# European Flood Awareness System

# EFAS *Bulletin*

## October – November 2021

Issue 2021(6)

# NEWS

## *Upcoming Event*

**5th H SAF User Workshop**

The **5th H SAF User Workshop** supported by *EUMeTrain* will be held online from **24** to **28 January 2022**.

**Figure 1: EUMETSAT Network of Satellite Application Facilities H SAF logo**

The EUMETSAT Satellite Application Facility on Support to Operational Hydrology and Water Management (H SAF) aims to provide satellite derived products related to precipitation, soil moisture and snow over land in support to hydrology and water management. In addition, H SAF provides both continuous quality assessment of products and the evaluation of their hydrological impact for the benefit of the end user communities.

The workshop objectives will be:

- To introduce the H SAF products and their evolutions with respect to the future European satellite missions
- The usage of satellite products for flood and drought monitoring and water resources management applications
- To present use cases of the H SAF products in hydrological applications and emergency management in various regions, including Europe and Africa
- To demonstrate how to download, process, and apply products for different goals related to water monitoring and water management applications, with examples over the European and African Regions
- H SAF products quality assessment and applications

Participants are eligible to present at the workshop and are encouraged to browse through the session programme and select the session of interest (Session 2 - Session 6 are open for abstract submission).

Please follow the link for guidelines on how to submit your abstract for the H SAF Workshop. The **deadline for abstract submission is 24 December 2021**. Detailed information about the workshop agenda and registration links for individual sessions are available here.

## *New features*

**New EFAS Webinars**

Three new webinars have been published on the EFAS Webinars page. The topic of the three webinars is 'What to do once you have received an EFAS flood notification' (Parts 1 and 2) and 'What do if you do not receive an EFAS flood notification (Part 3).

**New EFAS partners**

We gladly welcome the Thüringer Landesamt für Umwelt, Bergbau und Naturschutz, TLUBN (Germany) as new EFAS full partner.

# RESULTS

## *Summary of EFAS Flood and Flash Flood Notifications*

The 17 formal and 26 informal EFAS flood notifications issued in October - November are summarised in Table 1. The locations of all notifications are shown in Figure 24 and Figure 26 in the appendix.

124 Flash flood notifications were issued in October - November. They are summarised in Table 2. The locations of all notifications are shown in Figure 25 and Figure 27 in the appendix.

## *Meteorological situation*

*by EFAS Meteorological Data Collection Centre*

**October**

October 2021 was characterized by lower than normal sea surface pressure over Scandinavia, Iceland, Great

Britain and Ireland, as well as over the central and eastern Mediterranean region. Above normal sea surface pressure was present everywhere else across the EFAS domain. Monthly precipitation totals were above the long-term mean in the northwest and northern Europe as well as the northern central Mediterranean region. Sums below the long-term mean were observed mainly in the eastern and southern parts of the EFAS domain. Monthly mean air temperature values were below the long-term mean in the central parts and above the long-term mean over the remaining parts of the EFAS domain.

At the beginning of October, the Iceland low and Azores high were around their typical positions. Another high-pressure system was located over eastern Europe and an upper-level low-pressure system over the eastern Black Sea. While the high-pressure system over eastern Europe was stable and extended to the southeast in the first decade of October, the Azores high shrunk and finally dissipated. The trough associated with the Iceland low expanded to the western Mediterranean region and swung eastward. Several heavy precipitation events were associated with this trough. A low-pressure system developed over the Ligurian Sea and moved south-eastward. It brought heavy rains to Greece and neighbouring countries for several days. While the high-pressure system over east Europe dissipated, another high-pressure system moved to Great Britain and Ireland and a low-pressure system moved to northern Scandinavia. An upper-level trough expanded from this low-pressure system to the central Mediterranean region, and later a low-pressure system was cut-off there. This system was associated with heavy rainfall events in southern Italy, southern Balkans and western Turkey. At the same time, another low-pressure system arrived in Scandinavia. In the next days, the high-pressure system located over Great Britain and Ireland moved towards central, and later, southern Europe. A low-pressure system moved from the Atlantic to Scandinavia. It got intensified and brought strong winds to northern, central and eastern Europe while moving to the Kara Sea. A high-pressure system moved from the Azores over central to eastern Europe and transformed into a ridge reaching out to the Azores High. During the same days, a quasi-stationary low-pressure system developed over the central Mediterranean Region and intensified to a medicane (named Apollo or Gloria depending on the country). It brought high precipitation amounts over this region. In the last days of October, the ridge disappeared, and a high-pressure system remained just over east Europe. A low-pressure system moved from Iceland to Great Britain and Ireland.

The highest precipitation amounts were observed over the central Mediterranean region, east of the Black Sea and at the west coasts of Scandinavia, the Iberian Peninsula, Great Britain and Ireland (Figure 10). No or almost no precipitation fell in many parts of east Europe and Anatolia as well as the south-western and south-eastern parts of the EFAS domain. Monthly precipitation totals above the long-term mean occurred mainly over Scandinavia, Great Britain and Ireland, the Balkans, Sicily, and over some parts of the southern coast of the Mediterranean Sea (Figure 11). Monthly totals below the long-term mean were reported mainly over central and east Europe, Anatolia as well as over the south-western and south-eastern parts of the EFAS domain.

The monthly mean air temperature ranged from -9.5°C to 32.4°C with the highest values in the southern parts of the EFAS domain. The lowest temperature values were reported in the northern and mountainous parts (Figure 14). Air temperature anomalies ranged from -4.3°C to 9.6°C (Figure 15). Monthly mean air temperature values below the long-term mean occurred in south and southeast Europe, and in some regions in Northern Africa, while positive air temperature anomalies appeared in the other parts of the EFAS domain.

**November**

November 2021 was characterized by lower than normal sea surface pressure over the majority of the land area in the EFAS domain and above normal sea surface pressure over the Atlantic Ocean between the Azores and Iceland.

At the beginning of November, a strong low-pressure system was located over Great Britain and Ireland. An upper-level low-pressure system was situated over southeast Europe. The remaining parts of the EFAS domain were influenced by high-pressure systems. The upper-level low-pressure system merged with the trough associated with the low-pressure system over Great Britain and Ireland, while this low-pressure system was weakening and moving to the Norwegian sea. The western parts of the trough expanded towards the Iberian Peninsula. Heavy precipitation

occurred along the eastern edge of the trough, for example in Bosnia-Herzegovina. The trough was cut-off over the western Mediterranean region on 5 November and developed further to medicane 'Blas'. 'Blas' remained active until 18 November and brought in this period heavy precipitation, severe weather, strong winds, floods and landslides at many locations in this region. During this period, a high-pressure system moved to the Bay of Biscay and a low-pressure system from Iceland to northern Scandinavia. As the high-pressure system moved to eastern Europe, a high-pressure ridge formed from the Azores to eastern Europe, trapping 'Blas' together with the high pressure over northern Africa. A low-pressure system moved from the Atlantic Ocean to Great Britain and Ireland and dissipated there. The high-pressure ridge extended further northward and blocked the low-pressure systems located over the Atlantic. While a new high-pressure system developed in the ridge over western Europe, a low-pressure system moved from Iceland to northern Scandinavia, and later to northwest Russia. The corresponding trough extended to the Iberian Peninsula and an upper-level low-pressure system was cut-off. It caused once again heavy precipitation in the western and central Mediterranean regions. The above-mentioned high-pressure system moved further towards the Atlantic Ocean. Consequently, low-pressure systems developed over Scandinavia and east of Iceland. One of these systems moved in the last days of November via Great Britain and Ireland to central Europe and later further to eastern Europe. By the end of the month, the Azores high was around its usual position. Weak low-pressure systems were located over the Norwegian Sea, as well as over Great Britain and Ireland. A strong low-pressure system was situated over northwest Russia.

*Currently, we cannot provide maps for November Meteorological Situation due to missing meteorological observations caused by an IT security incident at the Meteorological Data Collection Center. For more information visit the EFAS Known Issues wiki.

### *Hydrological situation*

*by EFAS Hydrological Data Collection Centre*

**October**

During the month of October, the highest concentration of stations with exceedances is in the Po river basin (Italy), with 20 stations affected. The situation of exceedances in southern Norway and Sweden is also remarkable. In a more dispersed way, there are four stations with exceedances in Belarus (Dnieper, Neman, and Vistula river basins), one in Ukraine (Vistula river basin), one in Hungary (Danube basin), one in northern Poland, also in Germany, Slovenia, Croatia, and Bosnia & Herzegovina. Finally, 10 stations in Spain exceeded their thresholds, specifically in the east of the country (Llobregat, Ter, Besòs, Serpis, Seco, Almanzora, and Adra basins).

Regarding stations registering values above the 90% quantile, a small number of stations (72) exceeded this value in October. The majority of these stations were located in Scandinavian basins throughout Norway, Sweden, and Finland. Exceedances of the 90% quantile was also noteworthy Spain, where several basins in the east and south of the country had stations with values that were above the 90% quantile. To a lesser degree, other stations found with exceedances over their 90% quantile were located in the Dnieper basin, throughout Ukraine and Belarus, and in the Danube basin (crossing Bosnia and Herzegovina, Croatia, Germany, and Serbia). Isolated stations exceeding the 90% quantile occurred in stations in the Loire and Seine basins (France), Luxembourg (Rhine basin), Poland (Vistula basin), Belgium (Scheldt basin) and in England (Thames and Clyst basins).

Finally, regarding stations that registered values below the 10% quantile (38 in total), the highest concentration of them corresponded to the Danube basin, most prominently along the Austrian stretch of the river with seven stations highlighted. Also, in the Danube basin, we find three stations in Hungary and Ukraine, two stations in Romania, and a single station in Germany, Serbia, Slovakia, and Slovenia. In a more dispersed pattern, we find four stations around the border between France and Spain and four more in the Rhine basin in Germany. A lower density of stations under the 10% quantile occurred in southern Spain, the Oder basin in Poland, and the Dniester basin in Ukraine, with two stations each. At last, we can also find isolated stations fulfilling this criterion in the Tinnelva river (Norway), the Iijarvi river (Finland), the Aire river (France), the Attert river (Luxembourg) and the Parthe river in Germany.

**November**

During the month of November, the highest concentration of stations with exceedances is located in the Danube river basin (in Croatia and Bosnia and Herzegovina), the Po river basin (Italy), and across northern Spain (in the Douro, Minho, Ter, Llobregat, Tordera, Besòs, and Foix basins). There are also some additional stations in Italy with exceedances (Tiber and Garigliano basins). In a more isolated way, there are four stations in the Oder river basin (Poland), one in the Elbe and the Rhine river basins (Germany), another in Hungary (Danube river basin), and lastly, five stations in southern Norway.

Regarding stations registering values above the 90% quantile, a small number of stations (91) exceeded this value in November. Fifty-six per cent of the stations were located in the Scandinavian Peninsula basins throughout Norway, Sweden, and Finland with 26, 15, and 10 stations respectively. It was also remarkable Spain, where several basins where involved in the east (Ebro, Jucar, Gallinera, Algar, and Monegre) and south (Guadalquivir) of the country. Similar number of stations (15) surpassing the 90% quantile occurred in the central western Italy, in the basins: Tiber, Marta, Garigliano, and Fiora. To a lesser degree, other stations over their 90% quantile were located in the Danube basin throughout Bosnia and Herzegovina (three stations), and one isolated station in Germany. Other three stations exceeded this value in the Dnieper basin in Belarus and Ukraine. Iceland also had two stations which surpassed their 90% quantile in the Nupsvoetn and Bakkahlaup basins. Isolated stations exceeding the 90% quantile can be seen in the Pripyat basin (Belarus) and in the Rhine basin (Luxembourg).

Finally, and according to those stations registering values below the 10% quantile (52 in total), the highest concentration of them corresponded to the Danube basin, mainly the central area, where 12 stations are spread along the borders of Austria, Croatia, Slovenia, and Hungary. Still in the Danube basin we can find three stations in Serbia, three more in Romania, one station in Germany, and one in Ukraine. Secondly, we also have a high density of stations fulfilling this criterion in the Rhine basin, with seven stations in Switzerland and four stations in Germany. In a more dispersed pattern, six stations can be found in the polish basins of Oder and Vistula, and another six stations in Ukraine (Dnieper and Dniester basins). Finally, a lower density of stations under the 10% quantile occurred in Spain (five stations in the Minho, Ebro and Verde basins), the south of England (two stations in the Thames and Exe basins), and in France (two stations in the Seine and Garonne basins).

*Verification*

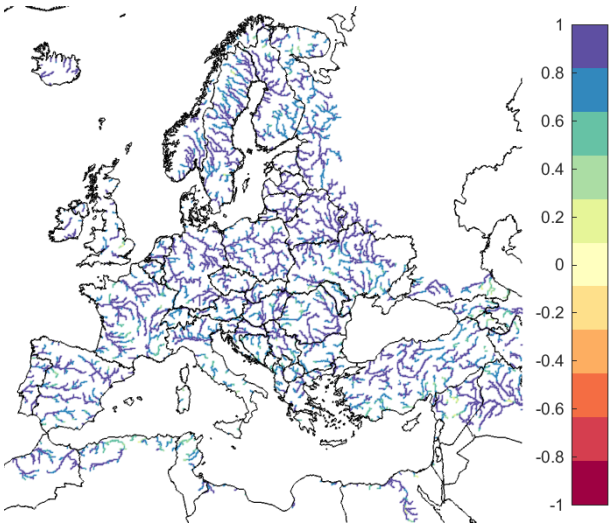


**Figure 2: EFAS CRPSS at lead-time 1 day for October-November 2021, for catchments >2000km2. The reference score is persistence of using previous day's forecast.**

Figure 2 and Figure 3 shows the EFAS headline score, the continuous ranked probability skill score (CRPSS) for lead times 1 and 5 days for October-November across the EFAS domain for catchments larger than 2000km$^2$. A CRPSS of 1 indicates perfect skill, 0 indicates that the performance is equal to that of the reference, and any value <0 (shown in orange-red on the maps) indicates the skill is worse than the reference. The reference score is using yesterday's forecast as today's forecast, which is slightly different than we used previously and very difficult to beat.

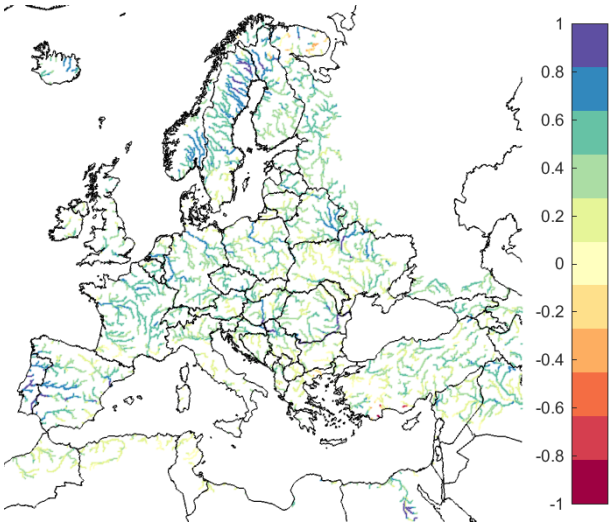


**Figure 3. EFAS CRPSS at lead-time 5 days for October-November 2021 for catchments >2000km2. The reference score is persistence of using previous day's forecast.**

These maps indicate that across much of Europe for forecasts are more skilful than persistence at both lead times. Regions shown in blue are those where EFAS forecasts are more skilful than persistence, with darker shading indicating better performance.

The skill of the forecast was quite good over the period, and similar to the same period last year (Figure 4). An inter-annual variability of the scores is to be expected. The long-term trend is neutral over the first two years since the domain was extended, but there is an indication of increase in skill with EFAS 4.0, especially for the areas with generally lower skill.

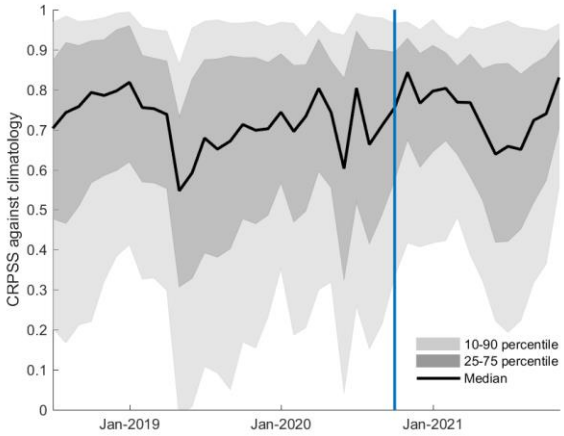


**Figure 4. Monthly means of CRPSS the for lead-time 5 days for all the major river points in Europe with ECMWF ENS as forcing. Reference forecast was climatology. The skill is largest during the winter months, when there is less variation in the flow in large parts of Europe. The blue line indicates the release of EFAS 4.0.**

# ARTICLES

## *High reliability of EFAS notifications for Spain during 2020*

*by Marc Girons Lopez, EFAS Dissemination Centre*

A team from the Spanish directorate for civil protection and the Jaume I University in Castellón found that EFAS notifications had been highly reliable for Spain in 2020, during which a number of major storms hit the country.

**Figure 5: Inundated streets in Burriana (Castellón province) as a result of heavy rainfall and strong wind gusts in March 2020 (Source: El Mundo).**

EFAS supports preparatory measures in advance of major flood events by providing complementary information to relevant national and regional authorities across Europe. To this end, flood and flash flood notifications are sent to EFAS partners before such events strike.

During 2020 a number of storms hit Spain, leading to considerable amounts of rain and strong winds, and producing significant damage in different parts of the country. Several of these storms were major named storms that affected large parts of the country: Gloria (January), Karine (March), Barbara (October), Dora and Bella (December).

In the aftermath of these events, a team from the Spanish directorate for civil protection and the Jaume I University in Castellón analysed the performance of the notifications sent by EFAS to the Spanish authorities based on reports on the predicted events from local and regional newspapers. The analysis was done at the provincial level and the results were then aggregated by regions (autonomous communities). These results are summarised in the figure below.

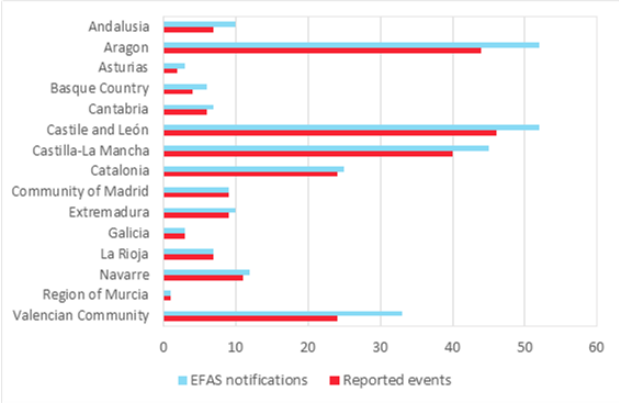


**Figure 6: EFAS notifications and reported events for each region in Spain during 2020.**

The authors found out that the regions which received the largest number of EFAS notifications (Aragon, Castile and León, Castilla-La Mancha and Valencian Community) were also the ones with the largest percentage of false alarms (i.e. no event occurred in connection with a given notification). Conversely, the regions with the lowest number of EFAS notifications had the largest percentage of hits.

Overall, EFAS notifications had a high efficiency for Spain in 2020, with over 85% efficiency across the country. Notifications tended to correspond best with observations when these were connected to large storm events, such as during the aforementioned Gloria, Karine, Barbara, Dora and Bella storms, but also during "cold drop" events (pockets of cold air detached from the jet stream typically producing downpours in south-eastern Spain).

The full report containing the analysis of EFAS notifications for Spain during 2020 can be accessed here. The team is now focusing on quantifying the damages produced by these storms in order to further understand the economic impacts of these events.

## *Floodlist Article*

*by Richard Davies, floodlist*


**Figure 7: Flood rescues in Alessandria Province, Piedmont, 04 October 2021. Credit: Vigili Del Fuoco**

Severe weather affected areas of northern Italy from 04 to 05 October 2021. Dozens of people were rescued from flooding in the regions of Liguria and Piedmont.

Figures from the Liguria's environment agency showed a record 181 mm of rainfall in just 1 hour and over 900 mm in 24 hours.

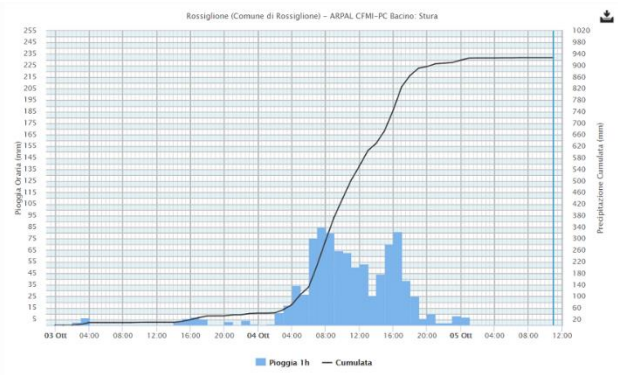


**Figure 8: Rainfall figures for 04 October in Rossiglione, Liguria, Italy in 24 hours. Credit: ARPAL**

The President of Liguria said in a statement late 04 October that almost all emergency situations were concentrated in the Savona area, in the Bormida valley and in the hinterland of Genoa in the Stura valley. The president said the situation was critical given the extreme levels of rainfall. As much as 604 mm of rain fell in 12 hours in Rossiglione and 540 mm in 12 hours in Savona, Toti said.

Liguria's environment agency, Agenzia Regionale Protezione Ambiente Ligure (ARPAL) reported 1-hour rainfall totals of 145.2 mm in Cairo Montenotte, 178.2 mm in Urbe and 181 mm in Vicomorasso, which is a new national record. Furthermore, figures from ARPAL show the station at Rossiglione recorded more than 900 mm of rain in 24 hours.

Several rivers broke their banks in the region. The Erro flooded areas of Pontinvrea; the Bormida river overflowed in Cairo Montenotte; and the Letimbro caused flooding in the city of Savona.

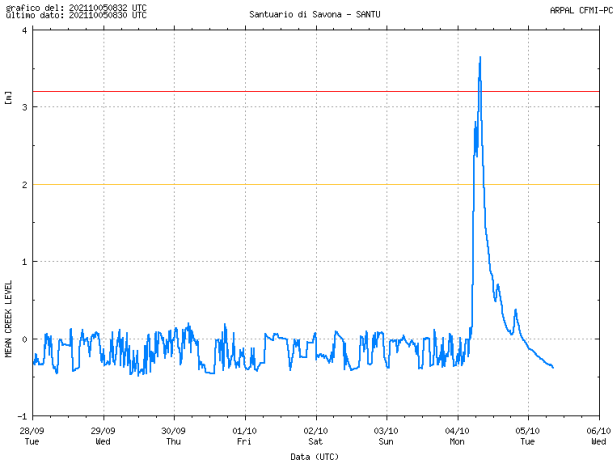


**Figure 9: Levels of the Letimbro river in Savona, Liguria, 04 to 05 October 2021. Credit: ARPAL**

Italy's fire service, Vigili Del Fuoco, carried out 30 interventions in the city of Savona; rescued 13 trapped motorists in Rossiglione; and evacuated five families trapped in a building in Ponteinvrea.

Several roads including motorways were temporarily closed, and some rail services were suspended. A bridge was wiped out in Quiliano. Flooding also affected areas of Camporosso and other parts of the Province of Imperia. Schools, public buildings, and parks were closed in the city of Genoa.

In the Piedmont Region, firefighters rescued 29 people from flooding caused by the overflowing Orba river in Ovada, Alessandria Province, late on 04 October 2021.

## *16th EFAS Annual Meeting*

*by EFAS Analytics and Dissemination Centre*

The 16th EFAS Annual Meeting was again transferred to an on-line platform due to the Covid-19 pandemic situation. The meeting was part of the Copernicus Emergency Management Service Week 2021 that was organized with the aim to bring together experts, users and policy makers to discuss the future of CEMS. The meeting took place over two half days on 27 and 28 October 2021. In the first part of the meeting 174 participants from EFAS partners, third party partners and operational centres were logged in. In the second part 147 people participated. The EFAS Annual Meeting was organized by the Joint Research Centre (JRC) and the EFAS Dissemination Centre (DISS) with the support of all EFAS operational centres. EFAS/GLOFAS activities will continue in new framework contracts for the period 2021-2027. Contracts have been awarded in July 2021. The only change is that HYDRO continues with only Soologic. In the new framework contracts, there is additional user support, more analytical service, additional and improved data validation procedures.

**Achievements during the last year**

EFAS DISS presented the 4 new full partners and 5 new third party partners that have joined EFAS since the last annual meeting. In 2020 240 formal, 159 informal and 1815 flash flood notifications were issued. In the period from January till September 2021 106 formal, 117 informal and 1283 flash flood notifications were sent to EFAS partners. The analysis of provided feedback showed that partners were happier with the predictions than last year. Webinars were held – Use of EFAS 4.0 (December 10, 2020) and Rapid Mapping for Satellite pre-tasking (June 15, 2021). Both are recorded and uploaded on EFAS IS. The Annual Survey was not carried out during this virtual meeting; however, the partners will be requested to provide feedback on EFAS for the entire year 2021 and will receive a questionnaire in January 2022.

The EFAS Hydrological Data Collection Centre (HDCC) presented their Annual report 2020, in which 1149 discharge stations are analyzed. The percentage of stations for which threshold levels were exceeded has increased in the past year compared to the previous year but is still lower than the historical average between 1991 and 2015. Currently 1824 stations from 48 partners are providing water level or discharge data. EFAS HDCC has contributed to the event assessment report for the 2020 spring flood event in Scandinavia.

The EFAS Meteorological Data Collection Centre (MDCC) currently collects data from over 240.000 sensors and stations, does quality control checks on these data, runs automatic data aggregation and validation calculations, to prepare data for generation of gridded spatial information, that is used as input for COMP. A filter has been developed to detect and remove multiple stations and merge them into one station. This prevents overrating of multiple available stations and improves the performance of grid creation. Necessary minimum data coverage for including stations in post processing was reduced and acceleration of interpolation has been achieved. An annual overview report of the meteorological data collection in 2020 has been produced. This will be done every year from now.

**Feedback Collection**

DISS highlighted one again the importance of feedback on issued notifications. Feedback is essential to improve the EFAS system. It helps to verify case studies, validate skill scores, assess the model performance, and shape future developments. Presently feedback is collected on formal notifications, flash flood notifications but also on missed events. Feedback is analyzed on a yearly basis. A summary of the feedback of 2020 is available on the EFAS website. In the new framework contract feedback collection will be asked for all types of EFAS notifications.

In a parallel session partner feedback for flash flood verification was presented. The aim of the verification is to identify the optimal criteria for issuing flash flood notifications. Flash flood forecasts are compared against observations at the administrative region level. Observations are derived from media, but also from EFAS partners and from the European Severe Weather Database.

**What's new & next for EFAS?**

The next version of EFAS is referred to as EFAS 5.0 or EFAS-Next. Important features of EFAS-Next are increased spatial resolution to 1 arcmin (~1.3 km), new

meteo and hydro datasets with longer lead times, more stations and improved interpolation methods, new improved static maps and a new LISFLOOD calibration with more stations and longer calibration periods.

The higher spatial resolution leads to an improved representation of the drainage network and better modelling of small catchments. EFAS 5.0 will be operational by the end of 2022.

**Performance of the EFAS System**

In EFAS-IS, a number of evaluation layers is available. The layers show performance and forecasting skill. For the hydrological performance 1137 observation stations from 1990 to 2017 with at least 4 years of data have been evaluated. Evaluation was done at 6-hourly time steps, but model series averaged to daily for stations with only daily data. The KGE efficiency metric gives information on correlation, bias and variability. Forecast skill refers to the relative accuracy of a set of forecasts, with respect to a set of standard benchmark forecasts. Benchmarks are persistence and climatology. Next steps will be to implement operational monitoring of forecast skill and scalability of evaluation products.

**The CEMS Global Flood Monitoring Service**

GFM is a system based on 2 Sentinel-1 satellites that provides systematic coverage and near real time monitoring of land surfaces. A fully automatic process derives 11 output layers with a spatial resolution of 20 meters, including a flood extent map and uncertainty maps. A beta version of the GFM is available on the GLOFAS website since 27 October 2021 and will be integrated in EFAS-IS next year.

**The European Coastal Flood Awareness System - ECFAS**

ECFAS is a Horizon2020 funded project for predicting coastal flooding. From hazard forecasting to flood mapping. ECFAS provides validated pan-European forecasts of total water levels at the coast (including the effects of ocean circulation, atmospheric pressure forcing, tides and waves). It provides thresholds that can trigger the awareness system. Total water levels will be produced as hourly time series of sea level forecasts along the EU coast. Flood impact forecasts will be made by combining water levels with information on population, buildings, land-use, transport and infrastructure. The result of the project will be a proof of concept that can possibly be integrated in CEMS.

**The TAMIR Project and the link to EFAS**

TAMIR is a DG Echo funded project to enhance the response capacity in emergencies caused by convective and heavy rainfall events by developing rapid risk assessment products and IT tools for improved impact forecasting to support decision making. In TAMIR flash flood impact forecast products are developed to display on the EFAS website. Prototype of TAMIR products will be available in EFAS-IS and as web services by March-May 2022.

**The South-East European Multi-Hazard Early Warning Advisory System – SEE-MHEWS**

South-East Europe has experienced a significant number of severe meteorological and hydrological hazardous events such as floods, extreme temperatures, severe storms, droughts, wildfires and landslides. National hydrological and meteorological Services are facing challenges to secure adequate financial and human resources to provide timely and accurate warnings. International cooperation can improve the quality of weather and water related information, forecasts and warnings. In the first phase (2016-2017) an implementation plan was prepared. Between 2018 and 2022 a pilot phase supporting the implementation of a prototype was conducted. In the period 2022-2026 an operational system should be implemented.

**The recent floods in Germany, Belgium and Luxembourg**

The floods that happened in July 2021 in the catchments of Rhine and Meuse had tragic impact. EFAS can contribute to improve the situation and reduce impact.

**EFAS performance during the July 2021 floods**

The EFAS operational centres will produce a detailed assessment report about the July 2021 floods. The report will focus on the quality of EFAS model simulations and forecasts and the quality of the EFAS service. In the report that should be published in December 2021 it will be investigated whether notifications were sent to the appropriate recipients,

whether they were used in forecast informed decision-making (if so, how) and whether the EFAS forecasts provide additional information over 'home produced' forecasts.

**The July flood in Germany with focus on the Ahr basin and challenges in forecasting**

In her presentation Margret Johst from the German State Environmental Agency Rhineland-Palatinate gave an introduction in the flood that happened in the Ahr basin between 14 and 15 July. The return period of the flood (based on 80 years measurements) is estimated to be larger than 1000 years. About 130 people died in the flood. Copernicus EMS was activated. 5 EFAS notifications were received. 1 of them was as predicted, 2 were in fact more severe and 2 were false alarms.

**Summary**

The meeting was full of information and organizers appreciated a lot that partners provided feedback and had many questions that could move EFAS forward. The EFAS annual meeting concluded with a hope that next year we will be able to meet again face to face.

A comprehensive list of the presentations given at the 16th EFAS Annual Meeting can be found on this webpage. The minutes of the meeting 2021 can be downloaded here.

## *1st Global Flood Forecasting and Monitoring meeting*

*by EFAS Analytics and Dissemination Centre*

As part of the CEMS week, the first GloFAS Annual Meeting was organized in the afternoon of 28 October. In this meeting 117 participants were logged in. Presentations were given on developments and use cases in GloFAS and the Global Flood Monitoring System.

**GloFAS – highlights of the last year**

GloFAS is part of the Copernicus Emergency Management Service (CEMS). The system couples information from numerical weather prediction with hydrological modelling to provide global flood forecasts for large river catchments. GloFAS is complementary to national hydrological and meteorological systems. Information from GloFAS is freely available and provides ensemble hydrological forecasts and is updated daily. GloFAS also contains a seasonal component that is updated weekly. Version 3.2 of GloFAS is available since 27-10-2021.

The flood risk assessment layers in GloFAS are comparable to EFAS. The rapid impact assessment layer gives information on lead time and exposure.

**Global Flood Monitoring**

A new operational, near real-time global flood monitoring system (GFM) has been integrated into GloFAS. The new GFM provides a continuous monitoring of floods worldwide by immediately processing and analyzing all incoming Sentinel-1 Synthetic Aperture Radar (SAR) satellite data. Information is obtained from 2 satellites for systematical monitoring of floods around the world. Three algorithms run in parallel to compute the near-real time flood mapping products.

GFM computes on a regular basis 11 different flood-related products, accessible via the hydrological layer tab of the GloFAS map viewer. Seasonal differences can be taken into account.

**CEMS Hydrological Data Collection Centre (HDCC) for GloFAS**

Given the fact that this was the first annual meeting for GloFAS within the Copernicus EMS, the setup of the Copernicus services was explained. JRC is responsible for the management and the future development of the EMS, but the operational work is contracted to a number of service providers. In a separate session the global hydrological data collection, one of the services of the operational CEMS was presented.

The GloFAS Hydrological Data Collection is outsourced to the Spanish company Soologic. Soologic (together with REDIAM) has been operating the EFAS HDCC since 2012. The new framework contract that starts 2021 includes data collection for Europe as well as for the global domain. The HDCC collects historical hydrological data and metadata, harmonizes the data, does quality control and data sharing within CEMS.

**A first glimpse into GloFAS 4.0**

GloFAS 4.0, also referred to as GLOFAS Next will be operational at the end of 2022. In the new version the spatial resolution will be doubled from 0.1 degree to 0.05 degree, the LISFLOOD model will be upgraded and

the system will be recalibrated with new data. That way the river network will be better represented and eventually forecasts will improve. In GloFAS 4.0 catchments with an area over 500 km2 are calibrated (in the previous version this was 5000 km2).

**Global use case and applications – Global user stories**
In a number of users' stories, the application of GloFAS and the Global Flood Monitoring System was presented.

Two extreme flood events occurred in the 2020 monsoon in the Brahmaputra basin in Pakistan. The GloFAS forecasts hydrograph showed high forecasts probabilities for flood onset, peak time and duration with a lead time between 10 and 15 days. Bangladesh flood forecasting and warning centre plans to integrate GloFAS forecasts to the national model to predict water levels.

The World Food Program has been using an in-house system called the automated disaster analysis and mapping system. Flood forecasting (river reporting points, inundation forecasts and rainfall forecasts) is coming in from GloFAS and from ECMWF.

The use of flood forecasts and the implementation of systems like GloFAS in Disaster Risk Financing was presented. The aim of DRF is to get the right amount of money where it needs to be in the right time. Forecasts are used for risk analytics. Financing a contingency planning will be rolled out based on risk assessment coming from forecasting systems like GloFAS.

An example was presented were GloFAS is used for risk analytics prior to river flooding. Insurance needs a probabilistic analysis of historical events and real time forecasts.

An example from a Swiss trader specialized in energy commodities was presented. Discharge forecast from GloFAS are used to forecast power production. GloFAS improved performances compared to persistency.

The Aristotle project aims at transboundary early earning. Aristotle provides guidance on 6 types of natural hazards to the EU Emergency Response Coordination Centre (ERCC). This guidance is used by the ERCC to coordinate preparatory and response actions to global natural disasters. Information from GloFAS is used for the flood hazard part in the guidance reports.

Case studies on how GloFAS and GFM complement each other for Thailand, China, India and Mexico were presented. It was concluded that GloFAS is not perfect but usable.
A comprehensive list of presentations given at the 1st Global Flood Forecasting and Monitoring meeting can be found on this webpage.

## Acknowledgements

The following partner institutes and contributors are gratefully acknowledged for their contribution:

- DG DEFIS - Copernicus and DG ECHO for funding the EFAS Project
- All data providers including meteorological data providers, hydrological services & weather forecasting centres
- The EFAS Operational Centres
- Richard Davies, Floodlist.com

**Cover image:** Flood rescues in Alessandria Province, Piedmont, 04 October 2021. Credit: Vigili Del Fuoco

## Appendix – figures

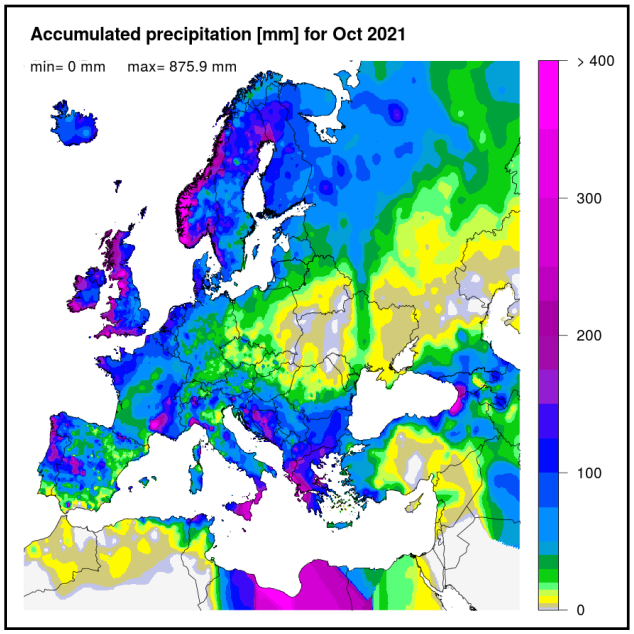


Figure 10: Accumulated precipitation [mm] for October 2021.

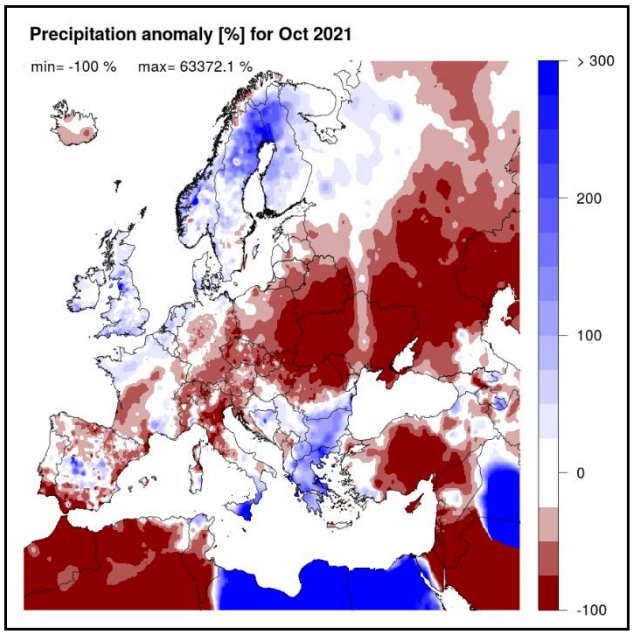


Figure 11: Precipitation anomaly [%] for October 2021, relative to a long-term average (1990-2013). Blue (red) denotes wetter (drier) conditions than normal.

*Currently, we cannot provide maps for November Meteorological Situation due to missing meteorological observations caused by an IT security incident at the Meteorological Data Collection Center. For more information visit the EFAS Known Issues wiki.

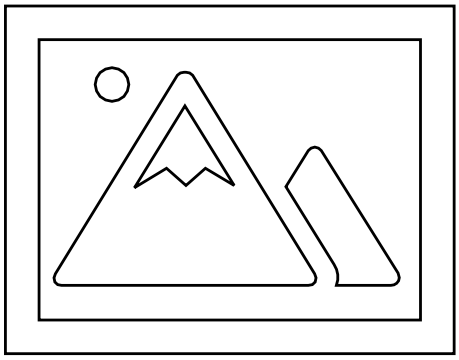

Figure 12: Accumulated precipitation [mm] for November 2021.

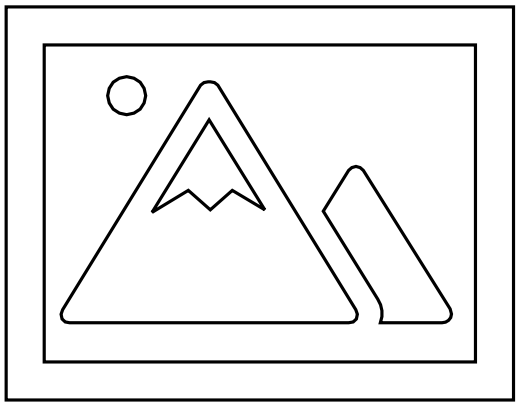

Figure 13: Precipitation anomaly [%] for November 2021, relative to a long-term average (1990-2013). Blue (red) denotes wetter (drier) conditions than normal.

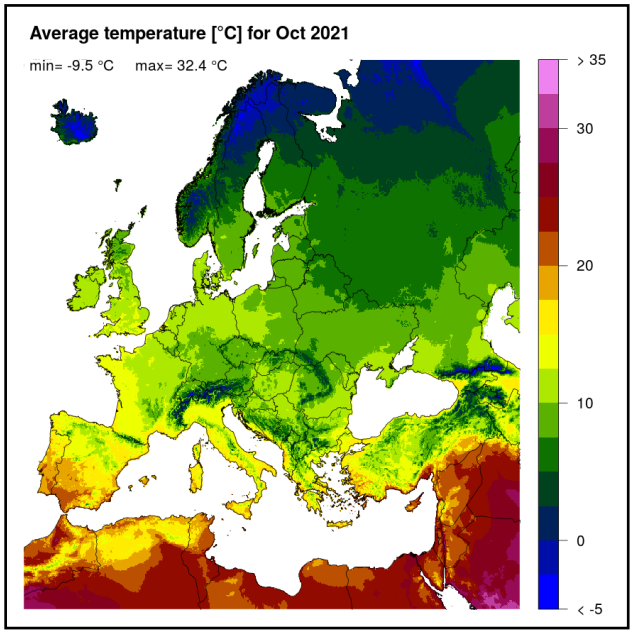


Figure 14: Mean temperature [°C] for October 2021.

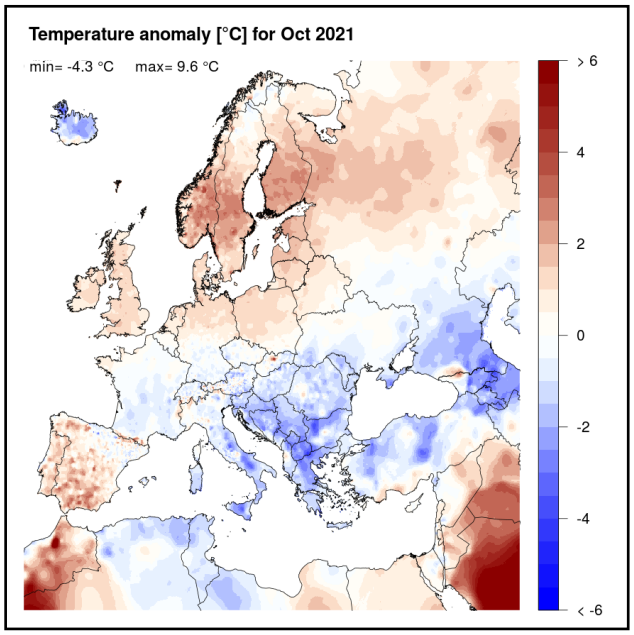


Figure 15: Temperature anomaly [°C] for October 2021, relative to a long-term average (1990-2013). Blue (red) denotes colder (warmer) temperatures than normal

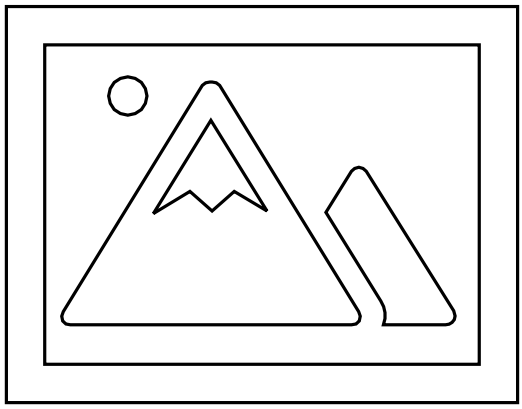

Figure 16: Mean temperature [°C] for November 2021.

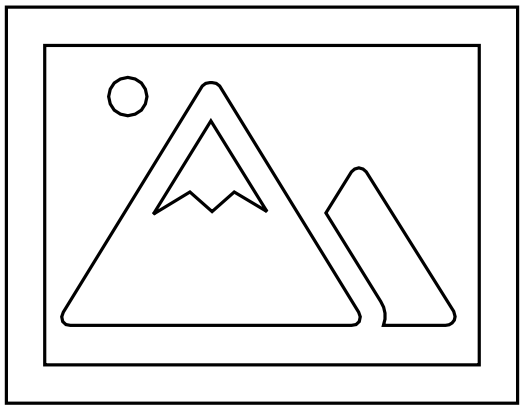

Figure 17: Temperature anomaly [°C] for November 2021, relative to a long-term average (1990-2013). Blue (red) denotes colder (warmer) temperatures than normal.

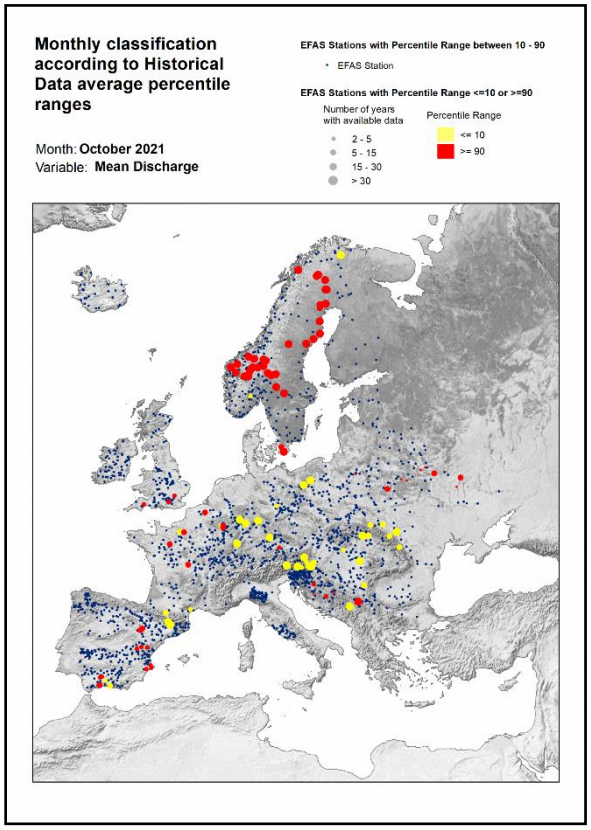


Figure 18: Monthly discharge anomalies October 2021.

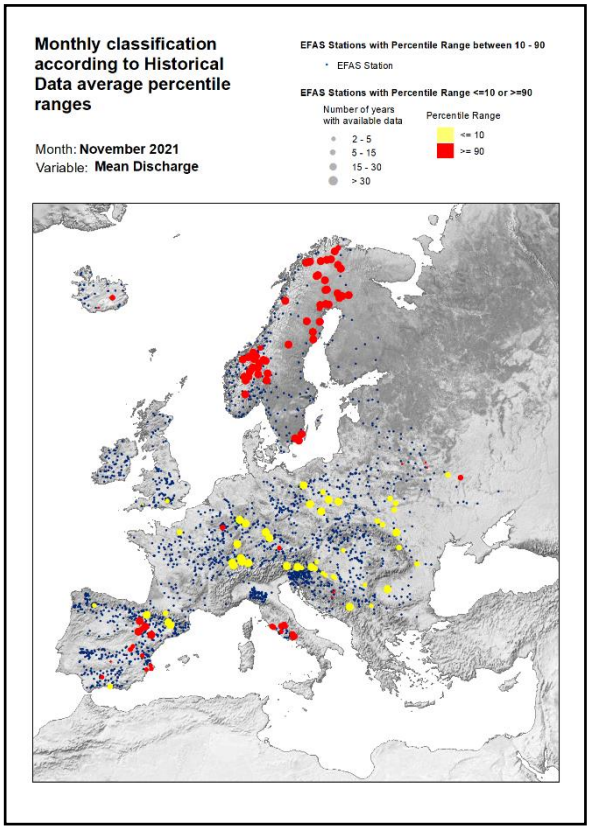


Figure 20: Monthly discharge anomalies November 2021.

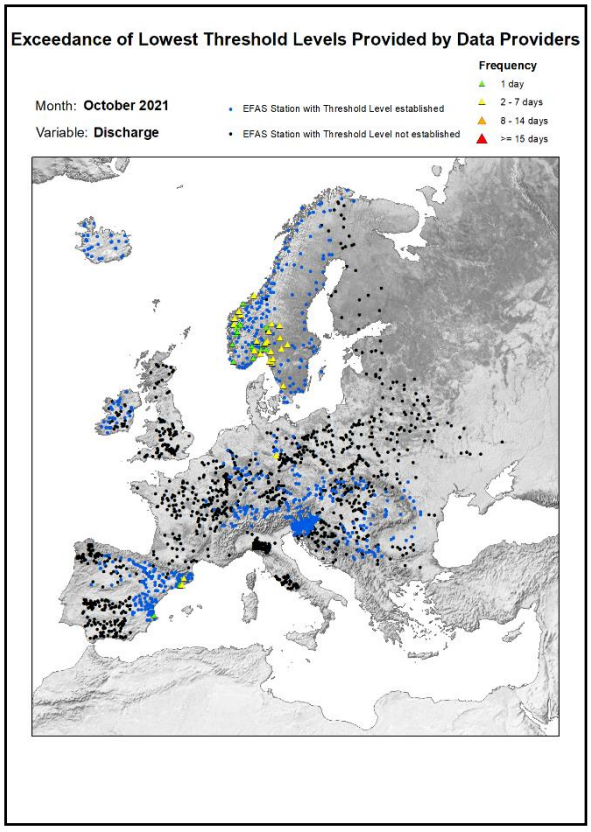


Figure 19: Lowest alert level exceedance for October 2021.

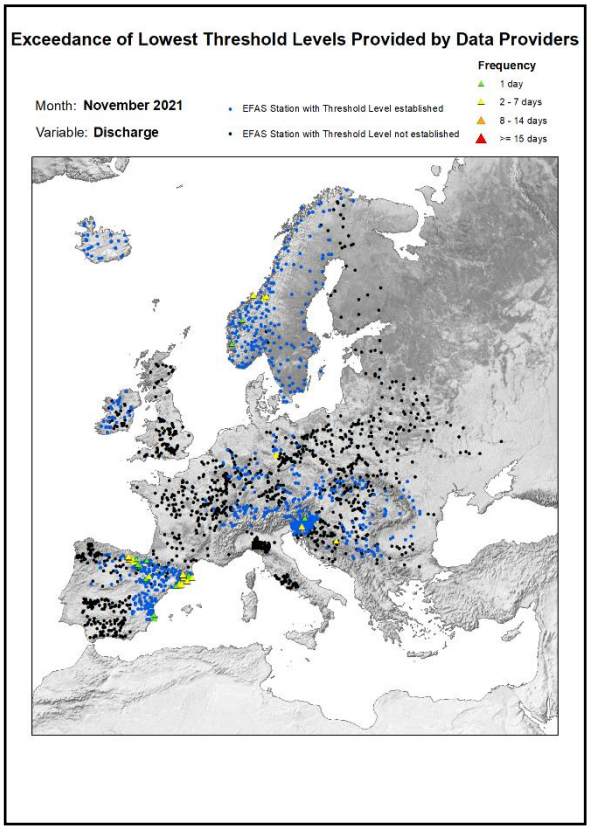


Figure 21: Lowest alert level exceedance for November 2021.

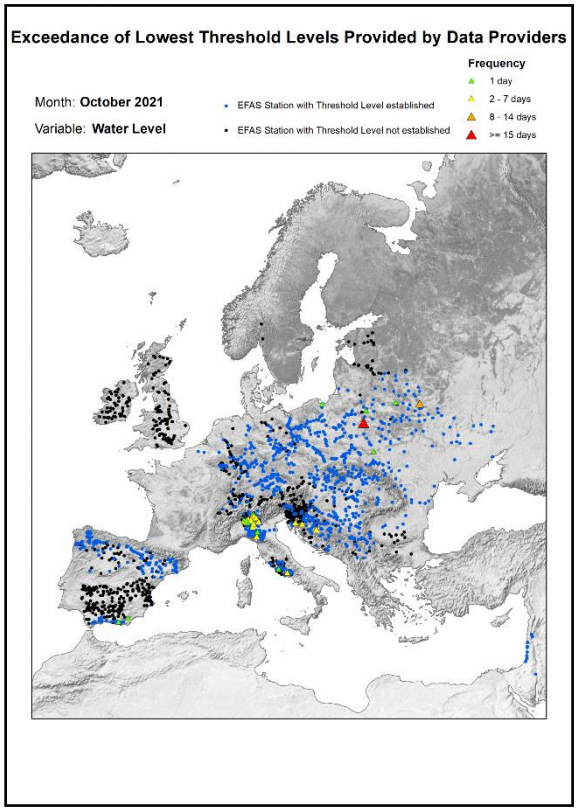


Figure 22: Lowest threshold exceedance for October 2021.

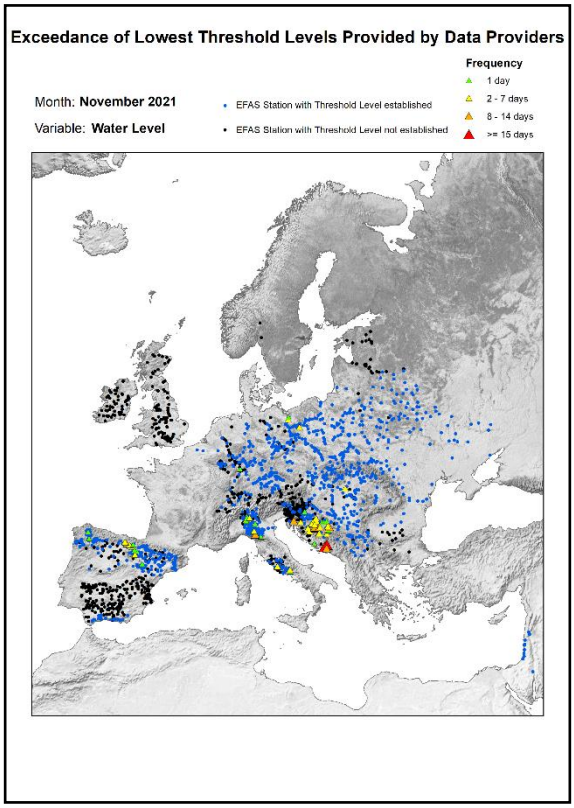


Figure 23: Lowest threshold exceedance for November 2021.

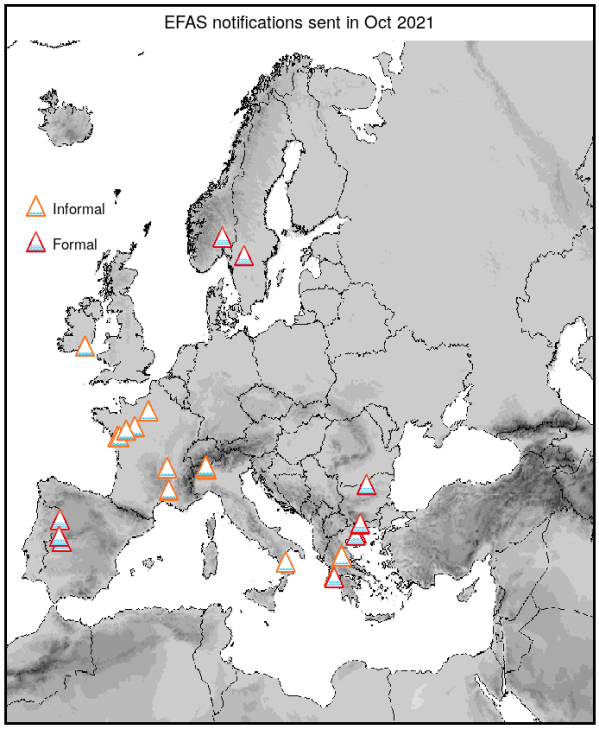


Figure 24: EFAS flood notifications sent for October 2021.

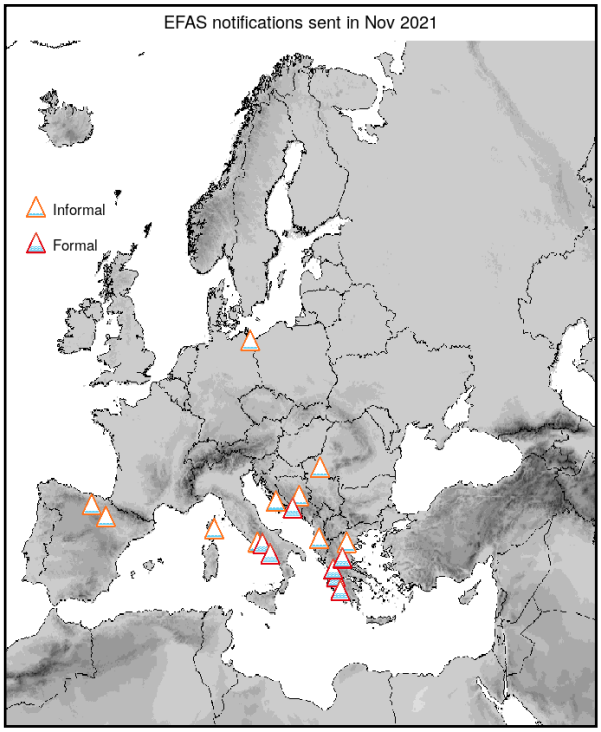


Figure 26: EFAS flood notifications sent for November 2021.

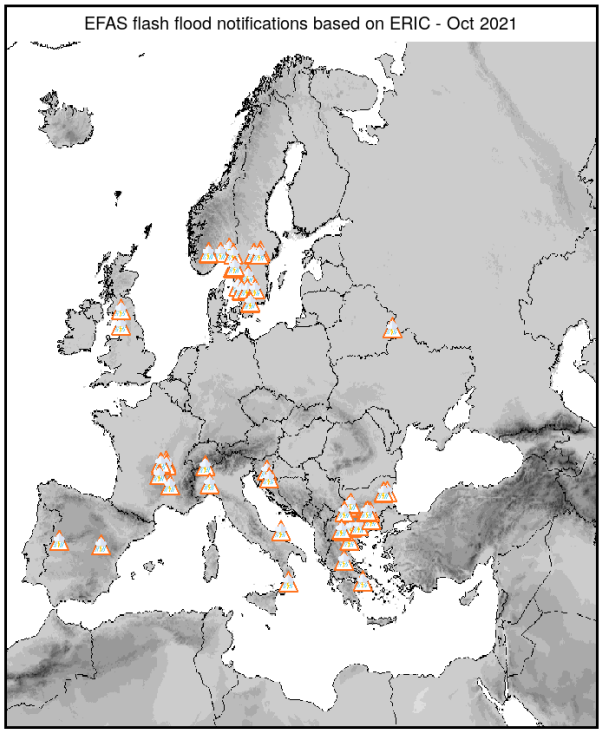


Figure 25: Flash flood notifications sent for October 2021.

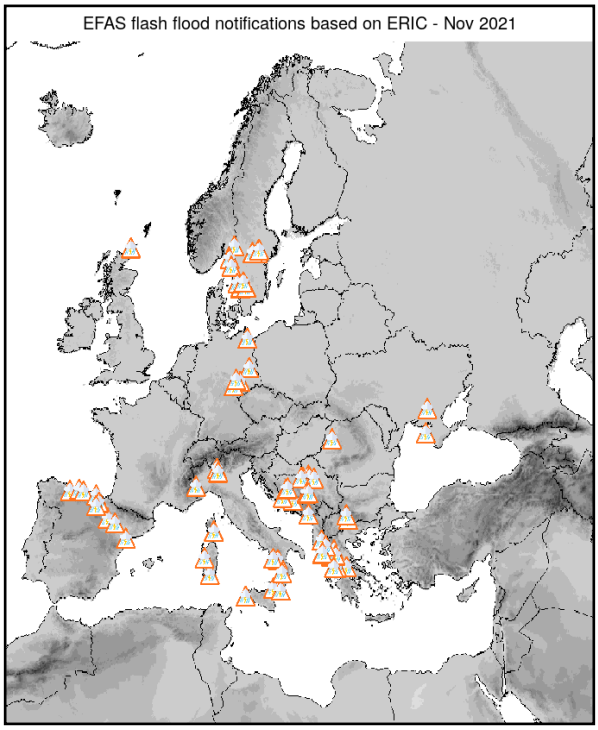


Figure 27: Flash flood notifications sent for November 2021.

## Appendix - tables

**Table 1: EFAS flood notifications sent in October – November 2021**

| Type | Forecast date | Issue date | Lead time | River | Country |
|---|---|---|---|---|---|
| Informal | 30/09/2021 12UTC | 01/10/2021 | 60 | La Goulaine | France |
| Informal | 30/09/2021 12UTC | 01/10/2021 | 60 | La Sevre Nantaise | France |
| Formal | 01/10/2021 00UTC | 01/10/2021 | 60 | Dokka | Norway |
| Informal | 01/10/2021 00UTC | 01/10/2021 | 48 | Huisne | France |
| Informal | 01/10/2021 12UTC | 02/10/2021 | 42 | Mayenne | France |
| Informal | 02/10/2021 00UTC | 02/10/2021 | 54 | Loire | France |
| Informal | 02/10/2021 00UTC | 02/10/2021 | 30 | Epte | France |
| Informal | 02/10/2021 00UTC | 02/10/2021 | 42 | Ardèche | France |
| Informal | 03/10/2021 00UTC | 03/10/2021 | 42 | Ticino | Italy |
| Informal | 03/10/2021 12UTC | 04/10/2021 | 24 | Lago di Mergozzo | Italy |
| Formal | 03/10/2021 12UTC | 04/10/2021 | 54 | Gota alv | Sweden |
| Informal | 07/10/2021 00UTC | 07/10/2021 | 18 | Pineios | Greece |
| Formal | 10/10/2021 12UTC | 11/10/2021 | 66 | Yantra | Bulgaria |
| Formal | 10/10/2021 12UTC | 11/10/2021 | 18 | Strimonas | Greece |
| Formal | 11/10/2021 12UTC | 12/10/2021 | 78 | Nestos | Greece |
| Formal | 11/10/2021 12UTC | 12/10/2021 | 24 | Coastal Catchment Eastern | Greece |
| Informal | 13/10/2021 00UTC | 13/10/2021 | 30 | Pineios | Greece |
| Informal | 13/10/2021 12UTC | 14/10/2021 | 24 | Acheloos | Greece |
| Formal | 13/10/2021 12UTC | 14/10/2021 | 24 | Acheloos | Greece |
| Informal | 14/10/2021 00UTC | 14/10/2021 | 6 | Coastal Catchment Eastern | Greece |
| Informal | 14/10/2021 12UTC | 15/10/2021 | 12 | Nestos | Greece |
| Informal | 23/10/2021 12UTC | 24/10/2021 | 30 | Coastal zone | Italy |
| Formal | 25/10/2021 12UTC | 26/10/2021 | 102 | Tietar | Spain |
| Formal | 26/10/2021 12UTC | 27/10/2021 | 114 | Duero | Spain |
| Formal | 26/10/2021 12UTC | 27/10/2021 | 114 | Tajo | Spain |
| Informal | 27/10/2021 12UTC | 28/10/2021 | 12 | Suir | Ireland |
| Formal | 31/10/2021 12UTC | 01/11/2021 | 66 | Volturno | Italy |
| Formal | 31/10/2021 12UTC | 01/11/2021 | 84 | Trebizat | Bosnia And |
| Informal | 01/11/2021 00UTC | 01/11/2021 | 60 | Coastal zone | Italy |
| Informal | 02/11/2021 00UTC | 02/11/2021 | 48 | Krka | Croatia |
| Informal | 03/11/2021 00UTC | 03/11/2021 | 48 | Bosna | Bosnia And |
| Informal | 04/11/2021 00UTC | 04/11/2021 | 36 | Tamis | Serbia |
| Informal | 05/11/2021 00UTC | 05/11/2021 | 18 | Coastal zone | Germany |
| Informal | 08/11/2021 12UTC | 09/11/2021 | 36 | TAVIGNANO | France |
| Formal | 22/11/2021 12UTC | 23/11/2021 | 30 | Acheloos | Greece |
| Formal | 24/11/2021 12UTC | 25/11/2021 | 54 | Sele | Italy |
| Formal | 26/11/2021 12UTC | 27/11/2021 | 36 | Pineios | Greece |
| Formal | 26/11/2021 12UTC | 27/11/2021 | 36 | Alfeios | Greece |
| Informal | 26/11/2021 12UTC | 27/11/2021 | 48 | Nela | Spain |
| Informal | 26/11/2021 12UTC | 27/11/2021 | 72 | Ebro | Spain |
| Formal | 26/11/2021 12UTC | 27/11/2021 | 54 | Arachthos | Greece |
| Informal | 28/11/2021 00UTC | 28/11/2021 | 18 | Shkumbin | Albania |
| Informal | 29/11/2021 00UTC | 29/11/2021 | 24 | Aliakmonas | Greece |

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

**Table 2: EFAS flash flood notifications sent in October – November 2021**

| Type | Forecast date | Issue date | Lead time | Region | Country |
|---|---|---|---|---|---|
| Flash Flood | 01/10/2021 00UTC | 01/10/2021 | 30 | Ostfold | Norway |
| Flash Flood | 02/10/2021 00UTC | 02/10/2021 | 42 | Allier | France |
| Flash Flood | 02/10/2021 00UTC | 02/10/2021 | 48 | Vestfold | Norway |
| Flash Flood | 02/10/2021 00UTC | 02/10/2021 | 48 | Loire | France |
| Flash Flood | 02/10/2021 00UTC | 02/10/2021 | 36 | Telemark | Norway |
| Flash Flood | 02/10/2021 00UTC | 02/10/2021 | 48 | Orebro lan | Sweden |
| Flash Flood | 02/10/2021 00UTC | 02/10/2021 | 48 | Vastmanlands lan | Sweden |
| Flash Flood | 02/10/2021 00UTC | 02/10/2021 | 48 | Saone-et-Loire | France |
| Flash Flood | 02/10/2021 00UTC | 02/10/2021 | 42 | Puy-de-Dome | France |
| Flash Flood | 02/10/2021 00UTC | 02/10/2021 | 42 | Haute-Loire | France |
| Flash Flood | 02/10/2021 12UTC | 03/10/2021 | 30 | Vastra Gotalands lan | Sweden |
| Flash Flood | 03/10/2021 00UTC | 03/10/2021 | 24 | Varmlands lan | Sweden |
| Flash Flood | 03/10/2021 12UTC | 04/10/2021 | 36 | Piemonte | Italy |
| Flash Flood | 04/10/2021 00UTC | 04/10/2021 | 24 | Lombardia | Italy |
| Flash Flood | 04/10/2021 12UTC | 05/10/2021 | 36 | Jonkopings lan | Sweden |
| Flash Flood | 04/10/2021 12UTC | 05/10/2021 | 36 | Hallands lan | Sweden |
| Flash Flood | 04/10/2021 12UTC | 05/10/2021 | 42 | Vastmanlands lan | Sweden |
| Flash Flood | 05/10/2021 00UTC | 05/10/2021 | 30 | Orebro lan | Sweden |
| Flash Flood | 05/10/2021 12UTC | 06/10/2021 | 48 | Jugovzhodna Slovenija | Slovenia |
| Flash Flood | 06/10/2021 00UTC | 06/10/2021 | 48 | Karlovacka zupanija | Croatia |
| Flash Flood | 07/10/2021 00UTC | 07/10/2021 | 48 | Puglia | Italy |
| Flash Flood | 10/10/2021 00UTC | 10/10/2021 | 30 | Thessalia | Greece |
| Flash Flood | 11/10/2021 12UTC | 12/10/2021 | 30 | Shumen | Bulgaria |
| Flash Flood | 11/10/2021 12UTC | 12/10/2021 | 30 | Varna | Bulgaria |
| Flash Flood | 12/10/2021 12UTC | 13/10/2021 | 48 | Bryansk | Russia |
| Flash Flood | 13/10/2021 12UTC | 14/10/2021 | 42 | Blagoevgrad | Bulgaria |
| Flash Flood | 13/10/2021 12UTC | 14/10/2021 | 42 | Sofia | Bulgaria |
| Flash Flood | 13/10/2021 12UTC | 14/10/2021 | 42 | Jugoistocen | N. Macedonia |
| Flash Flood | 13/10/2021 12UTC | 14/10/2021 | 36 | Sofia (stolitsa) | Bulgaria |
| Flash Flood | 13/10/2021 12UTC | 14/10/2021 | 42 | Kentriki Makedonia | Greece |
| Flash Flood | 13/10/2021 12UTC | 14/10/2021 | 48 | Attiki | Greece |
| Flash Flood | 14/10/2021 00UTC | 14/10/2021 | 42 | Haskovo | Bulgaria |
| Flash Flood | 14/10/2021 00UTC | 14/10/2021 | 42 | Anatoliki Makedonia, | Greece |
| Flash Flood | 14/10/2021 00UTC | 14/10/2021 | 24 | Pernik | Bulgaria |
| Flash Flood | 14/10/2021 00UTC | 14/10/2021 | 42 | Plovdiv | Bulgaria |
| Flash Flood | 14/10/2021 00UTC | 14/10/2021 | 42 | Kardzhali | Bulgaria |
| Flash Flood | 14/10/2021 00UTC | 14/10/2021 | 42 | Stara Zagora | Bulgaria |
| Flash Flood | 15/10/2021 00UTC | 15/10/2021 | 24 | Vardarski | N. Macedonia |
| Flash Flood | 18/10/2021 12UTC | 19/10/2021 | 48 | Hallands lan | Sweden |
| Flash Flood | 18/10/2021 12UTC | 19/10/2021 | 48 | Vastra Gotalands lan | Sweden |
| Flash Flood | 19/10/2021 12UTC | 20/10/2021 | 48 | Jonkopings lan | Sweden |
| Flash Flood | 20/10/2021 00UTC | 20/10/2021 | 36 | Skane lan | Sweden |
| Flash Flood | 20/10/2021 00UTC | 20/10/2021 | 36 | Kronobergs lan | Sweden |
| Flash Flood | 24/10/2021 00UTC | 24/10/2021 | 42 | Calabria | Italy |
| Flash Flood | 26/10/2021 00UTC | 26/10/2021 | 48 | Vastra Gotalands lan | Sweden |

| | | | | | |
|---|---|---|---|---|---|
| Flash Flood | 26/10/2021 00UTC | 26/10/2021 | 48 | Cumbria | United Kingdom |
| Flash Flood | 26/10/2021 12UTC | 27/10/2021 | 48 | Southern Scotland | United Kingdom |
| Flash Flood | 30/10/2021 00UTC | 30/10/2021 | 48 | Caceres | Spain |
| Flash Flood | 30/10/2021 00UTC | 30/10/2021 | 12 | Cuenca | Spain |
| Flash Flood | 30/10/2021 00UTC | 30/10/2021 | 24 | Telemark | Norway |
| Flash Flood | 30/10/2021 00UTC | 30/10/2021 | 30 | Ardeche | France |
| Flash Flood | 01/11/2021 12UTC | 02/11/2021 | 48 | Vastmanlands lan | Sweden |
| Flash Flood | 01/11/2021 12UTC | 02/11/2021 | 48 | Orebro lan | Sweden |
| Flash Flood | 02/11/2021 12UTC | 03/11/2021 | 48 | Federacija Bosna i | Bosnia And |
| Flash Flood | 02/11/2021 12UTC | 03/11/2021 | 48 | Splitsko-dalmatinska | Croatia |
| Flash Flood | 03/11/2021 00UTC | 03/11/2021 | 48 | Region Vojvodine | Serbia |
| Flash Flood | 03/11/2021 00UTC | 03/11/2021 | 42 | Republika Srpska | Bosnia And |
| Flash Flood | 03/11/2021 00UTC | 03/11/2021 | 48 | Region Sumadije i Zapadne | Serbia |
| Flash Flood | 03/11/2021 00UTC | 03/11/2021 | 30 | Lombardia | Italy |
| Flash Flood | 04/11/2021 00UTC | 04/11/2021 | 36 | Beogradska oblast | Serbia |
| Flash Flood | 04/11/2021 00UTC | 04/11/2021 | 24 | Mecklenburg- | Germany |
| Flash Flood | 04/11/2021 00UTC | 04/11/2021 | 36 | Brcko | Bosnia And |
| Flash Flood | 04/11/2021 00UTC | 04/11/2021 | 30 | Brandenburg | Germany |
| Flash Flood | 04/11/2021 00UTC | 04/11/2021 | 36 | Vukovarsko-srijemska | Croatia |
| Flash Flood | 04/11/2021 00UTC | 04/11/2021 | 30 | Leipzig | Germany |
| Flash Flood | 04/11/2021 00UTC | 04/11/2021 | 30 | Sachsen-Anhalt | Germany |
| Flash Flood | 04/11/2021 00UTC | 04/11/2021 | 24 | Thuringen | Germany |
| Flash Flood | 04/11/2021 12UTC | 05/11/2021 | 24 | Bihor | Romania |
| Flash Flood | 05/11/2021 00UTC | 05/11/2021 | 24 | Republika Srpska | Bosnia And |
| Flash Flood | 05/11/2021 00UTC | 05/11/2021 | 24 | Zlatiborska oblast | Serbia |
| Flash Flood | 05/11/2021 00UTC | 05/11/2021 | 48 | Vastra Gotalands lan | Sweden |
| Flash Flood | 05/11/2021 00UTC | 05/11/2021 | 48 | Jonkopings lan | Sweden |
| Flash Flood | 05/11/2021 12UTC | 06/11/2021 | 48 | Vastmanlands lan | Sweden |
| Flash Flood | 05/11/2021 12UTC | 06/11/2021 | 48 | Varmlands lan | Sweden |
| Flash Flood | 05/11/2021 12UTC | 06/11/2021 | 48 | Hallands lan | Sweden |
| Flash Flood | 05/11/2021 12UTC | 06/11/2021 | 48 | Orebro lan | Sweden |
| Flash Flood | 06/11/2021 12UTC | 07/11/2021 | 18 | Ostfold | Norway |
| Flash Flood | 07/11/2021 00UTC | 07/11/2021 | 48 | Federacija Bosna i | Bosnia And |
| Flash Flood | 08/11/2021 00UTC | 08/11/2021 | 48 | Vastra Gotalands lan | Sweden |
| Flash Flood | 08/11/2021 12UTC | 09/11/2021 | 48 | Hallands lan | Sweden |
| Flash Flood | 08/11/2021 12UTC | 09/11/2021 | 48 | Sicilia | Italy |
| Flash Flood | 08/11/2021 12UTC | 09/11/2021 | 42 | Vastmanlands lan | Sweden |
| Flash Flood | 08/11/2021 12UTC | 09/11/2021 | 42 | Orebro lan | Sweden |
| Flash Flood | 11/11/2021 00UTC | 11/11/2021 | 24 | Haute-Corse | France |
| Flash Flood | 11/11/2021 00UTC | 11/11/2021 | 24 | Corse-du-Sud | France |
| Flash Flood | 13/11/2021 12UTC | 14/11/2021 | 30 | Lombardia | Italy |
| Flash Flood | 14/11/2021 12UTC | 15/11/2021 | 30 | Piemonte | Italy |
| Flash Flood | 15/11/2021 12UTC | 16/11/2021 | 24 | Sardegna | Italy |
| Flash Flood | 16/11/2021 00UTC | 16/11/2021 | 36 | Sicilia | Italy |
| Flash Flood | 19/11/2021 00UTC | 19/11/2021 | 36 | Highlands and Islands | United Kingdom |
| Flash Flood | 19/11/2021 00UTC | 19/11/2021 | 48 | Vastra Gotalands lan | Sweden |
| Flash Flood | 19/11/2021 00UTC | 19/11/2021 | 48 | Jonkopings lan | Sweden |
| Flash Flood | 19/11/2021 00UTC | 19/11/2021 | 48 | Hallands lan | Sweden |
| Flash Flood | 22/11/2021 00UTC | 22/11/2021 | 36 | Tarragona | Spain |
| Flash Flood | 22/11/2021 00UTC | 22/11/2021 | 42 | Navarra | Spain |
| Flash Flood | 22/11/2021 00UTC | 22/11/2021 | 42 | Zaragoza | Spain |

| | | | | | |
|---|---|---|---|---|---|
| Flash Flood | 23/11/2021 12UTC | 24/11/2021 | 36 | Asturias | Spain |
| Flash Flood | 23/11/2021 12UTC | 24/11/2021 | 24 | Sterea Ellada | Greece |
| Flash Flood | 24/11/2021 00UTC | 24/11/2021 | 48 | Calabria | Italy |
| Flash Flood | 24/11/2021 00UTC | 24/11/2021 | 48 | Jonkopings lan | Sweden |
| Flash Flood | 24/11/2021 12UTC | 25/11/2021 | 24 | Vastra Gotalands lan | Sweden |
| Flash Flood | 25/11/2021 12UTC | 26/11/2021 | 48 | Calabria | Italy |
| Flash Flood | 25/11/2021 12UTC | 26/11/2021 | 48 | Campania | Italy |
| Flash Flood | 26/11/2021 12UTC | 27/11/2021 | 42 | Cantabria | Spain |
| Flash Flood | 26/11/2021 12UTC | 27/11/2021 | 42 | Asturias | Spain |
| Flash Flood | 27/11/2021 00UTC | 27/11/2021 | 48 | Ipeiros | Greece |
| Flash Flood | 27/11/2021 00UTC | 27/11/2021 | 42 | Crna Gora | Montenegro |
| Flash Flood | 27/11/2021 00UTC | 27/11/2021 | 48 | Sterea Ellada | Greece |
| Flash Flood | 27/11/2021 12UTC | 28/11/2021 | 48 | Sardegna | Italy |
| Flash Flood | 27/11/2021 12UTC | 28/11/2021 | 30 | Thessalia | Greece |
| Flash Flood | 27/11/2021 12UTC | 28/11/2021 | 30 | Dytiki Makedonia | Greece |
| Flash Flood | 28/11/2021 00UTC | 28/11/2021 | 24 | Gjirokaster | Albania |
| Flash Flood | 28/11/2021 00UTC | 28/11/2021 | 24 | Elbasan | Albania |
| Flash Flood | 28/11/2021 00UTC | 28/11/2021 | 30 | Bizkaia | Spain |
| Flash Flood | 28/11/2021 00UTC | 28/11/2021 | 24 | Korce | Albania |
| Flash Flood | 28/11/2021 00UTC | 28/11/2021 | 30 | Araba/Alava | Spain |
| Flash Flood | 28/11/2021 00UTC | 28/11/2021 | 24 | Vlore | Albania |
| Flash Flood | 28/11/2021 00UTC | 28/11/2021 | 30 | Burgos | Spain |
| Flash Flood | 28/11/2021 00UTC | 28/11/2021 | 36 | Blagoevgrad | Bulgaria |
| Flash Flood | 28/11/2021 00UTC | 28/11/2021 | 42 | Kyustendil | Bulgaria |
| Flash Flood | 28/11/2021 12UTC | 29/11/2021 | 24 | Kherson | Ukraine |
| Flash Flood | 29/11/2021 00UTC | 29/11/2021 | 30 | Dytiki Ellada | Greece |
| Flash Flood | 29/11/2021 00UTC | 29/11/2021 | 48 | Crimea | Ukraine |
| Flash Flood | 29/11/2021 00UTC | 29/11/2021 | 24 | Calabria | Italy |

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

**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), 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 GROW 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 ERCC.
A Spanish consortium (REDIAM and SOOLOGIC) has been awarded the contract for the EFAS Hydrological data collection centre. They are responsible for collecting discharge and water level data across Europe.
A German consortium (KISTERS and DWD) has been awarded the contract for the EFAS Meteorological data collection centre. They are responsible for collecting the meteorological data needed to run EFAS over Europe.
Finally, the JRC is responsible for the overall project management related to EFAS and further development of the system.

## Contact details:

European Centre for Medium-Range Weather Forecasts (ECMWF)
Shinfield Park, Reading,
RG2 9AX, UK

Tel: +44-118-9499-303
Fax: +44-118-9869-450
Email: comp@efas.eu

www.efas.eu
www.ecmwf.int