European Flood Awareness System

EFAS *Bulletin*

June – July 2021

Issue 2021(4)

NEWS

New features

Job opportunity – Full Stack Web Developer for Environmental Forecasts

Figure 1: Job opportunity - Full Stack Web Developer for Environmental Forecasts

ECMWF has published a vacancy for a Full Stack Web Developer for Environmental Forecasts. The role of this position is to maintain and further develop the CEMS-Floods web applications (EFAS and GloFAS) with a focus on the back-end aspects while liaising frequently with front-end developers from other teams.

The successful candidate will participate in the design of new features, bringing their experience in web design and ensure that any new developments are smoothly integrated into the ECMWF operational environment. All the components are using Docker containers technology deployed on a Kubernetes cluster. Previous experience in Python, Django, RESTful web services, and GIS tools are essential. Application deadline: **31 August 2021.** Click the links to find more information on the job description and how to apply.

CEMS MDCC integrated meteorological station data

In June 2021, the CEMS MDCC team integrated the meteorological station data from three providers into the operational processing routines.

Lazio's Agenzia Regionale Di Protezione Civile delivers precipitation, temperature, relative air humidity, solar radiation, as well as wind speed and direction data on a high temporal resolution. Depending on the parameter, data from 8 (solar radiation) up to 196 (precipitation) stations are loaded into the CEMS MDCC database.

The data are processed and included into the gridded precipitation, temperature, solar radiation and wind speed fields produced every day in the early morning as input for EFAS forecasts as well as for EFFIS.

Figure 2: Stations from Agenzia Regionale DI Protezione Civile in Lazio, Italy

OMSZ provides precipitation, temperature, relative air humidity, solar radiation, as well as wind speed and direction data on a 10-minute basis. Depending on the parameter, data for 136 stations are loaded into the CEMS MDCC database.

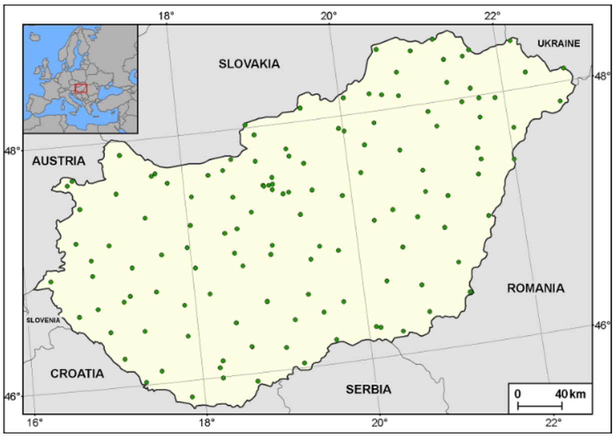


Figure 3: Stations from OMSZ in Hungary

SMC provides precipitation, temperature, relative air humidity, solar radiation, as well as wind speed and direction data on a 30-minute basis. Depending on the parameter data from 92 (wind speed) up to 185 (precipitation) stations are loaded into the CEMS MDCC database.

Figure 4: Stations from Servei Meteorològic de Catalunya (Spain)

CEMS MDCC would like to thank Lazio's Agenzia Regionale Di Protezione Civile (Italy), Hungarian Meteorological Service (OMSZ), and Servei Meteorològic de Catalunya (Spain) very much for providing their data and for helping to resolve questions from their data users.

RESULTS

Summary of EFAS Flood and Flash Flood Notifications

The 22 formal and 35 informal EFAS flood notifications issued in June - July are summarised in Table 1. The locations of all notifications are shown in Figure 30 and Figure 32 in the appendix.

109 Flash flood notifications were issued in June - July. They are summarised in Table 2. The locations of all notifications are shown in Figure 31 and Figure 33 in the appendix.

Meteorological situation

by EFAS Meteorological Data Collection Centre

June

June 2021 was characterized by higher than normal mean sea surface pressure nearly everywhere in the EFAS domain except around the Black Sea, Iceland, the Iberian Peninsula, and northwest Africa, where it was slightly below the long-term mean. Monthly precipitation totals were below the long-term mean at Iceland, Great Britain and Ireland, around the Baltic Sea, north of the central and in the southern and eastern Mediterranean region, and around or above normal elsewhere in the EFAS domain. The monthly mean air temperature was above normal nearly everywhere in the EFAS domain except around the Black Sea and the eastern Mediterranean region and in parts of the Iberian Peninsula and northwest Africa.

In the beginning of June, high pressure occurred in the majority of the EFAS domain with mostly undefined circulation patterns. A weak upper-level low-pressure system occurred over the Black Sea associated with intense precipitation. The situation with weak near-surface pressure gradients remained for the first decade of June, even if some weak low-pressure systems reached Iceland. Weak upper-level troughs with an unstable layer triggered partly very heavy, convective rain, primarily over central Europe. By nature of convective precipitation, some locations were hit several times and others received no rain at all. With the start of June's second decade, a low-pressure system moved from the Atlantic Ocean via Iceland to Scandinavia. A steep trough developed over the Baltic, was cut off and the resulting upper-level low-pressure system moved to the Aegean Sea. Another low-pressure system followed on a similar track but moved to the Norwegian Sea. The upper-level low-pressure system moved from the Aegean Sea to the Black Sea, while precipitation intensified. An old and weak upper-level low-pressure system was reactivated westward of the Iberian Peninsula and caused continuous rain there. A low-pressure system moved from the Atlantic southward of Iceland to the Norwegian Sea, while from the corresponding upper-level trough a low-pressure system was cut-off westward of the Iberian Peninsula. A weak low-pressure system moved from the Atlantic Ocean to the Bay of Biscay. The near-surface system vanished while the upper-level part formed a weak system over western Europe. An upper-level low-pressure system was dripped off over Great Britain and Ireland from a system located over the Norwegian Sea. It moved via the Bay of Biscay to central Europe and triggered again heavy precipitation till the end of the month.

In June 2021, the highest precipitation totals were observed in western and central Europe and north of the Black Sea (Figure 16). No or almost no precipitation fell in the African and Middle East parts of the EFAS domain. Monthly precipitation totals above the long-term mean occurred from the Iberian Peninsula to western-central Europe, around the Black Sea and in parts of eastern Europe, Scandinavia as well as northwest Africa (Figure 17). Monthly totals below the long-term mean were reported over northeast Africa and the Middle East, eastern Europe, southern Scandinavia, Great Britain and Ireland, Iceland as well as in the central Mediterranean Region towards the western Carpathian Mountains.

The monthly mean air temperature ranged from -4.4°C to 38.9°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 20). Air temperature anomalies ranged from -8.3°C to 11.9°C (Figure 21). Monthly mean air temperatures below the long-term mean occurred in northwest Africa along the Atlantic coast, at the Iberian Peninsula, Iceland, east of the Ural Mountains, around the Black Sea, and the eastern shore of the Mediterranean Sea, while positive temperature anomalies appeared in the remaining part of the EFAS domain.

July

July 2021 was characterized by recurring severe weather, causing many as well as extreme floods. Around normal mean sea surface pressure appeared nearly everywhere across the EFAS domain. Slightly lower than normal mean sea surface pressure occurred southwest of Great Britain and Ireland, whereas higher than normal sea surface pressure was observed around Scandinavia and eastern Europe. Monthly precipitation totals were above the long-term mean in central and western Europe as well as around the Black Sea and below normal over the remaining part of the EFAS domain. The monthly mean air temperature was lower than the mean in the northeast of the EFAS domain and western Europe and higher than the mean over the rest of the EFAS domain.

At the beginning of July, a low-pressure system was located north of the Azores. Another low-pressure system was situated over the southern Baltic Sea and a high-pressure system over the Norwegian Sea. The high-pressure system moved to Northern Scandinavia, while the low-pressure system vanished at the surface, but remained in the upper levels and moved eastward. Due to the unstable atmospheric stratification, many heavy precipitation events were triggered (this applies also to the other low-pressure systems mentioned below). The above-mentioned low-pressure system moved from the Atlantic Ocean to Great Britain and Ireland. It was associated with an upper-level trough, which swung eastwards and triggered many severe thunderstorms at its eastern edge. In the meantime, the high-pressure system moved from Scandinavia to western Russia. While this high-pressure system weakened, several upper-level low-pressure systems moved from the Atlantic Ocean to western and central Europe. Some days earlier, a low-pressure system developed over northern Canada. It moved via the Atlantic Ocean and the Bay of Biscay to central Europe, causing severe floods in these regions, and later shifted further towards the Balkans, also associated with severe weather also there. In the same days, the Azores High moved to Great Britain and Ireland and a low-pressure system moved from the Greenland Sea to the Arctic Ocean. The high-pressure system weakened but extended eastwards to central and eastern Europe. While the high-pressure system moved eastward, a low-pressure system moved from the Atlantic Ocean via the Bay of Biscay to the North Sea. It weakened and merged with another low-pressure system from the Atlantic Ocean over Great Britain and Ireland. It split into two cores, one moved via southern Scandinavia to the northern Baltic Sea by the end of the month. The other and smaller core remained at Great Britain and Ireland and moved later across the North Sea to southern Scandinavia. Furthermore, the Azores High was around its usual position by the end of July. The African and south-eastern parts of the EFAS domain were characterized by high pressure with weak gradients over the whole month.

The highest precipitation totals were observed in the Alps and over central Europe (Figure 18). No or almost no precipitation fell around the Mediterranean Sea, as well as in the African and Middle Eastern parts of the EFAS domain. Monthly precipitation totals above the long-term mean occurred in western and central Europe, around the Black Sea, and in southern

Scandinavia (Figure 19). Monthly totals below the long-term mean were reported over the Iberian Peninsula, Iceland, Northern Scandinavia, the eastern part of eastern Europe, and around the Mediterranean Sea.

The monthly mean air temperature ranged from -0.9°C to 39.2°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 22). Air temperature anomalies ranged from -10.7°C to 8.7°C (Figure 23). Monthly mean air temperatures below the long-term mean occurred in western and central Europe as well as in the north-eastern part of the EFAS domain, while positive temperature anomalies appeared in the remaining part of the EFAS domain.

Hydrological situation

by EFAS Hydrological Data Collection Centre

June

In June, the highest concentration of stations that exceeded their first threshold level is between Switzerland, Italy, Austria, and southern Germany (mainly on the Rhine), the Po, and the western Danube basins. In a more dispersed way, along the Danube basin, there are exceedances in Hungary, Romania, Ukraine, Croatia, Slovenia, and Kosovo. In eastern Europe, the Dnieper river basin stands out with 9 stations overpassing thresholds. A lower concentration of stations can be observed in northern Norway and Sweden, in Iceland, in eastern Spain (around the Jucar basin and in Catalonia), and at last in central Italy (Tiber and Garibliano basins).

Regarding stations registering values above the 90% quantile, 120 stations exceeded this value in June. The vast majority of these stations were located in central Europe, where the Danube basin stands out with nearly 30% of the total stations exceeding the 90% quantile. These are located through Germany, Austria, Czech Republic, Slovakia, Ukraine, Hungary, Romania, Bulgaria, Serbia, Bosnia and Herzegovina, and Slovenia. Other basins with stations surpassing the 90% quantile in central Europe are Vistula, Oder, Elbe, Rhine, and Dnieper. Another considerable number of stations also surpassing the 90% quantile (just over 16%) can be found in Spain, mainly in the Ebro basin and the rest in stations scattered between different basins at the north, east, and south of the country. To a lesser degree, other stations above the 90% quantile are located in river basins in the Nordic countries (Norway, Sweden, Finland, and Iceland) and the British Isles (southern England and Ireland). A handful of stations over the 90% quantile occurred in several basins in France (Meuse, Seine, Loire, and Rhône) and isolated stations in the Maritsa/Evros basin (Bulgaria), Daugava basin (Latvia), Dniester basin (Ukraine), and Narva basin (Estonia).

At last, and focusing on those stations registering values below the 10% quantile, although they are quite dispersed throughout Europe, we can find nearly a third of them in Spain, along the Douro basin in the north, the Jucar basin in the east, and the Guadalquivir and Verde basins in the south. In Germany, we have 3 stations in the Elbe and Danube basins, 2 stations can be found in Belgium in the Scheldt and Meuse basins, and 2 more in France in the Garonne and Rhone basins. Finally, we can also find isolated stations with values under the 10% quantile in the Suir river (Ireland), Hvíta river (Iceland), Ryton river (England), Lagen river (Norway), Uzh river (Ukraine), and the Gothemsan river located on the Swedish island of Gotland.

July

In mid-July, several stations located in the Rhine river basin were affected by a sharp increase in their water flow, generating devastating floods that mainly affected Germany and Belgium. Of the 76 EFAS stations with threshold levels defined in the system and located in the Rhine river basin, 43 exceeded almost one of them, in Germany, Switzerland, and Austria and 25 of them maintained the overflow for more than 10 days. Other affected areas with exceedances in central Europe were the Danube, Elbe, Oder, and Po river basins (Germany, Austria, Slovenia, Croatia, Hungry, Slovakia, Poland, Czech Republic, and Serbia). A lower concentration of stations can be observed in northern Norway, Iceland, Ireland, eastern Spain (around the Jucar river basin and Catalonia), central Italy (Tiber and Garbliano basins), and western Ukraine and Belarus.

Regarding stations registering values above the 90% quantile, 286 stations exceeded this value in July - the record number of stations surpassing the 90% quantile so far this year. The vast majority of the stations (nearly 82%) are located in central Europe mainly in France, Germany, Switzerland, Belgium, and Czech Republic. These stations are monitoring the river basins of the Rhine (73), Rhône (36), Loire (31), Seine (29), Danube

(26), Elbe (14), Meuse, Dordogne, Garonne, Scheldt, Oder, and Orne. Another considerable number of stations also surpassing the 90% quantile can be found in Great Britain (mainly in the Thames basin). To a minor extent, values exceeding the 90% quantile can be found in stations in Spain: (south, east and north-western basins). To a lesser degree, other stations over their 90% quantile are in basins located in eastern Europe in the Dnieper basin (Ukraine) and in the Daugaba and Vistula basins (Belarus). Isolated stations exceeding the 90% quantile occurred in the Drnica and Badasevica basins (Slovenia) and in basins in Finland, Norway, and Iceland.

Finally, and focusing on those stations registering values below the 10% quantile (37 in total), the highest concentration of them can be found in two areas. Firstly, around the border between France and Spain (9 stations), specifically along the Ebro and Llobregat basins in Spain and the Garonne basin in France, and secondly in the southeast of Norway with 10 stations. A lower density of stations is present in Ukraine, along the Dnieper and Dniester basins (4 stations), in the Danube basin, where a number of 6 stations are spread around Austria, Hungary, Bosnia-Herzegovina and Serbia, and in Ireland (2 stations). At last, we can also find isolated stations with values under the 10% quantile in the Anllo river (Spain), Verde river (Spain), Muonio river (Finland), Lahn river (Germany), Muritz-Elde river (Germany), and the Notec river (Poland).

Verification

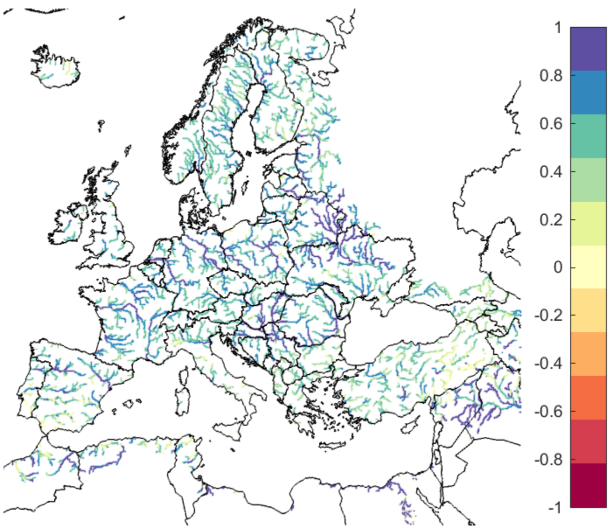


Figure 5: EFAS CRPSS at lead-time 1 day for June-July 2021, for catchments >2000km2. The reference score is persistence of using previous day's forecast.

Figure 5 and Figure 6 shows the EFAS headline score, the continuous ranked probability skill score (CRPSS) for lead times 1 and 5 days for June-July across the EFAS domain for catchments larger than 2000km2. 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.

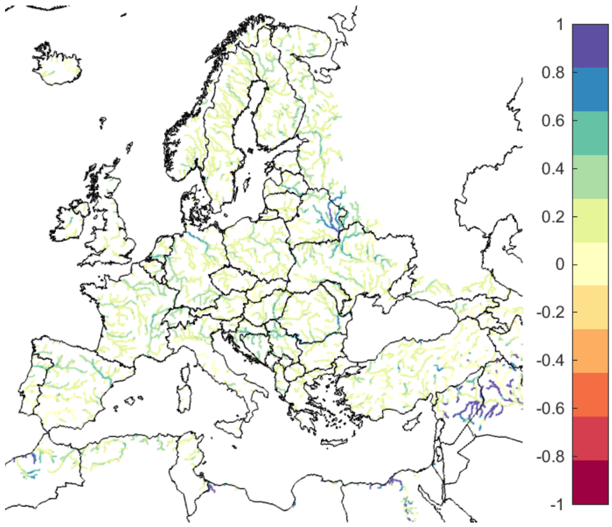


Figure 6. EFAS CRPSS at lead-time 5 days for June-July 2021 for catchments >2000km2. The reference score is persistence of using previous day's forecast.

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 7). 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.

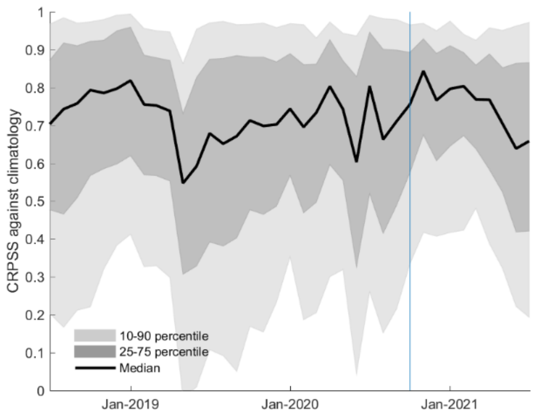


Figure 7. Monthly means of CRPSS the for lead-time 5 days for all the major river points in Europe with ECMWF ENS as forcing. Reference forecast was climatology. The skill is largest during the winter months, when there is less variation in the flow in large parts of Europe. The blue line indicates the release of EFAS 4.0.

ARTICLES

Widespread European Flooding, July 2021

by Richard Davies, floodlist

A series of summer storms and severe weather in Europe in July resulted in significant rainfall and flooding throughout the month. FloodList recorded over 40 flood events - both major and minor - in more than 135 locations across the continent.

Figure 8: Aerial photo of the flood in Oberpinzgau between Mittersill and Bramberg, Austria, 18 July 2021. Photo: Land Salzburg / Franz Wiese

As well as the catastrophic floods in Belgium, western Germany, Luxembourg, and the Netherlands, other significant flood events included those seen in southern Germany, Austria, and Switzerland; Crimea and Russia's Black Sea region; southeast England; northern Italy, and eastern Europe.

Southern Germany, Austria, and Switzerland: Just days after the flooding in the western states of North Rhine-Westphalia and Rhineland-Palatinate in Germany, flash floods swept through the southern state of Bavaria on 17 July. The district of Berchtesgadener Land declared a disaster.

Rivers broke their banks in parts of neighbouring northern Austria on the same day, causing widespread damage in several towns in the state of Salzburg.

Figure 9: Floods in Hallein, Salzburg, Austria, 18 July 2021. Photo: Land Salzburg

Parts of Switzerland saw dramatic flooding struck on 24 July when 26 mm of rain fell in just 10 minutes in Wolhusen in the district of Entlebuch, Lucerne Canton. Raging torrents of water swept vehicles along the streets of Wolhusen and dumped them into the Kleine Emme river below.

Black Sea: Areas along the Black Sea saw significant flooding from 03 to 06 July, including districts in the Crimea for the second time in 2 weeks and Russia's Krasnodar Region where 8 fatalities were reported. Officials said areas saw more than 2 months' worth of rain in a few hours. The city of Sochi saw yet more flooding on 23 July where 4 people lost their lives.

Southeast England: In the UK, the capital London and southeast England saw flash flooding from 10 to 12 July. The London Fire Brigade received more than 1,000 calls related to flooding.

More flooding struck in the city on 25 July. Vehicles were stranded on flooded roads, including on the M11 motorway, and several train stations were closed. UK's Met Office said St James Park in central London recorded 41.6 mm of rain on 25 July.

Figure 10: Floods in London 25 July 2021. Photo: London Fire Brigade

Northern Italy: Areas around Lake Como suffered landslides and flash floods after heavy rain flowed down slopes around the lake, causing significant material damages in the communes of Cernobbio, Brienno, Laglio, and Argegno in Como Province, Lombardy Region, on 27 July.

Figure 11: Flood damage in Como Province, Lombardy, Italy 27 July 2021. Photo: Government of Lombardy

Eastern Europe: In eastern Europe, stormy weather resulted in minor flooding in Poland throughout the month of July. Flooding was also reported in Czechia, Slovakia, Croatia, Serbia, and Romania where one 1 person died, and dozens were evacuated or rescued by emergency services from 15 to 20 July. The counties of Iași, Argeș, Neamț, and Alba were the worst affected areas.

For a comprehensive list of European flood events during July 2021 supplied by FloodList, we refer to the related news item on EFAS-IS

FAQs on EFAS and the information EFAS provided during the flood events affecting the Rhine and Meuse river basins

In view of the numerous questions received in relation to EFAS and the recent flood events affecting the Rhine and Meuse river basins, a Frequently Asked Questions document has been prepared outlining the main aim of EFAS and what information was provided by EFAS during these flood events.

What information did EFAS provide in relation to the recent flood events affecting the Rhine and Meuse river basins?

On 9 and 10 July, flood forecasts by the European Flood Awareness System (EFAS) of the Copernicus Emergency Management Service indicated a high probability of flooding for the Rhine River basin, affecting Switzerland and Germany.

The following day, subsequent forecasts also indicated a high risk of flooding for the Meuse River basin, affecting Belgium. The magnitude of the floods forecasted for the Rhine River basin increased significantly in this period.

The first EFAS notifications for the Rhine River basin were sent to the relevant national authorities starting on 10 July. The first EFAS notifications for the Meuse River basin were sent to the relevant national authorities starting on 12 July. With the continuously updated forecasts, more than 25 notifications were sent for specific regions of the Rhine and Meuse River basins in the following days until 14 July.

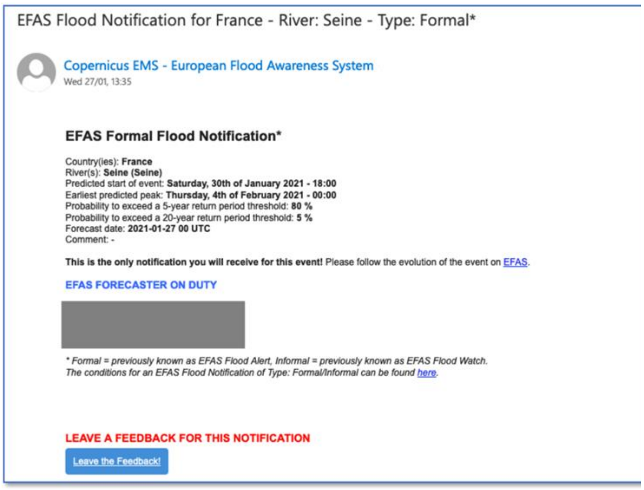
When, and on which basis does EFAS issue flood notifications?

EFAS produces twice-daily updated hydrological predictions for riverine and flash floods across Europe. These are analysed by trained hydrologists and, based on standardised criteria, EFAS flood forecast information, called 'EFAS flood notifications', are issued.

EFAS flood notifications are issued based on the type of flooding (e.g. riverine or flash flood), its probability of exceeding specific notification criteria (e.g. probability for the predicted river discharge to exceed a 5-year return period) and other criteria such as the size of the river.

What type of information is contained in EFAS flood notifications?

EFAS flood notifications contain an indication of the potentially affected larger region or river/tributary section and a very short and basic information on the predicted probabilities to exceed a certain flood return period. Furthermore, there is an advisory message to follow a link to access the more detailed, regularly updated flood forecast information displayed in the EFAS web portal. An example of a typical flood notification is shown below:



EFAS Flood Notification for France - River: Seine - Type: Formal*

Copernicus EMS - European Flood Awareness System
Wed 27/01, 13:35

EFAS Formal Flood Notification*

Country(ies): **France**
River(s): **Seine (Seine)**
Predicted start of event: **Saturday, 30th of January 2021 - 18:00**
Earliest predicted peak: **Thursday, 4th of February 2021 - 00:00**
Probability to exceed a 5-year return period threshold: **80 %**
Probability to exceed a 20-year return period threshold: **5 %**
Forecast date: **2021-01-27 00 UTC**
Comment: -

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

EFAS FORECASTER ON DUTY

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

LEAVE A FEEDBACK FOR THIS NOTIFICATION

Leave the Feedback!

What are the usual next steps after EFAS has sent a flood notification?

Once an EFAS notification has been received, the relevant national authority is advised to connect to the EFAS map viewer for a more detailed forecast information, and to analyse the situation together with the available national or local early warning information, to decide on the next actions.

Who receives EFAS flood notifications?

EFAS flood notifications are sent out to all the "EFAS partners" (see here for a list of EFAS partners: https://www.efas.eu/en/partners-list-0) in the potentially affected river basin and the European Response and Coordination Centre (ERCC), the heart of the EU Civil Protection Mechanism, in order to create early awareness on the high risk of flooding in the coming days. An 'EFAS partner' is any national, regional or local authority with a legal obligation to provide flood forecasting services or that has an institutional mandate in flood risk management within its territory. In the case of trans-national river basins, EFAS notifications are also shared with national authorities that might not be immediately affected by the forecasted flood (e.g. EFAS notifications for the German section of the Rhine are always also shared with the relevant Dutch and Belgian authorities). EFAS notifications related to flash floods are only sent to the relevant national or regional authority.

Are EFAS flood notifications available to the public?

EFAS notifications are not aimed at warning the public as the notifications contain expert information that should be combined with the relevant available national and local information to provide the best possible basis for decision making.

To respect the national competence for warnings and the single-one-voice warning principle, EFAS Flood notifications and other related forecast information cannot be shared publicly unless the relevant national authority decides to share the information.

Archived EFAS forecast data including an overview of EFAS flood notifications (example: https://www.efas.eu/en/notifications?field_month_value=05&field_year_value=2021) and a list of all flood notifications indicating the river section or region, the lead time, the forecast date and the main affected country are publicly available after 30 days. (example: https://www.efas.eu/sites/default/files/efasBulletins/2021/EFAS_Bimonthly_Bulletin_Apr_May2021_0.pdf)

Are EFAS Flood Notifications without any obligation?

Yes. EFAS notifications aim at providing complementary forecast information. The relevant national authority may or may not use the provided forecast information, and is likely to also take into account other information in deciding on any measures to be taken.

Does EFAS monitor what is being done after the notification has been issued?

EFAS monitors the flood situation but does not monitor actions taken by national authorities based on EFAS flood forecast information or national warning system information, as such actions fall outside EU competence.

Does EFAS request acknowledgement of receipt from the relevant authorities once a notification has been received?

Partners who receive an EFAS Flood notification are not requested to send acknowledgement of receipt. In a flood situation, forecasting and emergency response authorities are extremely busy with processing and integrating all relevant information coming from a variety of sources and usually only reply to notifications if further questions arise. Regular feedback on EFAS flood notifications is requested in the aftermath of an event to continuously adapt and improve the system.

Does EFAS forecast floods only for large rivers?

EFAS aims at predicting floods for large rivers and their tributaries but provides as well flash flood predictions for smaller scale rivers. In the case of the Meuse and Rhine river flood events both, predictions for the large scale river sections of the Rhine and Meuse as well as the flash flood predictions for many of the small scale tributaries of these river basins indicated a high probability of flooding or flash flooding, respectively.

Are EFAS forecasts precise and reliable?

EFAS does not make any claims as to the completeness of the information provided. On the contrary, EFAS forecasts are complementary to national warning and information systems, and it is the competence of national or regional / local competent authorities to draw the necessary conclusions from all available information.

EFAS is a European scale forecasting system that aims to provide additional forecast information at the larger scale (river basin wide, European scale) including flash floods and with longer forecast horizons then most national systems to raise early awareness about the risk of flooding. The reliability of EFAS forecasts are assessed using a number of different technical skill scores that are published and available on the website and the map viewer.

General info about EFAS, the Copernicus Emergency Management Service and early warning
What is EFAS?

The European Flood Awareness Systems (EFAS; www.efas.eu) of the Copernicus Emergency Management Service (CEMS; https://emergency.copernicus.eu/) is the first operational pan-European flood forecasting and monitoring system. EFAS provides a wide range of complementary early flood forecasting information based on models, satellite and in-situ data, to support national and regional authorities with flood risk management duties in arranging preparatory measures before an event strikes. In addition, EFAS provides a unique overview across Europe and neighbouring countries on currently observed and forecasted flood events.

Why and when was EFAS founded?

In 1999 the Joint Research Centre (JRC) of the European Commission started a research study for a European scale flood forecasting system (EFFS) in collaboration with national authorities and experts from different Member States.

The disastrous floods in Elbe and Danube rivers in 2002 confronted the European Commission with non-coherent flood warning information from different sources and of variable quality, complicating planning and organisation of aid. The EFFS, developed at the JRC, provided successfully ad-hoc simulations of the ongoing floods and a forecast on how the flood waves could be expected to travel down the Danube river.

In response to this event and following a Communication of the Commission on the Elbe and

Danube floods, the Joint Research Centre of the European Commission was assigned with the task to further develop EFFS into a fully operational, European-wide flood forecasting model. The first developments towards such a European Flood Awareness System (EFAS) were initiated in 2003, together with experts from Austria, Czech Republic, Germany, Hungary, and Slovakia and using forecasts from the German weather service.

In 2004 a collaboration agreement with ECMWF was signed, allowing the JRC to also incorporate ECMWF ensemble prediction data and its higher resolution deterministic forecast into EFAS in real-time.

From 2005 to 2010 EFAS was tested in real-time mode, together with the newly established EFAS partner network, consisting of national and regional flood forecasting authorities, and later also with the European Civil Protection.

In 2011 EFAS became part of the Copernicus Emergency Management Service initial operations and in support to European Civil Protection. The operational components have been outsourced to Member State organisations.

EFAS is running fully operational since autumn 2012.

What other services relevant for flood risk management are available under CEMS

The rapid mapping component of the Copernicus Emergency Management Service (CEMS) provides mapping products based on satellite imagery and is usually activated for a certain area by an authorised user (typically regional/national authority responsible for civil protection). For this event, the rapid mapping component of CEMS is providing critical flood maps and damage assessment since 13 July for the floods in Germany, Netherlands, Belgium and Switzerland. An EFAS based pre-tasking of the rapid mapping component was launched on 14th July for the Upper and Lower part of Rhine Basin and on 15th July for the Meuse River basin in order provide timely flood observations to the civil protection authorities. All mapping products can be found at this link: https://emergency.copernicus.eu/mapping/ems/copernicus-emergency-management-service-forecasts-notifies-and-monitors-devastating-floods

Who is responsible for preventing, preparing and responding to natural and man-made disasters in EU Member States?

The primary responsibility for preventing, preparing for (including early warning and public warning), and responding, to natural and man-made disasters lies with the Member States.

On what basis is the European Commission supporting Member States in the field of early warning?

Art. 8 (c) of the of the Regulation 2021/836 amending Decision No 1313/2013/EU on a Union Civil Protection Mechanism (UCPM) has attributed a mandate to the European Commission in the field of EWS to complement and support the work of the Member States developing, e.g. transnational detection and early warning systems, such as the European Flood Awareness System, mainly for transboundary floods.

Global Hydrological Workshop 2021

by Karen O'Regan, Ilias Pechlivanidis & Maria-Helena Ramos

Close to 600 people registered for the Joint Virtual Workshop on "Connecting global to local hydrological modelling and forecasting: scientific advances and challenges" which ran from 29 June 2021 to 01 July 2021. Attendance for the event was impressive – with over one thousand unique attendees viewing the livestreamed presentations on ECMWF's virtual event platform and over 70 attending each of the interactive poster sessions in gather.Town.

The sessions were headlined by six excellent keynote talks from our guest speakers on various subjects of interest to the wider hydrological community. We received submissions of nearly 100 abstracts on hydrology and related topics presented in poster format which described work ranging from global hydrology, earth observation and machine learning, to catchment-scale modelling and forecasting, with links to local decision making. Recordings of keynote talks and presentation slides can be viewed on the dedicated workshop webpage.

Figure 12: Participants of the Joint Virtual Workshop on Connecting global to local hydrological modelling and forecasting: scientific advances and challenges.

Irina Sandu (ECMWF) introduced the European Commission's Destination Earth (DestinE) programme. The programme aims to advance further the Earth system modelling across all scales. This is a key effort that will not only develop a high precision model of the Earth but also provides information to support sustainable development and environmental policy making. It is expected to include hydrological extremes (floods and droughts) for a better understanding of their drivers and impacts on building resilience under future climate conditions. Coordinated model development efforts between the atmosphere/land and hydrology communities are anticipated.

Wendy Parker (Virginia Tech) analysed the perspective of uncertainty communication within the hydrological modelling sphere, where large sets of ensembles are currently considered as a state-of-the-art. The keynote talk emphasised the need to change the way we view our models: from a mirror view, where models are perceived as faithful representations of the world and improving a model means adding detail and/or increasing fidelity, to a fit-for-purpose modelling view, where models are seen as representational tools that should be adequate/fit for a wide range of purposes of interest.

Liz Stephens (University of Reading) focused on the use of global forecasting for anticipatory humanitarian action, while highlighting the need to strengthen partnerships with local communities to improve the relevance and value of emergency management services. One of the main key messages delivered was that global forecasts can provide a consistent source of information to local authorities, with longer lead times and state-of-the art ensemble forecasts. However, on their own, they are not building national capacity. More work is needed to facilitate feedback from national hydrometeorological and engagement on systems' developments.

Micha Werner (IHE Delft) introduced a human-centred approach that more explicitly considers local needs, knowledge, and policy contexts, to evolve large-scale climate services and ensure their uptake for addressing users' challenges. With examples on water allocation, flash flood forecasting and rain-fed agriculture from all over the world, it was shown how different perspectives need to be considered when evaluating how good or how useful a forecast is. Listening to what local people have to say is as important as listening to our data and global models.

Louise Slater (University of Oxford) provided an overview of the recent developments with statistical models, including machine learning, and their applications to predict different hydroclimatic variables. She discussed the emergence of hybrid (dynamical/statistical) hydrological forecasting alongside traditional approaches and highlighted some potential strengths of hybrid forecasting; operational convenience (post-processing), learning from nonstationary predictors, reducing biases, combining sources of predictability. Remaining key challenges pointed out to data requirements, physical plausibility of model outputs and the assimilation of human influences in water systems.

Guy Schumann (University of Bristol) provided an overview of the advances in Earth Observation (EO) technologies and conveyed the opportunities EO advancements could offer to flood modelling and forecasting. The need to democratize availability, access and affordability of commercial EO data was highlighted. A call for action to the effective integration of the latest advances and capabilities of EO and Earth system modelling was issued towards, routinely evaluating flood forecasts, diagnosing forecast problems, and developing novel initialization, calibration, and post-processing procedures to deliver more skilful and reliable forecasts at longer lead times globally.

High quality research was also presented during the poster presentations, which covered six broad themes, from challenges and advances in modelling hydrologic variables at large scales (coupled water prediction systems), to catchment-scale hydrometeorological forecasting (nowcasting, short, medium and long ranges), monitoring, modelling and forecasting flood risk, and inundation mapping. Impact assessments and connections of large-scale water-cycle information to local needs, knowledge and decision making were also central to the workshop.

Several posters addressed challenges and new techniques on post-processing model outputs and evaluating forecast skill. The use of Earth Observations and data assimilation for hydrological forecasts and past reanalyses was explored as opportunities to better link global to local scales. The community has been investigating new methodologies and practices that clearly are a step beyond the current state-of-the-art. All posters presented during the workshop are available on the posters page of the workshop website. We strongly invite you to view the posters or directly contact the authors and initiate a fruitful scientific exchange of knowledge.

All interactive aspects including poster sessions, the Sci-Art event, CDS/CEMS/C3S information booths, and networking breaks were hosted on ECMWF's gather.Town platform. This method of hosting the workshop received much positive feedback from attendees, who enjoyed its game-like feel and 'natural' networking opportunities. One attendee stated: "*The workshop was really engaging. The 'virtual ECMWF' on Gather Town was a big hit. It allowed our hydrological community to interact at a more intensive level. The poster sessions felt very natural with people 'walking' past and many small group discussions were ignited. There was even an Early Career hangout room that again provided fantastic networking opportunities.*"

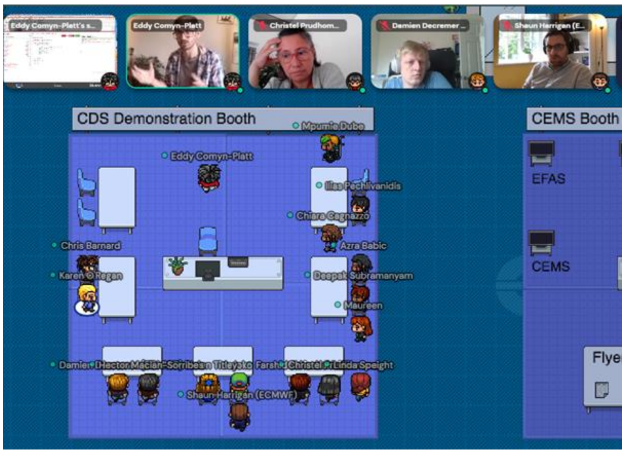


Figure 13: An interactive 'Activity Booth' demonstration of how to use datasets in the online processing suite, the CDS (Climate Data Store) Toolbox during the gather.Town session of the workshop.

The workshop was organised by a collaborative effort from the European Centre for Medium-range Weather Forecasts (ECMWF), the Copernicus Emergency Management Service (CEMS), the Copernicus Climate Change Service (C3S), the Hydrological Ensemble Prediction EXperiment (HEPEX) and the Global Flood Partnership (GFP). Six chairs hosted the ensemble of discussions, Hannah Cloke (University of Reading, UK), Christel Prudhomme (ECMWF, UK), Maria-Helena Ramos (INRAE, France), Peter Salamon (European Commission, Joint Research Centre, Italy), and Ilias Pechlivanidis (SMHI, Sweden), with the support of Karen O'Regan (ECMWF). The workshop was an excellent opportunity to showcase the hard work and inspiring science being produced within the global hydrological community. We extend our thanks to those who contributed to and attended this impressive virtual event!

ECMWF's role in the Copernicus Emergency Management Service renewed

by Georg Lentze

ECMWF is to continue as the computational centre for the hydrological forecasting activities of the EU-funded Copernicus Emergency Management Service (CEMS) for a further six years until 2027.

The computational centre helps to deliver the European and Global Flood Awareness Systems, EFAS and GloFAS.

Figure 14: The disastrous flood which hit several European countries in July 2021 illustrates well the importance of EFAS as a critical European tool to forecast flooding events. As the intensity and frequency of severe weather events increases around the world, it is paramount that forecasting skill should continue to improve. (Photo of Erfstadt-Blessem, Germany – credit: Rhein-Erft-Kreis)

The new framework contract is managed by the Joint Research Centre (JRC) of the European Commission – the entrusted entity responsible for CEMS – and has been awarded to ECMWF for the third time.

Flood awareness systems

The European and Global Flood Awareness Systems EFAS and GloFAS are at the core of the CEMS Early Warning System (CEMS-EWS) Flood component.

EFAS was the first of the CEMS-EWS services, run operationally by ECMWF since 2011 following its development by the JRC. In parallel, GloFAS, co developed by ECMWF and the JRC in collaboration with the University of Reading, was run by ECMWF as a prototype service from 2011 and became operational in 2018.

Since then, both systems have provided the European Union's Emergency Response Coordination Centre (ERCC), national hydrological and meteorological services (NHMS) and authorised users with a reliable and robust 24/7 service, including daily overviews on ongoing and predicted major floods in Europe and the world.

EFAS now has over 900 users from 141 institutions, while GloFAS has over 6,000 registered users worldwide.

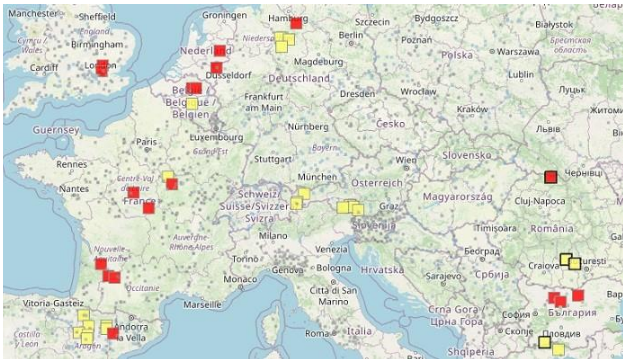


Figure 15: This EFAS map shows the risks of flooding on 12 June 2021. The red (yellow) squares show river points where flooding within the next 10 days is expected to exceed the 5-year (2-year) return period.

ECMWF's role

As the CEMS Hydrological Forecast Centre – Computation (COMP), ECMWF is responsible for the operation of the CEMS state-of-the-art hydrological probabilistic forecasting systems, which includes ECMWF ensemble weather forecasts, as a 24/7 service.

It is also in charge of the service evolution, migrating from research to operations new components developed by either ECMWF or other collaborators, such as the JRC. This includes:

- implementing scientific advances to improve hydrological forecast skill (e.g. hydrological modelling, product definition, error diagnostics, and performance improvement);
- continuous system upgrades, such as integrating new observational data and developing user-defined forecast products;
- delivering service improvements, ranging from website design and functionalities to optimised flood notification criteria;

- any development to ensure the timely delivery of products (e.g. system component and processing chain optimisation, continuous integration, software upgrade and maintenance).

ECMWF's responsibilities include developing, maintaining and hosting EFAS and GloFAS Information Systems and associated web services, in particular delivering tailored tools for the CEMS Hydrological Forecast Centre - Analytics and Dissemination.

ECMWF also integrates in the web platform relevant new products from other CEMS services as required, such as Global Flood Monitoring products, and provides data services, e.g. to other Copernicus Services.

ECMWF engages strongly with the CEMS-EWS for Floods user community. This ranges from being responsible for EFAS and GloFAS user management and service access to providing user support for all EFAS and GloFAS products and services.

Finally, ECMWF contributes to training and outreach activities with other CEMS hydrological forecast centres, by hosting meetings, delivering hydrological bulletins, contributing to the Copernicus Climate Change Service (C3S) State of the Climate reports, and promoting EFAS and GloFAS at relevant conferences and workshops.

In addition to the computational centre, three other operational centres deliver the CEMS-EWS for Floods, with support from the JRC: the CEMS-Flood Data Collection Centres METEO (KISTERS AG and DWD) and HYDRO (Soologic), and the CEMS Hydrological Forecast Centre - Analytics and Dissemination DISS (SMHI, SHMU and Rijkswaterstaat). ECMWF has strong interactions with all of them.

EFAS and GloFAS developments

As operational services, EFAS and GloFAS are always evolving to provide state-of-the-art flood forecasts and web and data services to registered users. A lot has happened in the last few years, with developments expected to continue during the next phase of the service:

- **Hydrological forecast improvement.** This includes new calibration for EFAS and a new hydrological model for GloFAS delivered in 2020. An increase in the spatial resolution is planned for both. This may also include the implementation of new components, such as improved river routing or development of a data assimilation module in the LISFLOOD model, now used for both EFAS and GloFAS.
- **Product evolution.** This includes improved flood impact forecast assessments delivered in 2020–2021, but also optimisation of flood notification criteria, or improvement in the flash flood forecasting method.
- **Service evolution.** This includes access to all hydrological simulations through the C3S Climate Data Store (started in 2019), improved websites and services, enhanced data sharing functionalities, and improved and extended collaboration with and feedback from users.

More information

EFAS and GloFAS have dedicated web interfaces accessible through registration: www.efas.eu and http://www.globalfloods.eu respectively.

In addition, a CEMS-Floods wiki provides more detailed information on the different service elements.

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: Photo of Erfstadt-Blessem, Germany – credit: Rhein-Erft-Kreis

Appendix – figures

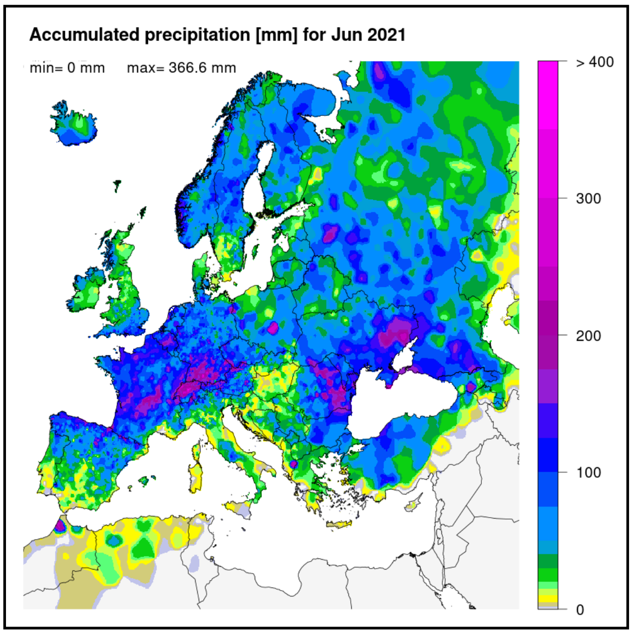


Figure 16: Accumulated precipitation [mm] for June 2021.

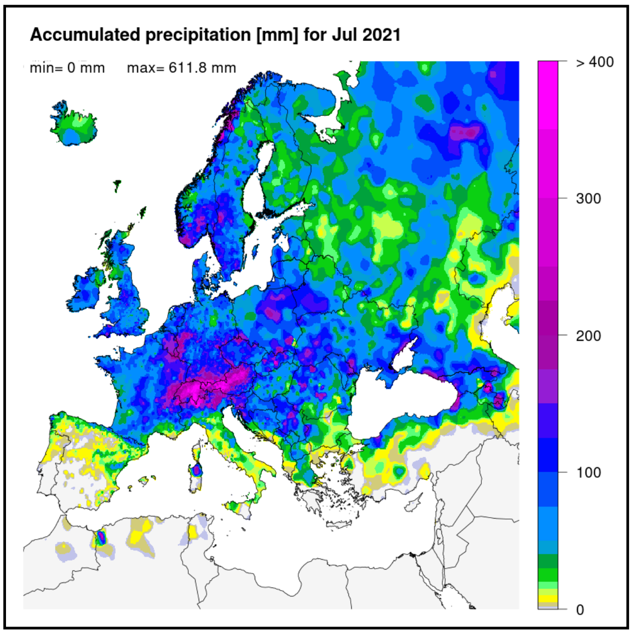


Figure 18: Accumulated precipitation [mm] for July 2021.

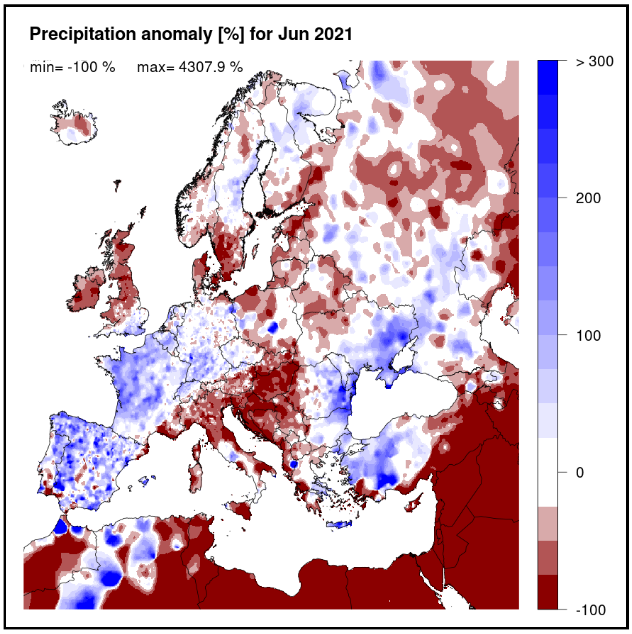


Figure 17: Precipitation anomaly [%] for June 2021, relative to a long-term average (1990-2013). Blue (red) denotes wetter (drier) conditions than normal.

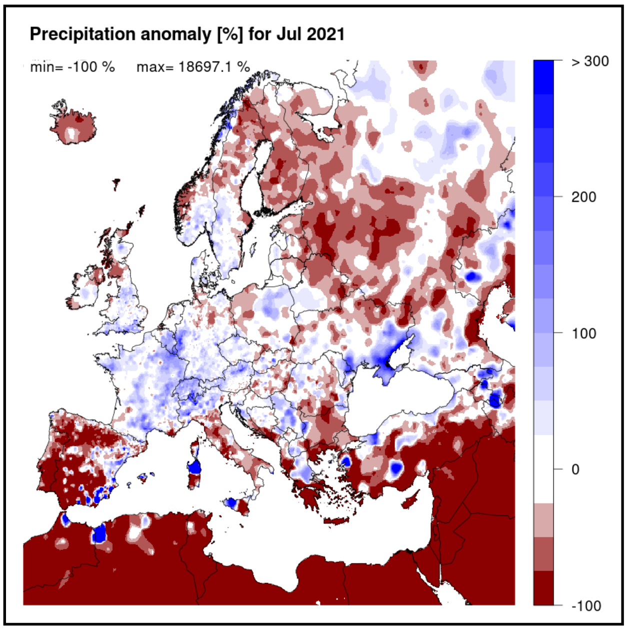


Figure 19: Precipitation anomaly [%] for July 2021, relative to a long-term average (1990-2013). Blue (red) denotes wetter (drier) conditions than normal.

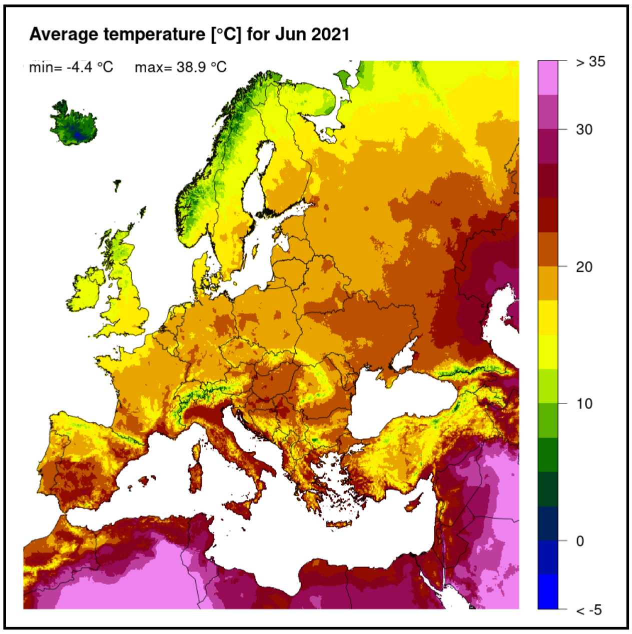


Figure 20: Mean temperature [°C] for June 2021.

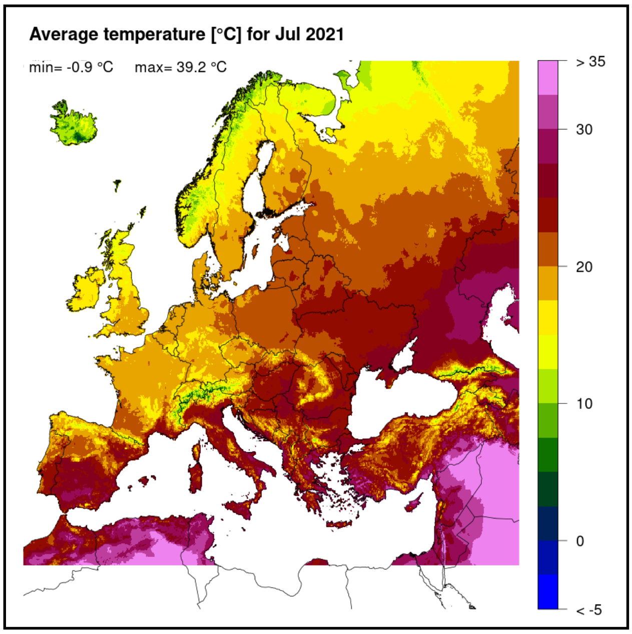


Figure 22: Mean temperature [°C] for July 2021.

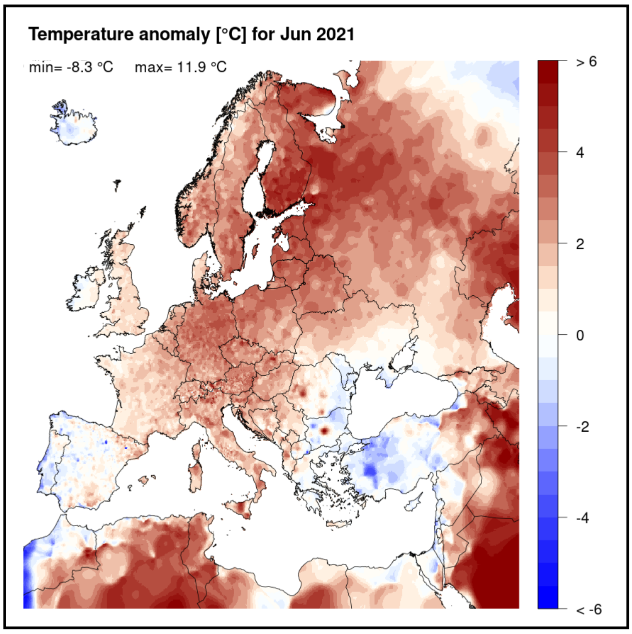


Figure 21: Temperature anomaly [°C] for June 2021, relative to a long-term average (1990-2013). Blue (red) denotes colder (warmer) temperatures than normal

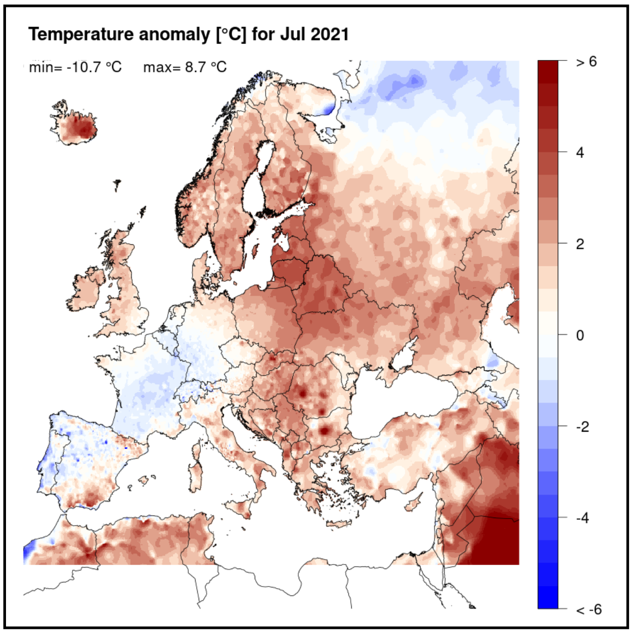


Figure 23: Temperature anomaly [°C] for July 2021, relative to a long-term average (1990-2013). Blue (red) denotes colder (warmer) temperatures than normal.

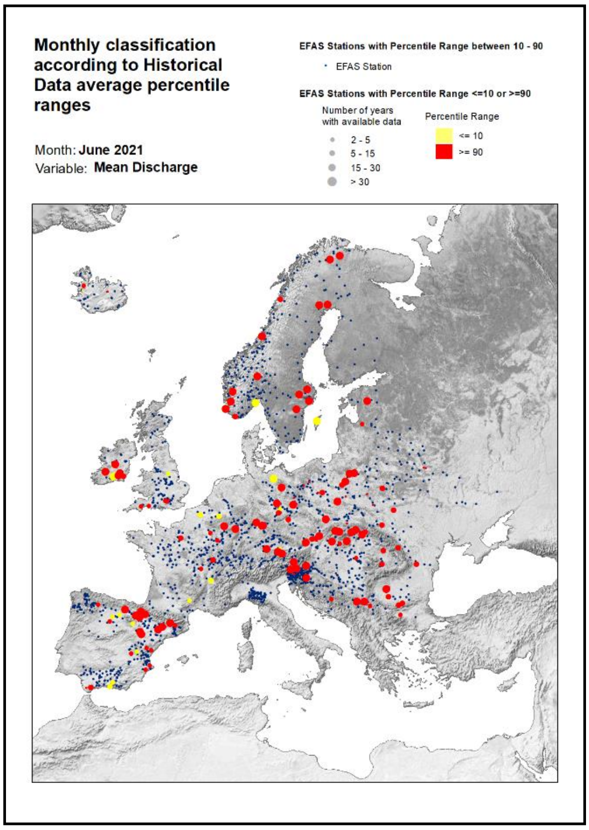


Figure 24: Monthly discharge anomalies June 2021.

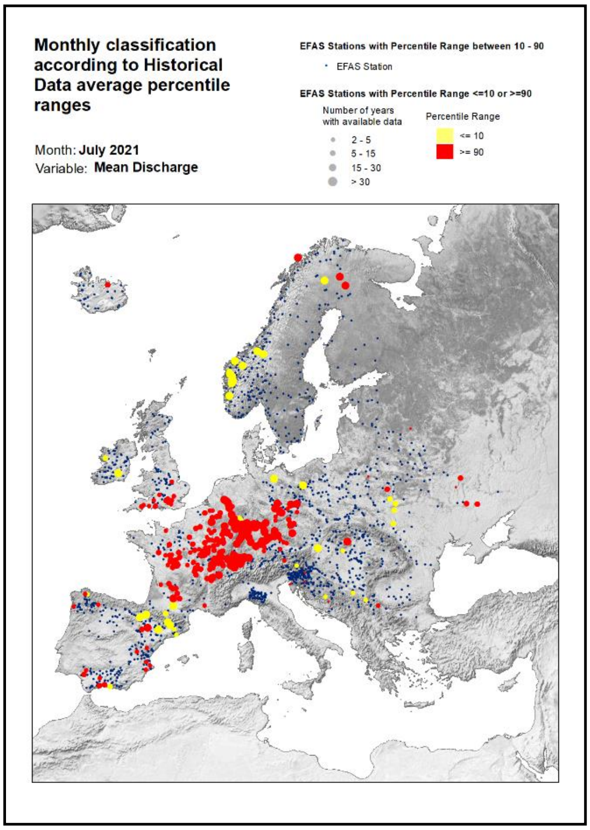


Figure 26: Monthly discharge anomalies July 2021.

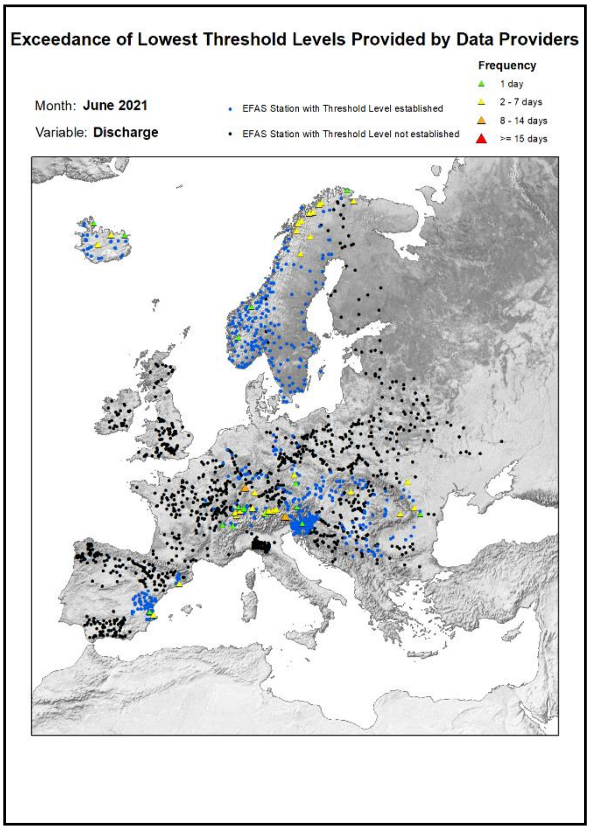


Figure 25: Lowest alert level exceedance for June 2021.

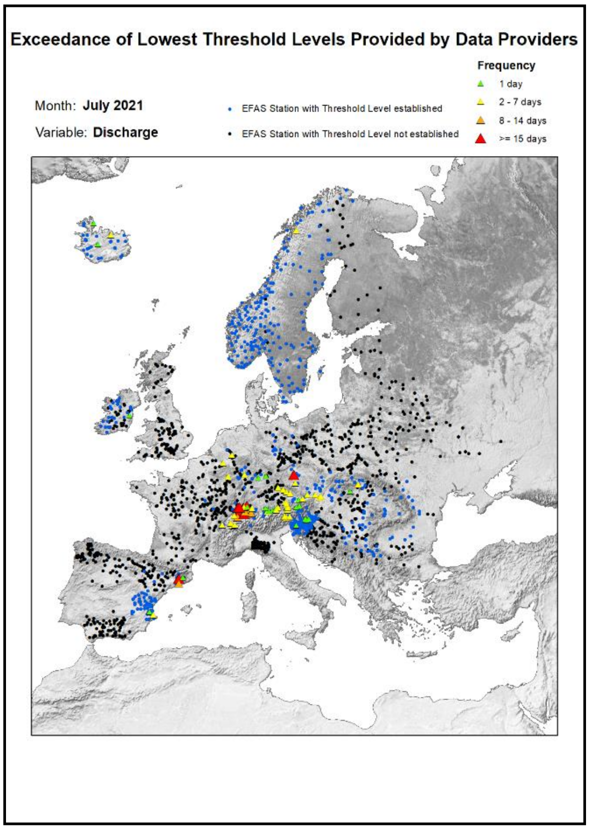


Figure 27: Lowest alert level exceedance for July 2021.

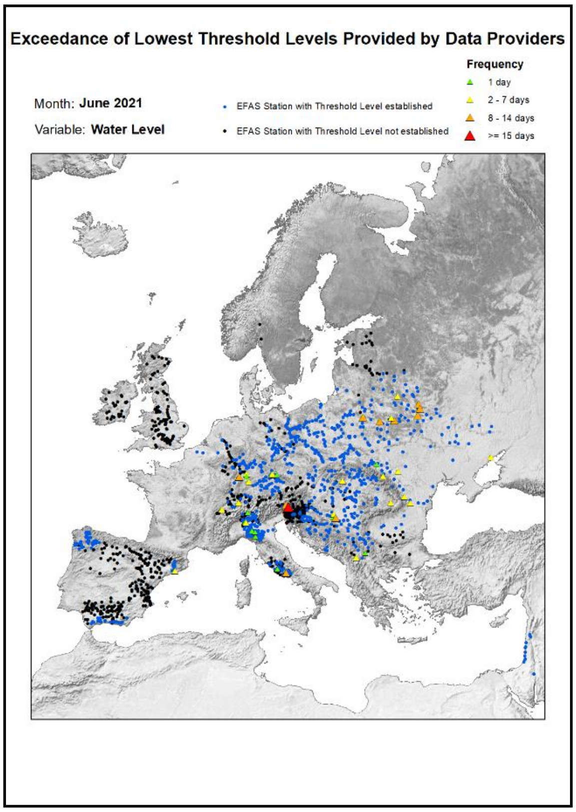


Figure 28: Lowest threshold exceedance for June 2021.

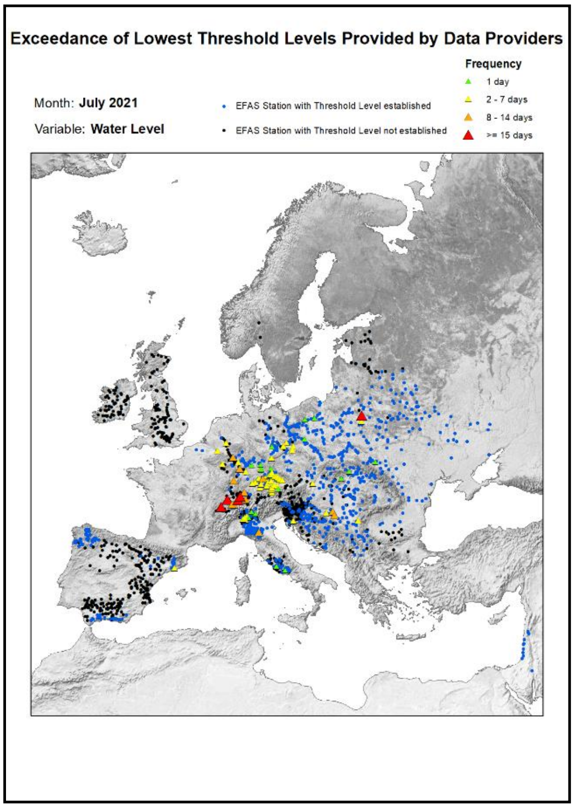


Figure 29: Lowest threshold exceedance for July 2021.

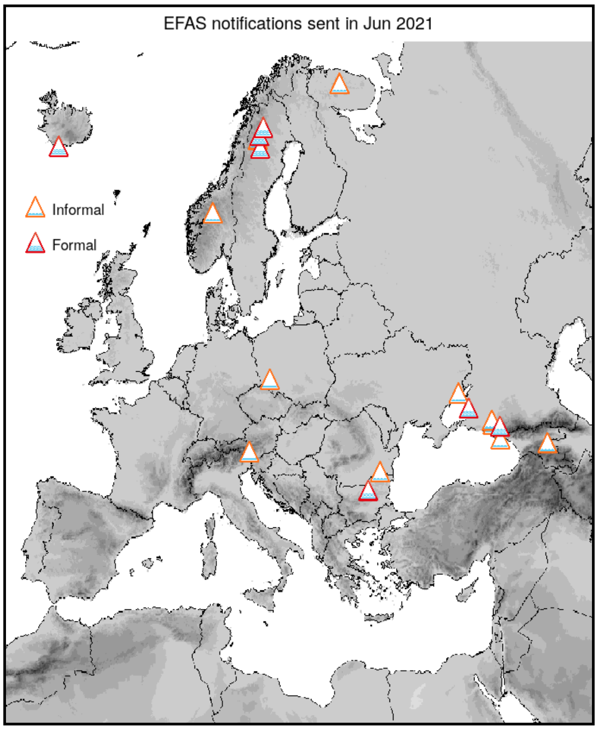


Figure 30: EFAS flood notifications sent for June 2021.

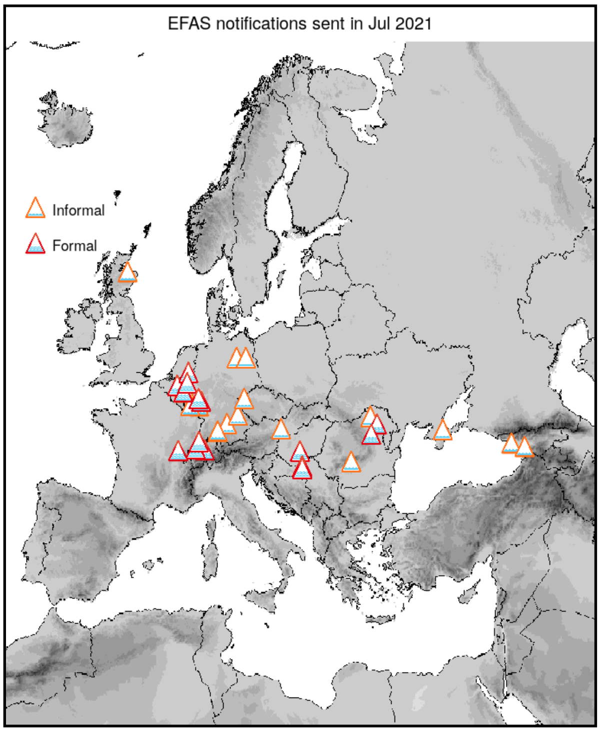


Figure 32: EFAS flood notifications sent for July 2021.

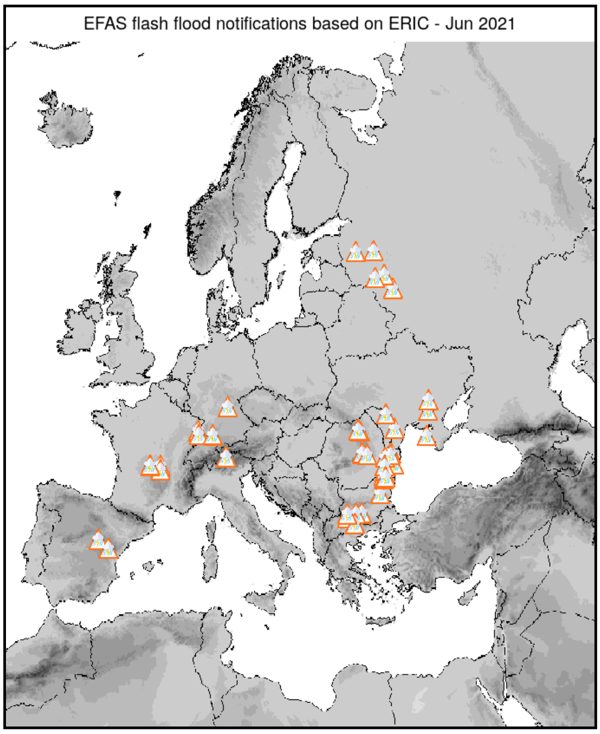


Figure 31: Flash flood notifications sent for June 2021.

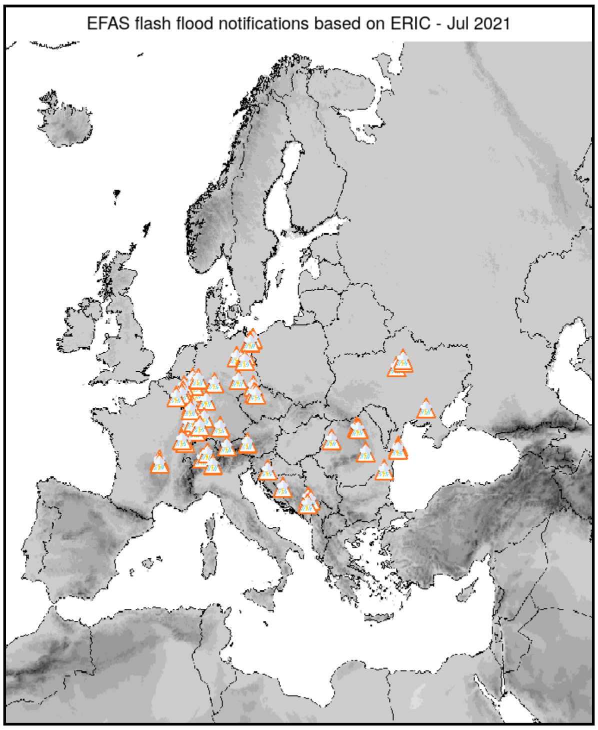


Figure 33: Flash flood notifications sent for July 2021.

Appendix - tables

Table 1: EFAS flood notifications sent in June – July 2021

Type	Forecast date	Issue date	Lead time	River	Country
Informal	31/05/2021 12UTC	01/06/2021	36	BZIPI	Georgia
Informal	31/05/2021 12UTC	01/06/2021	30	KURDZHIPS	Russia
Formal	01/06/2021 12UTC	02/06/2021	84	Umeälven	Sweden
Informal	01/06/2021 12UTC	02/06/2021	24	Coastal Catchment Black Sea	Ukraine
Formal	04/06/2021 00UTC	04/06/2021	48	Coastal zone	Iceland
Informal	04/06/2021 12UTC	05/06/2021	0	Belaja	Russia
Informal	06/06/2021 00UTC	06/06/2021	0	Glomma	Norway
Informal	06/06/2021 00UTC	06/06/2021	0	Voronja	Russia
Formal	09/06/2021 12UTC	10/06/2021	0	Malaja Laba	Russia
Formal	10/06/2021 00UTC	10/06/2021	48	Luleälven	Sweden
Formal	10/06/2021 00UTC	10/06/2021	48	Tjeggelvas	Sweden
Formal	15/06/2021 00UTC	15/06/2021	30	Yantra	Bulgaria
Formal	15/06/2021 00UTC	16/06/2021	48	Coastal Catchment Black Sea	Russia
Informal	17/06/2021 00UTC	17/06/2021	30	Ialomita (Yalomita)	Romania
Informal	17/06/2021 00UTC	17/06/2021	54	Moell	Austria
Informal	20/06/2021 00UTC	20/06/2021	30	Skellefteälven	Sweden
Informal	23/06/2021 00UTC	23/06/2021	0	Khrami	Georgia
Informal	23/06/2021 00UTC	23/06/2021	0	Kaczawa	Poland
Informal	26/06/2021 00UTC	26/06/2021	0	Voronja	Russia
Informal	01/07/2021 12UTC	02/07/2021	30	Lower Havel waterway	Germany
Informal	02/07/2021 00UTC	02/07/2021	6	Havel	Germany
Informal	03/07/2021 12UTC	04/07/2021	30	Coastal Catchment Black Sea	Georgia
Informal	03/07/2021 12UTC	04/07/2021	36	Rioni	Georgia
Informal	04/07/2021 00UTC	04/07/2021	18	Coastal Catchment Black Sea	Ukraine
Formal	06/07/2021 00UTC	06/07/2021	60	Reuss	Switzerland
Informal	06/07/2021 00UTC	06/07/2021	54	Rhine	Switzerland
Formal	06/07/2021 12UTC	07/07/2021	60	Aare	Switzerland
Informal	08/07/2021 00UTC	08/07/2021	24	Ohre	Czechia
Informal	08/07/2021 00UTC	08/07/2021	24	Ohre	Czechia
Informal	08/07/2021 00UTC	08/07/2021	24	Naab	Germany
Informal	08/07/2021 00UTC	08/07/2021	36	Danube	Germany
Informal	10/07/2021 00UTC	10/07/2021	18	Havel	Germany
Informal	10/07/2021 00UTC	10/07/2021	84	Rhine	Germany
Formal	11/07/2021 00UTC	11/07/2021	66	Rhine	Germany
Informal	12/07/2021 00UTC	12/07/2021	36	Ourthe	Belgium
Formal	12/07/2021 00UTC	12/07/2021	36	Demer	Belgium
Formal	12/07/2021 00UTC	12/07/2021	30	Rhine	Switzerland
Informal	12/07/2021 00UTC	12/07/2021	36	Rur	Netherlands
Formal	12/07/2021 12UTC	13/07/2021	30	Ourthe	Belgium
Formal	12/07/2021 12UTC	13/07/2021	60	Rhine	Netherlands
Formal	12/07/2021 12UTC	13/07/2021	24	Rur	Netherlands
Informal	13/07/2021 00UTC	13/07/2021	6	Nahe	Germany
Formal	13/07/2021 00UTC	13/07/2021	18	Doubs	France
Informal	13/07/2021 00UTC	13/07/2021	30	Meuse	Netherlands
Formal	13/07/2021 12UTC	14/07/2021	30	Moselle	Germany

Informal	14/07/2021 00UTC	14/07/2021	18	Sauer	Luxembourg
Informal	19/07/2021 00UTC	19/07/2021	6	Danube	Slovakia
Formal	21/07/2021 00UTC	21/07/2021	6	Danube	Hungary
Informal	21/07/2021 00UTC	21/07/2021	12	Prut	Romania
Formal	21/07/2021 00UTC	21/07/2021	42	Prut	Moldova
Informal	21/07/2021 00UTC	21/07/2021	6	Danube	Hungary
Formal	21/07/2021 00UTC	21/07/2021	18	Siret	Romania
Informal	21/07/2021 00UTC	21/07/2021	0	Olt	Romania
Formal	21/07/2021 00UTC	21/07/2021	60	Danube	Croatia
Formal	21/07/2021 00UTC	21/07/2021	54	Danube	Serbia
Informal	22/07/2021 12UTC	23/07/2021	60	Donau	Germany
Informal	27/07/2021 00UTC	27/07/2021	36	Spey	United Kingdom

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

Table 2: EFAS flash flood notifications sent in June – July 2021

Type	Forecast date	Issue date	Lead time	Region	Country
Flash Flood	31/05/2021 12UTC	01/06/2021	30	Neamt	Romania
Flash Flood	31/05/2021 12UTC	01/06/2021	30	Suceava	Romania
Flash Flood	03/06/2021 12UTC	04/06/2021	42	Puy-de-Dome	France
Flash Flood	04/06/2021 00UTC	04/06/2021	48	Teruel	Spain
Flash Flood	04/06/2021 00UTC	04/06/2021	42	Guadalajara	Spain
Flash Flood	06/06/2021 00UTC	06/06/2021	42	Plovdiv	Bulgaria
Flash Flood	06/06/2021 12UTC	07/06/2021	30	Pazardzhik	Bulgaria
Flash Flood	06/06/2021 12UTC	07/06/2021	36	Kyustendil	Bulgaria
Flash Flood	07/06/2021 00UTC	07/06/2021	18	Blagoevgrad	Bulgaria
Flash Flood	08/06/2021 12UTC	09/06/2021	30	Provincia Autonoma di Bolzano/Bozen	Italy
Flash Flood	12/06/2021 00UTC	12/06/2021	36	Neamt	Romania
Flash Flood	12/06/2021 12UTC	13/06/2021	24	Kyustendil	Bulgaria
Flash Flood	12/06/2021 12UTC	13/06/2021	24	Suceava	Romania
Flash Flood	14/06/2021 12UTC	15/06/2021	48	Dobrich	Bulgaria
Flash Flood	14/06/2021 12UTC	15/06/2021	42	Calarasi	Romania
Flash Flood	14/06/2021 12UTC	15/06/2021	42	Constanta	Romania
Flash Flood	14/06/2021 12UTC	15/06/2021	48	Ialomita	Romania
Flash Flood	14/06/2021 12UTC	15/06/2021	48	Tulcea	Romania
Flash Flood	14/06/2021 12UTC	15/06/2021	48	Odessa	Ukraine
Flash Flood	15/06/2021 12UTC	16/06/2021	24	Braila	Romania
Flash Flood	15/06/2021 12UTC	16/06/2021	24	Shumen	Bulgaria
Flash Flood	15/06/2021 12UTC	16/06/2021	24	Bender/Causeni and Stefan Voda	Moldova
Flash Flood	16/06/2021 00UTC	16/06/2021	30	Transnistria	Moldova
Flash Flood	16/06/2021 00UTC	16/06/2021	48	Crimea	Ukraine
Flash Flood	16/06/2021 00UTC	16/06/2021	48	Kherson	Ukraine
Flash Flood	17/06/2021 12UTC	18/06/2021	30	Ialomita	Romania
Flash Flood	17/06/2021 12UTC	18/06/2021	24	Dnipropetrovs'k	Ukraine
Flash Flood	17/06/2021 12UTC	18/06/2021	30	Brasov	Romania
Flash Flood	17/06/2021 12UTC	18/06/2021	36	Neamt	Romania
Flash Flood	18/06/2021 00UTC	18/06/2021	30	Constanta	Romania

Flash Flood	18/06/2021 00UTC	18/06/2021	36	Tulcea	Romania
Flash Flood	18/06/2021 12UTC	19/06/2021	24	Silistra	Bulgaria
Flash Flood	18/06/2021 12UTC	19/06/2021	24	Dobrich	Bulgaria
Flash Flood	19/06/2021 12UTC	20/06/2021	24	Ialomita	Romania
Flash Flood	19/06/2021 12UTC	20/06/2021	30	Neamt	Romania
Flash Flood	19/06/2021 12UTC	20/06/2021	30	Dobrich	Bulgaria
Flash Flood	20/06/2021 00UTC	20/06/2021	36	Covasna	Romania
Flash Flood	22/06/2021 12UTC	23/06/2021	48	Puy-de-Dome	France
Flash Flood	23/06/2021 12UTC	24/06/2021	42	Bas-Rhin	France
Flash Flood	24/06/2021 12UTC	25/06/2021	48	Neamt	Romania
Flash Flood	25/06/2021 00UTC	25/06/2021	42	Suceava	Romania
Flash Flood	27/06/2021 00UTC	27/06/2021	48	Smolensk	Russia
Flash Flood	27/06/2021 00UTC	27/06/2021	48	Bas-Rhin	France
Flash Flood	27/06/2021 00UTC	27/06/2021	30	Creuse	France
Flash Flood	27/06/2021 00UTC	27/06/2021	48	Tver'	Russia
Flash Flood	27/06/2021 00UTC	27/06/2021	48	Pskov	Russia
Flash Flood	27/06/2021 12UTC	28/06/2021	48	Pskov	Russia
Flash Flood	27/06/2021 12UTC	28/06/2021	48	Novgorod	Russia
Flash Flood	27/06/2021 12UTC	28/06/2021	42	Freiburg	Germany
Flash Flood	28/06/2021 12UTC	29/06/2021	18	Oberfranken	Germany
Flash Flood	28/06/2021 12UTC	29/06/2021	12	Tubingen	Germany
Flash Flood	30/06/2021 12UTC	01/07/2021	24	Zachodniopomorskie	Poland
Flash Flood	30/06/2021 12UTC	01/07/2021	24	Mecklenburg-Vorpommern	Germany
Flash Flood	30/06/2021 12UTC	01/07/2021	24	Sachsen-Anhalt	Germany
Flash Flood	01/07/2021 12UTC	02/07/2021	24	Constanta	Romania
Flash Flood	01/07/2021 12UTC	02/07/2021	30	Covasna	Romania
Flash Flood	02/07/2021 00UTC	02/07/2021	30	Neamt	Romania
Flash Flood	02/07/2021 00UTC	02/07/2021	36	Suceava	Romania
Flash Flood	04/07/2021 00UTC	04/07/2021	24	Salzburg	Austria
Flash Flood	05/07/2021 00UTC	05/07/2021	24	Tulcea	Romania
Flash Flood	05/07/2021 00UTC	05/07/2021	36	Kherson	Ukraine
Flash Flood	05/07/2021 00UTC	05/07/2021	24	Odessa	Ukraine
Flash Flood	08/07/2021 00UTC	08/07/2021	36	Stredocesky kraj	Czech Republic
Flash Flood	08/07/2021 00UTC	08/07/2021	36	Ustecky kraj	Czech Republic
Flash Flood	08/07/2021 00UTC	08/07/2021	36	Dresden	Germany
Flash Flood	08/07/2021 00UTC	08/07/2021	36	Schwaben	Germany
Flash Flood	09/07/2021 00UTC	09/07/2021	48	Tirol	Austria
Flash Flood	09/07/2021 00UTC	09/07/2021	24	Leipzig	Germany
Flash Flood	09/07/2021 00UTC	09/07/2021	24	Berlin	Germany
Flash Flood	09/07/2021 00UTC	09/07/2021	30	Mecklenburg-Vorpommern	Germany
Flash Flood	09/07/2021 00UTC	09/07/2021	24	Brandenburg	Germany
Flash Flood	11/07/2021 00UTC	11/07/2021	48	Bas-Rhin	France
Flash Flood	11/07/2021 12UTC	12/07/2021	42	Vosges	France
Flash Flood	11/07/2021 12UTC	12/07/2021	48	Valais	Switzerland
Flash Flood	11/07/2021 12UTC	12/07/2021	42	Meurthe-et-Moselle	France
Flash Flood	12/07/2021 00UTC	12/07/2021	30	Haut-Rhin	France
Flash Flood	12/07/2021 00UTC	12/07/2021	30	Moselle	France
Flash Flood	12/07/2021 12UTC	13/07/2021	48	Allier	France
Flash Flood	12/07/2021 12UTC	13/07/2021	36	Uri	Switzerland

Flash Flood	12/07/2021 12UTC	13/07/2021	48	Puy-de-Dome	France
Flash Flood	12/07/2021 12UTC	13/07/2021	42	Kassel	Germany
Flash Flood	13/07/2021 00UTC	13/07/2021	48	Limburg (NL)	Netherlands
Flash Flood	13/07/2021 00UTC	13/07/2021	48	Koln	Germany
Flash Flood	13/07/2021 00UTC	13/07/2021	48	Trier	Germany
Flash Flood	13/07/2021 00UTC	13/07/2021	48	Koblenz	Germany
Flash Flood	13/07/2021 00UTC	13/07/2021	48	Dusseldorf	Germany
Flash Flood	13/07/2021 00UTC	13/07/2021	48	Prov. Liege	Belgium
Flash Flood	13/07/2021 00UTC	13/07/2021	48	Prov. Luxembourg (BE)	Belgium
Flash Flood	13/07/2021 12UTC	14/07/2021	36	Darmstadt	Germany
Flash Flood	13/07/2021 12UTC	14/07/2021	42	Freiburg	Germany
Flash Flood	13/07/2021 12UTC	14/07/2021	36	Arnsberg	Germany
Flash Flood	13/07/2021 12UTC	14/07/2021	36	Saarland	Germany
Flash Flood	13/07/2021 12UTC	14/07/2021	42	Rheinhessen-Pfalz	Germany
Flash Flood	14/07/2021 00UTC	14/07/2021	42	Doubs	France
Flash Flood	14/07/2021 00UTC	14/07/2021	30	Prov. Namur	Belgium
Flash Flood	14/07/2021 00UTC	14/07/2021	42	Haute-Saone	France
Flash Flood	16/07/2021 00UTC	16/07/2021	48	Zlatiborska oblast	Republic Of Serbia
Flash Flood	16/07/2021 00UTC	16/07/2021	48	Republika Srpska	Bosnia And Herzegovina
Flash Flood	17/07/2021 12UTC	18/07/2021	30	Karlovacka zupanija	Croatia
Flash Flood	18/07/2021 12UTC	19/07/2021	24	Republika Srpska	Bosnia And Herzegovina
Flash Flood	18/07/2021 12UTC	19/07/2021	24	Crna Gora	Montenegro
Flash Flood	19/07/2021 00UTC	19/07/2021	48	Suceava	Romania
Flash Flood	19/07/2021 00UTC	19/07/2021	48	Neamt	Romania
Flash Flood	19/07/2021 12UTC	20/07/2021	30	Bihor	Romania
Flash Flood	20/07/2021 12UTC	21/07/2021	36	Kiev	Ukraine
Flash Flood	20/07/2021 12UTC	21/07/2021	36	Poltava	Ukraine
Flash Flood	20/07/2021 12UTC	21/07/2021	36	Chernihiv	Ukraine
Flash Flood	23/07/2021 12UTC	24/07/2021	48	Schwaben	Germany
Flash Flood	30/07/2021 00UTC	30/07/2021	48	Lombardia	Italy

a. * 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.

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