$ and red when $P(Q\geq MHQ)>10\%$. This will simplify the identification of points at risk of upcoming high streamflow.

Meetings - Updates of EFAS and performance during the June 2013 floods presented at the 24th Flood Protection Expert Group meeting of the ICPDR in Bratislava, Slovakia (03-04 October).

An overview of the recently introduced changes (see above) and planned updates (model calibration, improved initial conditions, display of snow anomalies, among others) was presented at the 24th Flood Protection Expert Group meeting of the ICPDR in Bratislava, Slovakia. Furthermore, the performance of EFAS during the June 2013 floods has been illustrated and discussed, with a focus on the Danube river basin. During this meeting the representatives from Ukraine as well as Bosnia and Herzegovina were invited to become EFAS partners.

New partners

We welcome the Confederación Hidrográfica del Duero, Spain (www.chduero.es), and the Latvian Environment, Geology and Meteorology Centre (www.meteo.lv), which have recently joined the EFAS network. From now on, EFAS Flood Alerts, Watches and Flash Flood Watches will be issued in case significant risk of flooding is detected in the Latvian river basins of Daugava, Aiviekste, Ogre and Dubna, and in the Duero river basin, in Spain.

EFAS results

Meteorological situation for October - November 2013

In October 2013, highest precipitation depths above 300 mm were recorded in some the countries facing the Atlantic Ocean and the North Sea, such as Spain, Portugal, UK and Norway. Areas in S France, Switzerland, N Italy and Slovenia recorded similar accumulations of precipitation (see Figure 4). Vast regions in Eastern Europe, Balkans and SE Spain recorded dry precipitation anomalies, with less than 40 mm of monthly accumulation (Figure 5).

In November 2013, areas with the largest precipitation accumulations were located in Norway, along the Pyrenees, and in all the countries facing the Adriatic Sea, including Italy, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Albania and Greece (Figure 6). It appears that in some areas of Europe, the network of reporting rain gauges is not dense enough to describe small scale convective cells producing locally large rainfall accumulations. A striking example is that of the extreme rain storm which hit the Sardinia region, Italy, (see dedicated section at page 5). The storm was not well captured by the available observation network, which stations are mostly located along the coast of the Sardinia Island. The anomaly map in Figure 7 points out a dry anomaly in most of Spain and Portugal, and significantly wet anomalies in E Spain, Central Italy and some areas of Central Norway.

Summary of EFAS flood alerts for October - November 2013

EFAS Flood Alerts and Flood Watches sent in October - November 2013 are summarized in Table 1 and their location is shown in Figure 8 and Figure 9.

Summary of flash flood watches for October - November 2013

In October 2013, 22 flash flood reporting points were detected by EPIC (Figure 10), 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 18 - 72 hours, with average lead time of 38 hours. Catchment size of flash flood alerts is in the range 51 - 4453 km^2, with average size of 1512 km^2.

In November 2013, 124 flash flood reporting points were detected by EPIC (Figure 11), 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 6 - 72 hours, with average lead time of 36 hours. Catchment size of flash flood alerts is in the range 52 - 4697 km^2, with average size of 1012 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 10 and Figure 11.

Table 1: EFAS flood alerts sent in October-November 2013

Type	Forecast date	Issue date	Lead time*	River	Country
Watch	01/10/2013 12 UTC	02/10/2013	0	Mures, below Tirnava	Romania
Watch	03/10/2013 12 UTC	04/10/2013	0	Arges	Romania
Watch	21/10/2013 00 UTC	21/10/2013	1	Tietar	Spain
Watch	22/10/2013 12 UTC	23/10/2013	0	Ticino	Italy
Watch	24/10/2013 12 UTC	25/10/2013	0	Tormes	Spain
Watch	28/10/2013 00 UTC	28/10/2013	1	Oglio	Italy
Watch	03/11/2013 12 UTC	04/11/2013	2	Rhone, above Saone	France

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

Table 2: EFAS flash flood watches sent in October-November 2013

Type	Forecast date	Issue date	Lead time*	River	Country
FF Watch	13/10/2013 12 UTC	14/10/2013	24	Haute-Normandie Region	France
FF Watch	21/10/2013 00 UTC	21/10/2013	72	Italy - Ticino	Italy
FF Watch	05/11/2013 00 UTC	05/11/2013	12	France - Gave	France
FF Watch	10/11/2013 00 UTC	10/11/2013	48	Croatia - Kupa	Croatia
FF Watch	10/11/2013 00 UTC	10/11/2013	48	Croatia - Gacka	Croatia
FF Watch	09/11/2013 12 UTC	10/11/2013	60	Croatia - Gacka	Croatia
FF Watch	16/11/2013 12 UTC	16/11/2013	54	Languedoc-Roussillon Region	France
FF Watch	16/11/2013 12 UTC	16/11/2013	24	Spain - Segre	Spain
FF Watch	17/11/2013 00 UTC	17/11/2013	42	Languedoc-Roussillon Region	France
FF Watch	17/11/2013 00 UTC	17/11/2013	42	Languedoc-Roussillon Region	France
FF Watch	17/11/2013 00 UTC	17/11/2013	42	Languedoc-Roussillon Region	France
FF Watch	17/11/2013 00 UTC	17/11/2013	48	France - Aude	France
FF Watch	22/11/2013 12 UTC	23/11/2013	36	Austria - Mura	Austria

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

Forecast verification

An evaluation framework has been set up to monitor the performance of EFAS ensemble streamflow predictions (ESP) in time. ESP are validated against the EFAS water balance for each point of the modelled European river network, including more than 37000 grid points. Average scores are updated on the 13th day of each month. They are calculated over a window including the corresponding 1st day of the month and the past 365 days, to reduce the effect of seasonality. Operational EFAS forecasts are run at the ECMWF twice per day since October 2012, using weather predictions initialized at 00 and 12 UTC. This operational dataset of hydrological forecasts was complemented by running 4 years of daily hindcasts starting on January 2009.

Skill scores are updated after all meteorological observations to run the EFAS water balance are received and the hydrological model is run. Simulated proxy discharges need to be computed until the 11th of the same month, so that 10-day ESP starting on the 1st can be evaluated. Results in Figure 1 and Figure 2 show the trend of two scores over the past 5 years, for a lead time of 7 days. Additional details on the meaning and the interpretation of the CRPSS and the CV of the RMSE can be found in previous issues of the EFAS bulletin - 2013(4) and 2013(3) respectively. In the two figures, a solid line indicates the mean value among all grid points, while grey shades denote the 5%-95% (light grey) and the 25%-75% (dark grey) of their distribution. In the analysis shown in these figures, the hydrological model and its parameterization is fixed and corresponds to the operational one (model release of November 2011). Therefore it mainly includes the skill contribution of weather forecasts used as input and of the point observations used to run the water balance, that is, the reference run. From now on, the evaluation will follow the model updates and thus reflect changes in both the model and the input data. In this regard, a new EFAS version is currently being tested, which include a new calibration of the hydrological model, based on more stations, and an enhanced dataset of meteorological observations.

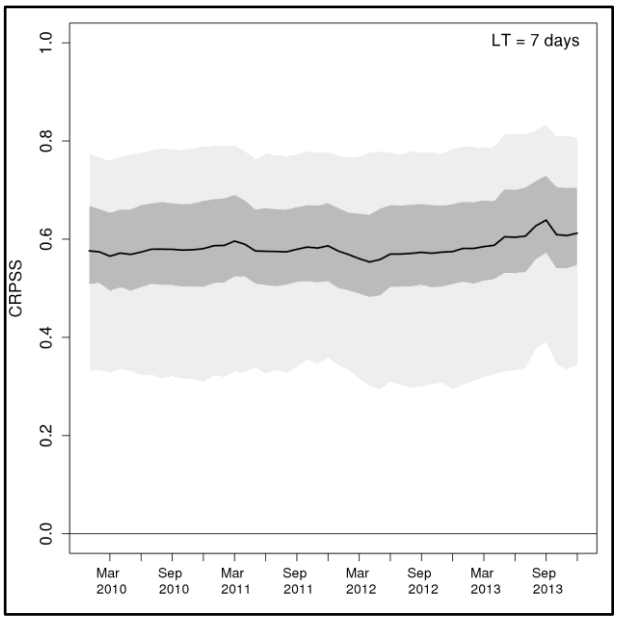

Figure 1: CRPSS of ECMWF ensemble streamflow prediction from 2009 onwards, 7-day lead time.

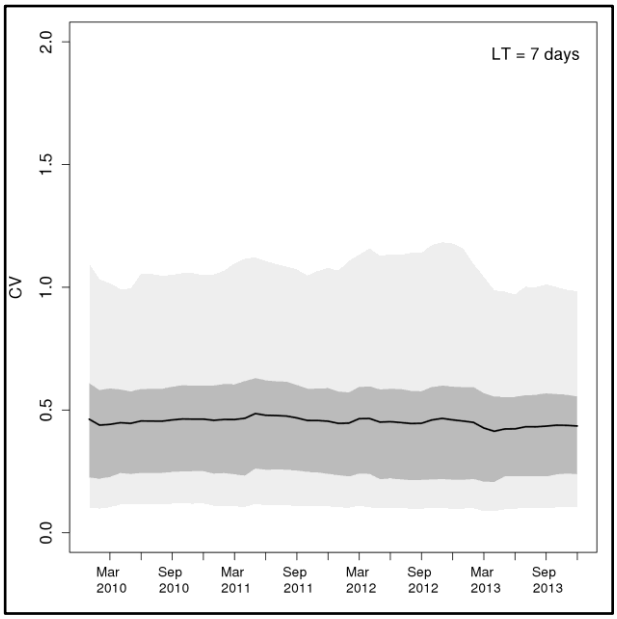

Figure 2: CV of the RMSE of ECMWF ensemble streamflow prediction from 2009 onwards, 7-day lead time.

Recent team publications

Alfieri, L., Pappenberger, F., and Wetterhall, F.: The extreme runoff index for flood early warning in Europe, Nat. Hazards Earth Syst. Sci. Discuss., 1, 7517-7548, doi:10.5194/nhessd-1-7517-2013, 2013.

Thirel, G.; Salamon, P.; Burek, P.; Kalas, M. Assimilation of MODIS Snow Cover Area Data in a Distributed Hydrological Model Using the Particle Filter. Remote Sens., 5, 5825-5850, 2013.

Wetterhall, F., Pappenberger, F., Alfieri, L., Cloke, H. L., Thielen-del Pozo, J., Balabanova, S., Daňhelka, J., Vogelbacher, A., Salamon, P., Carrasco, I., Cabrera-Tordera, A. J., Corzo-Toscano, M., Garcia-Padilla, M., Garcia-Sanchez, R. J., Ardilouze, C., Jurela, S., Terek, B., Csik, A., Casey, J., Stankūnavičius, G., Ceres, V., Sprokkereef, E., Stam, J., Anghel, E., Vladikovic, D., Alionte Eklund, C., Hjerdt, N., Djerv, H., Holmberg, F., Nilsson, J., Nyström, K., Sušnik, M., Hazlinger, M., and Holubecka, M.: HESS Opinions "Forecaster priorities for improving probabilistic flood forecasts", Hydrol. Earth Syst. Sci., 17, 4389-4399, doi:10.5194/hess-17-4389-2013, 2013.

Case study - Flash floods in Sardinia (Italy) in November 2013

During the night from 18th to 19th of November 2013 exceptionally high rainfalls fell in Sardinia, Italy. According to the website of Arpa Sardegna (see http://www.sar.sardegna.it/servizi/dati/datistazioni7gg.asp?stazione=Oliena), more than 350 mm of precipitation were recorded within 24 hours in a considerably large region in Central-East Sardinia. News reports from the BBC (http://www.bbc.co.uk/news/world-europe-24996292) quote up to 440 mm in 90 minutes (for comparison, the highest rainfall within 120 minutes recorded worldwide is reported by NOAA with 489 mm for an event that took place in China in 1975). The situation was aggravated by severe winds and waves along the coast. So far, a total of 18 casualties have been reported, with the region near Olbia being the most affected. The weather forecasts used in EFAS predicted high rainfalls for Sardinia, Corsica, Northern Spain and Southern France since the 14th of November, though forecasts were not persistent and underestimated the amount of precipitation.

For Italy, an EFAS partner only exists for the river Po but not for other river basins. The flash flood component of EFAS showed a medium probability for flash floods across the island about one day before the event, for which a warning would not have been sent out according to the current criteria. Only the forecast of 2013-11-18 12:00 UTC indicated a high probability for flash floods which would have resulted in a warning to authorities, but essentially at the time when the event was ongoing. Automated warning procedures are being explored, as they could provide additional lead time in such occasions, though at the expense of an increase in the number of false alarms.

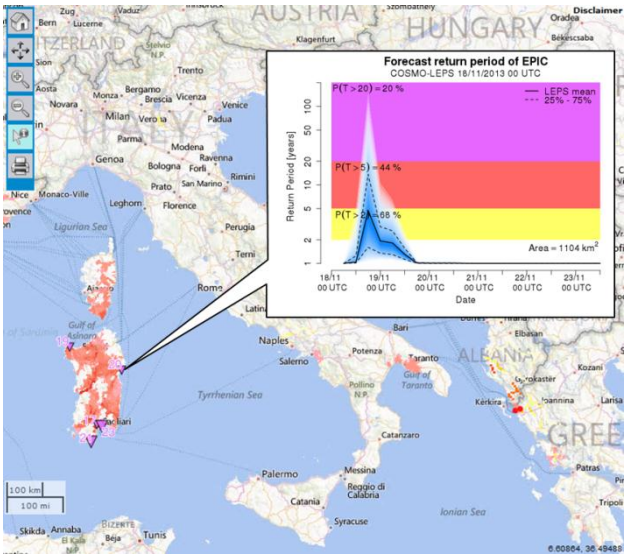

Figure 3: EFAS flash flood forecast of the 18/11/2013 00UTC, at the outlet of the Cedrino River.

Appendix - figures

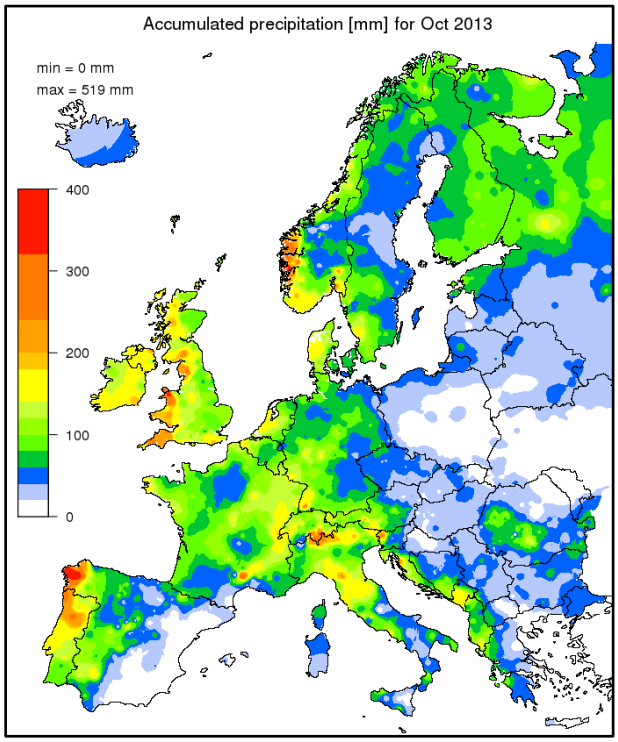

Figure 4: Accumulated precipitation [mm] for October 2013.

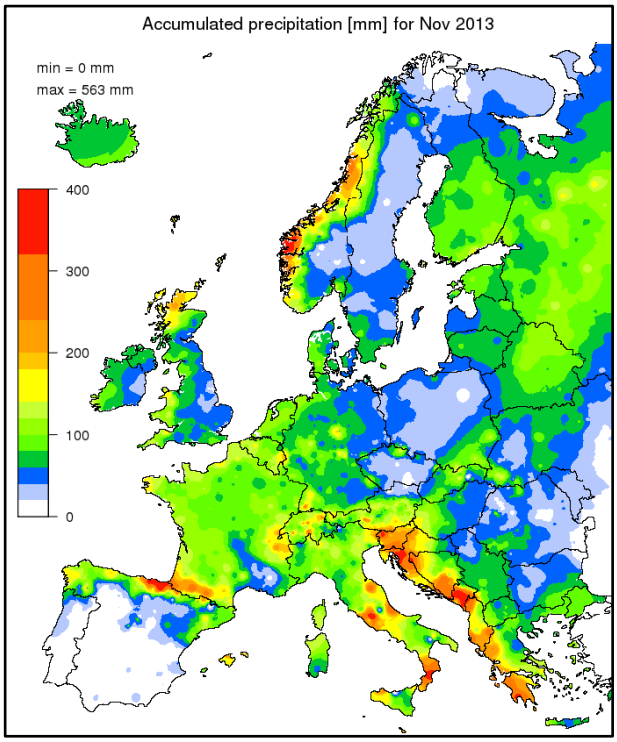

Figure 6: Accumulated precipitation [mm] for November 2013.

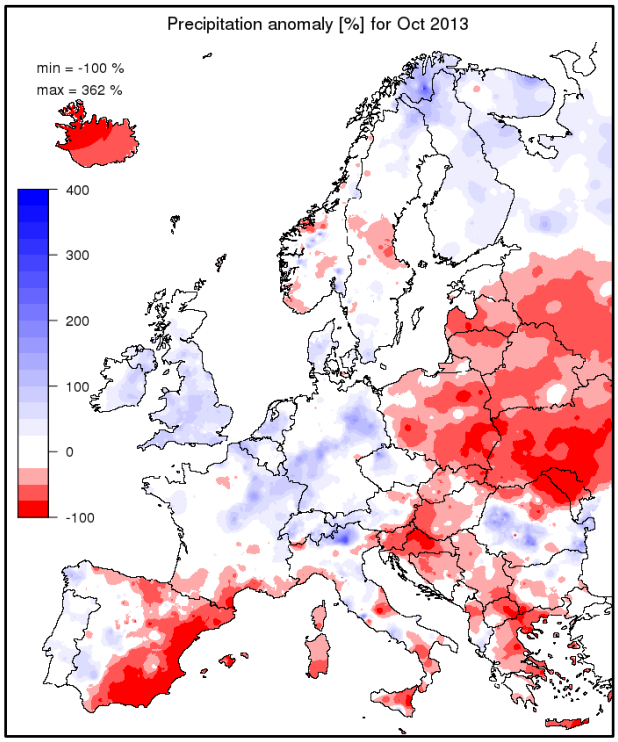

Figure 5: Precipitation anomaly [%] for October 2013, relatively to a long term average (1990-2011).

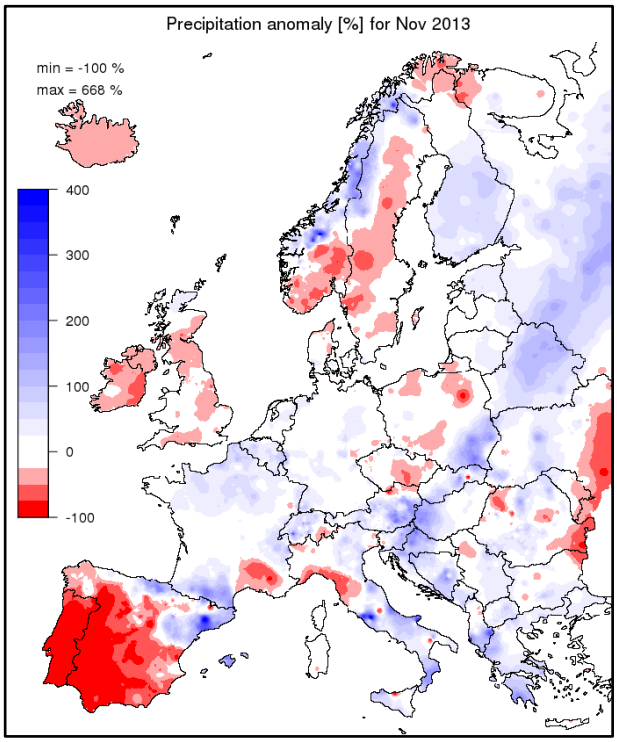

Figure 7: Precipitation anomaly [%] for November 2013, relatively to a long term average (1990-2011).

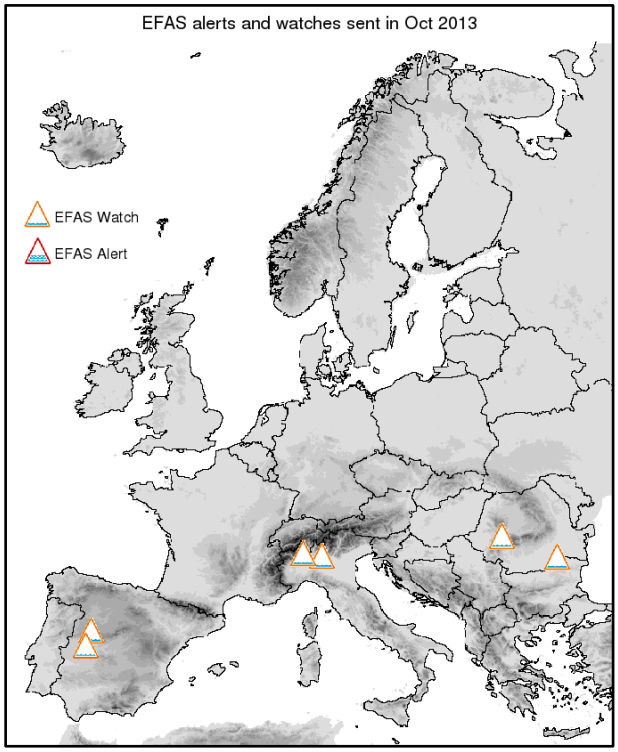

Figure 8: EFAS flood alerts and watches for October 2013.

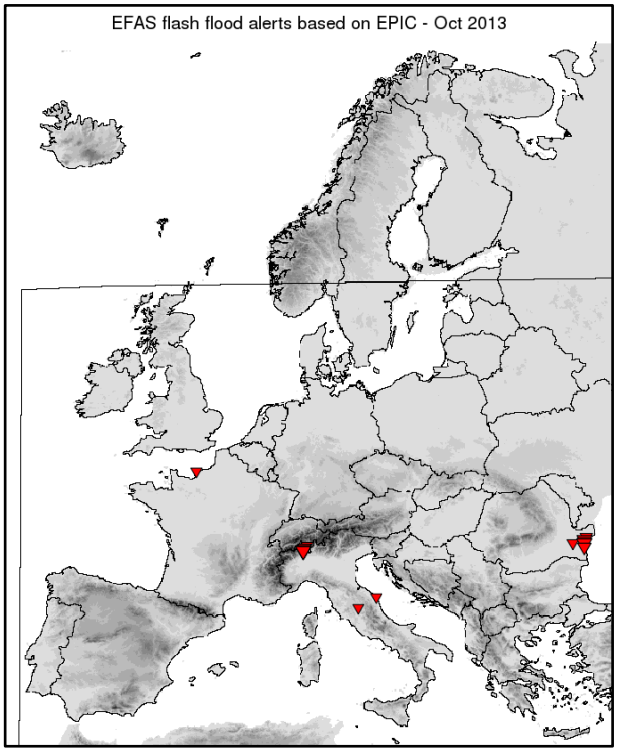

Figure 10: Flash flood reporting points for October 2013.

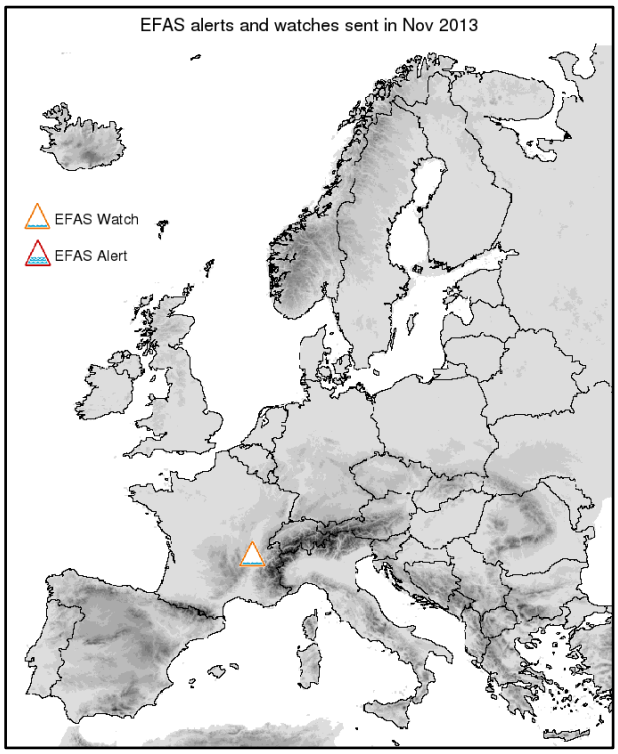

Figure 9: EFAS flood alerts and watches for November 2013.

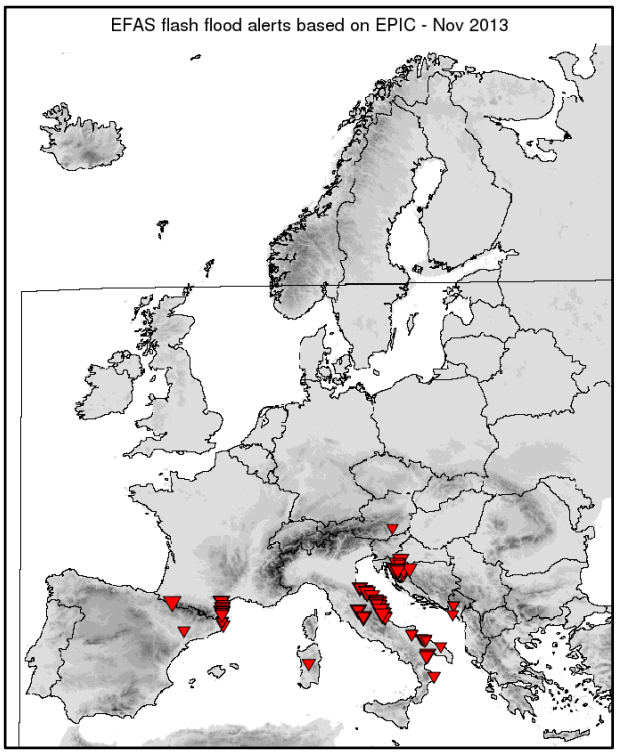

Figure 11: Flash flood reporting points for November 2013.

Acknowledgements

The following partner institutes are gratefully acknowledged for their contribution:

- DG Enterprise - Copernicus and DG ECHO for funding the EFAS Project.
- All data providers, including meteorological data providers, hydrological services and weather forecasting centres.
- The EFAS Operational Centres.
- The Hydrological Ensemble Prediction Experiment (HEPEX) community for providing inspiration and scientific support.