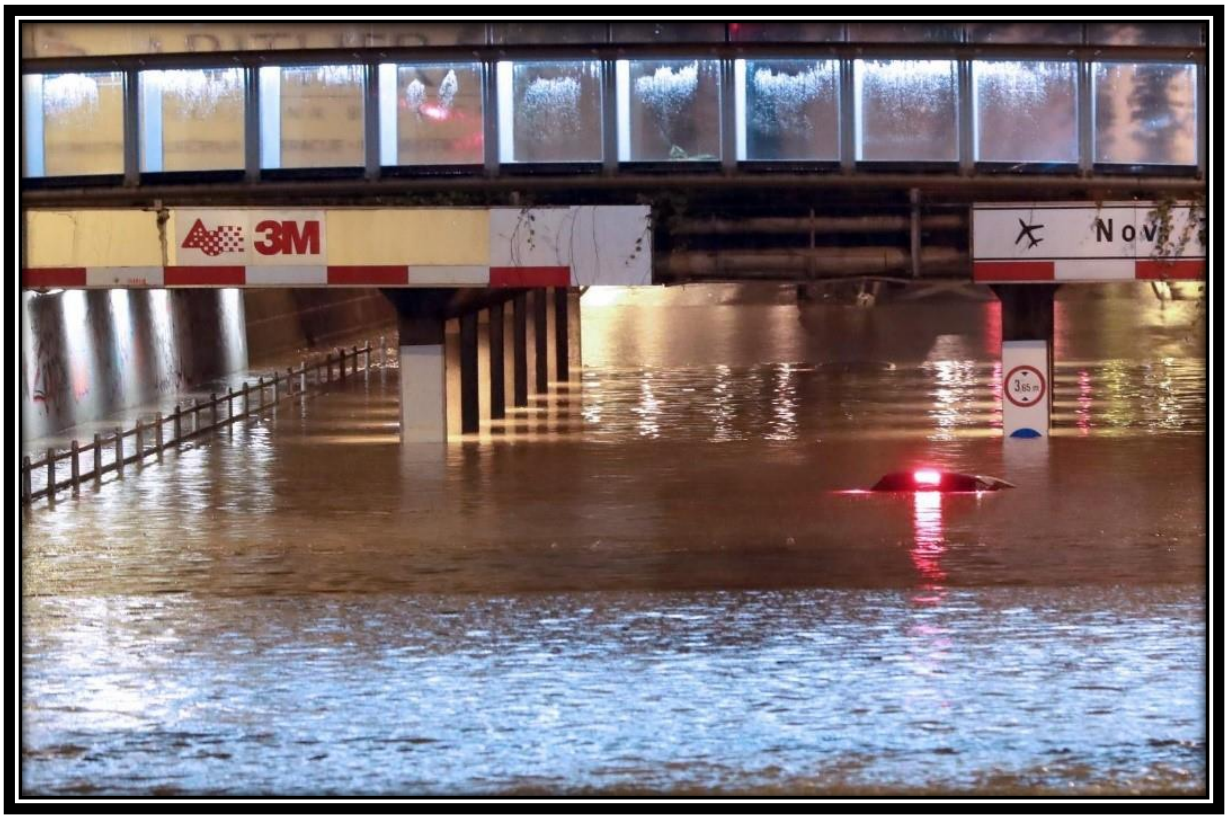
European Flood Awareness System

EFAS *Bulletin*

June – July 2020

Issue 2020(4)



NEWS

Upcoming Events

15th EFAS Annual Meeting

The physical 15th EFAS annual meeting has been cancelled due to the coronavirus (COVID-19) pandemic. The meeting will now take place online on Thursday, 22 October 2020.

We formally invite all EFAS Partners, including EFAS Third Party affiliates, to join the 1-day online meeting giving the opportunity to exchange latest developments that will address different EFAS-related interests. The meeting will be organised by the EFAS Dissemination Centre (SMHI, RWS and SHMÚ). The online meeting agenda can be found here.

Please express your interest in participation by filling out the MMS registration. The EU login tutorial can be found here, in case you experience any difficulties.

If you have any questions, please contact the technical and local organiser: Ilias Pechlivanidis: ilias.pechlivanidis@smhi.se

TAMIR Workshop

The TAMIR project welcome you to the first end-user workshop on tools for management of impacts and risks induced by severe weather with special emphasis on floods. The workshop is to be held online, the 27 October 2020.

The online workshop is targeted to experts dealing with hazards caused by storms and heavy precipitation as well as IT specialists supporting and developing related services. For example, civil protection professionals, hydrometeorological flood modelers and/or forecasters, risk managers, web developers and service providers are cordially invited to participate in the workshop. The workshop aims to:

- Promote the envisaged new products and tools for prediction and nowcasting of hazards induced by severe weather being developed in the TAMIR project;
- Provide an opportunity to discuss the necessary features in the tools for expressing the impact and risk information to the end-users;
- Discuss the technical realizations and IT aspects of integrating the services to local end-user platforms;
- Promote networking between end-users, providers and developers of the tools and services.

The initial agenda and information for the workshop can be viewed here. Further information will be released ahead of the event and after the registration deadline.

The deadline for registration is 12th of October 2020. Register online. For more information contact us by email at: tamir@fmi.fi

New features

New website

The new Copernicus Emergency Management Service (CEMS) website has been launched, with improved access to data and service components, a new FAQ section, and an intuitive layout.

IFS upgrade - Cycle 47r1

ECMWF's Integrated Forecasting System (IFS) was upgraded on 30 June 2020.

Cycle 47r1 improves global weather forecasts and substantially improves analyses and forecasts in the stratosphere. The upgrade brings many changes in data assimilation and Earth system modelling. It also introduces a new tropical cyclone wind radii product, which will facilitate the identification of wind-related hazards.

Further information on IFS cycle 47r1 and its release can be found here.

Analysis of the CEMS hydrological data collection for the year 2019

This report contains an analysis of the hydrological data received by the CEMS Hydrological Data Collection Centre (HDCC) for the year 2019. The HDCC is contracted by the European Commission and operated by the Agencia de Medio Ambiente y Agua de Andalucía-REDIAM in collaboration with Soologic Technological Solutions S.L. The HDCC is responsible for the collection, quality control, harmonisation and internal distribution of hydrological observations to various components of the Copernicus Emergency Management Service (CEMS), mostly to the European Flood Awareness System (EFAS).

By the end of 2019, 43 data providers contributed with near real-time hydrological data at 1,792 stations to the CEMS Hydrological Data Collection, covering 31 countries and 49% of all the European water basins.

RESULTS

Summary of EFAS Flood and Flash Flood Notifications

The 36 formal and 43 informal EFAS flood notifications issued in June-July 2020 are summarised in Table 3. The locations of all notifications are shown in Figure 30 and Figure 32 in the appendix.

270 Flash flood notification were issued in June - July 2020. They are summarised in Table 4. 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

The meteorological situation in June 2020 was characterised by unusually high monthly mean surface pressure over Scandinavia and Russia and exceptionally low in the other parts of the EFAS domain. Monthly precipitation totals were around or above normal in the majority of the EFAS domain, but not in every region, for example, in the south, southeast, east and north of the EFAS domain. The monthly mean air temperatures were below the long-term means in the Mediterranean region and eastern Russia and above elsewhere in the EFAS domain.

At the beginning of June 2020, an upper-level low-pressure system was located westward of the Iberian Peninsula and a high-pressure system was located over Scandinavia while eastwards there was an upper-level trough extending towards the eastern Mediterranean region. A cut-off of the trough was initiated as the high-pressure system moved to northern Russia. The resulting low-pressure system moved via eastern Europe to southern Scandinavia and merged over the North Sea with a low-pressure system developed under an upper-level trough over central Europe. Also, from this trough, a small low-pressure system was cut-off and moved via southern France and southern Italy towards Greece. It brought heavy precipitation along its track. The low-pressure system moved from the North Sea via Scandinavia to the Arctic and the Azores high extended towards the northeast. As leftover from the low-pressure system, an upper-level low-pressure system was located over the Ligurian Sea and moved eastward. Another low-pressure system was located between Iceland, Great Britain and Ireland and moved to the Gulf of Biscay. The Azores high then extended towards Scandinavia where it connected to the high-pressure system over Russia, so in the whole EFAS domain, there was a relatively high surface air pressure with very weak gradients. Several upper-level low-pressure systems and upper-level drops of cold air were active and associated with high-impact weather events in several locations in the EFAS domain. By the beginning of the last decade of June, a low-pressure system was located southwest of Iceland, a high-pressure system over northern Scandinavia and one remaining upper-level low-pressure system over the Balkans. As the Scandinavian high-pressure system weakened and the Azores high extended towards and developed a secondary core over Central Europe, a small upper-level low-pressure system was cut-off over the Skagerrak and moved via southern Sweden, Poland, Czechia to Austria and then on a similar track back to Poland, associated with heavy precipitation events. Later, a low-pressure system moved from the Atlantic Ocean to Great Britain and Ireland and further to Scandinavia by the end of June.

In June 2020, the highest precipitation totals were observed in the Alps and Carpathian Mountains (Figure 1). On the other hand, no or nearly no precipitation fell in the south and southeast of the EFAS domain, southwest of the Iberian Peninsula and some regions around the Caspian Sea. Monthly precipitation totals above the long-term means occurred in western, central, eastern and southern Europe and northwest Africa (Figure 2), whereas monthly totals below the long-term means were reported from the southwest Iberian Peninsula, northern Scandinavia, Russia as well as eastward and southward of the Mediterranean Sea.

The monthly mean air temperatures ranged from -4.5°C to 35.4°C with the highest values in the southern parts and the lowest in the northern and mountainous parts of the EFAS domain (Figure 3). Air temperature anomalies ranged from -7.1°C to 8.5°C (Figure 4). Monthly mean air temperatures above the long-term means were found in Scandinavia and eastern Europe as well as in Iceland, Great Britain and Ireland, the Asian and African regions of the EFAS domain, while below normal air temperatures were reported from eastern Russia and northward of the Mediterranean Sea.

July

The meteorological situation in July 2020 was characterised by very high monthly mean surface pressure over the Azores, which extended to most regions of central Europe and the south-western parts of the EFAS domain. Scandinavia, Russia, and south-eastern areas of the EFAS domain, notably Iraq, were influenced by low-pressure. Many regions had below normal monthly precipitation totals, except for the northern parts of the EFAS domain, the western Mediterranean, and southern Balkan regions. Monthly mean air temperatures were below the long-term means in Scandinavia, northwest Europe and western Russia while positive anomalies occurred in the other parts of the EFAS domain.

At the beginning of July 2020, a stable and strong low-pressure system was located over Scandinavia. The upper-level trough over Ireland and the UK was slowly weakening while the high-pressure system over the Azores extended eastwards towards central Europe. During the same time, the weak low-pressure system in Greenland moved towards Iceland and both low-pressure systems merged into one. This low-pressure area extended to the southeast and caused heavy precipitation amounts and strong winds in the Sofia area of Bulgaria in the night to 7 July. The high-pressure area in central Europe, surrounded by low-pressure systems, moved towards Russia. In the meantime, the high-pressure system over the Atlantic extended to Ireland and the UK, moved towards Scandinavia and displaced the low-pressure system. The low-pressure systems in the Mediterranean regions and south-eastern Europe caused flash floods in north and north-eastern Turkey on July 12 and the following days. Severe flash floods also occurred after torrential rain in Sicily on July 15.

In the middle of July, low-pressure systems dominated the weather conditions in the EFAS domain, which later extended to the east. In Russia, a low-pressure system developed and moved to the north, which brought heavy precipitation along its track. The upper low-pressure trough in Norway cut off and moved towards the Balkans. Another low-pressure system over Iceland moved towards Scandinavia and was split into two areas, which then both weakened. The high-pressure system over the Atlantic was extending towards southern and northern Europe. The low-pressure system over Russia moved towards the south and displaced the high-pressure area bringing heavy rainfall, flooding, and mudslides to western Georgia by the end of July. The high-pressure system over central Europe strengthening and forced the low-pressure system over Scandinavia to move eastwards. A new low-pressure system developed over the Atlantic and moved towards Iceland. The extension of the low-pressure system reached the coastline of Ireland, Scotland, and Norway.

In July 2020, the highest precipitation totals were observed in the Alps, the south-western coastline of Norway, the western coastlines of Ireland and the United Kingdom (Figure 1). No or nearly no precipitation fell in the south and southeast of the EFAS domain, in the south of the Iberian Peninsula and some regions to the north of the Caspian Sea. The high precipitation amount shown in the monthly grid in Iraq was caused by measurement errors. Monthly precipitation totals below the long-term means occurred in the Balkans, eastern, northern and southern Europe, and north Africa (Figure 2), whereas monthly totals above the long-term means were reported in central Europe, parts of Turkey and northern Africa as well as in some regions in eastern Russia and Kazakhstan.

The monthly mean air temperatures ranged from -3.0°C to 39.6°C with the highest values in the southern parts of the EFAS domain and the Caspian Sea region. The lowest temperature values were reported in the northern and mountainous parts (Figure 3). Air temperature anomalies ranged from -5.9°C to 7.6°C (Figure 4). Monthly mean air temperatures above the long-term means were found in northern and eastern parts of Russia, Kazakhstan, the bordering Mediterranean countries, and Portugal. Negative anomalies were reported in north Europe, the United Kingdom, Scotland, Ireland, as well as in the northern parts of central Europe and the north-western parts of eastern Europe.

Hydrological situation

by EFAS Hydrological Data Collection Centre

June

For the month of June, the highest concentration of stations that exceeded their lowest threshold level is located in central Europe, through the Danube, Oder, Vistula and Dniester basins (Poland, Czechia, Slovakia, Serbia, Romania, Bosnia and Herzegovina), in Italy (Po basin) and in the Scandinavian peninsula, mainly in

Norway. There was a more dispersed distribution of stations with exceedances in the basins of the Rhine (southern Germany), Dnieper (Ukraine), Neman (Belarus) and Llobregat (northeast of Spain).

Stations that registered discharge values above the 90% quantile are located mainly in Norway, also extending in the north of Finland too. There is a high concentration of stations in the Danube basin, through Austria, Bulgaria, Czechia, Hungary, Romania, Serbia, Slovakia, and southwest Ukraine. In the Dnieper basin, specifically in the north and centre of Ukraine (Styr, Psel, and Vorskla rivers). There are only three stations in Germany that exceeded the 90% quantile on the Main and Lusatian Neisse rivers. Some scattered stations in the same condition can be found in England (Thames and Brit basins) and in Spain (Ebro, Ter and Guadalhorce basins).

Stations registering values below the 10% quantile are found in a greater number in Spain (Ebro and Douro basins and in the south of the country), in England (Thames basin), in Ireland, in central European basins such as the Rhine, Elbe, Oder and Vistula basins (in a lower concentration), and in Ukraine (Dnieper basin).

July

For the month of July, the highest concentration of stations that exceeded their lowest threshold level is located in Poland through the Oder and Vistula basins, northern Italy (Po basin), Switzerland (Rhine basin), and the central Danube basin (Serbia, Croatia, Romania and Bosnia). There was a more dispersed distribution of stations with exceedances in the eastern and northern Danube basin (Germany, Austria, Czech Republic, Hungary, and Ukraine) and the Scandinavian peninsula (Norway and Sweden). In addition to the previous ones, we also find isolated stations exceeding the lowest threshold level in the rivers Uma in northwest Spain, Rioni in Georgia, and Dniester in southern Ukraine.

Regarding to stations registering values above the 90% quantile, these are mostly located in the northern and central Danube river basin (Hungary, Czech Republic, Romania and Austria) as well as in Norway, mainly in the south. To a minor extent, other stations also exceeding the 90% quantile occurred in several Spanish river basins, such as Guadalquivir, Ebro, Guadalhorce, Llobregat and Ter, the Dnieper river basin in Ukraine, the Thames, Welland and Mersey river basins in England, the Vistula basin in Poland, and in southern Sweden. Values above the 90% quantile were also registered in isolated stations in Moy river (Ireland), Clyde river (Scotland) and Rednitz river in the German Rhine basin.

German stations located in the Rhine, Danube and Elbe basins, the Oder river basin in Poland, as well as Douro, Ebro and Minho basins in Spain mainly registered values lower than the 10% quantile. We can also find stations showing values below 10% in the Thames (England) and southern Scandinavia (Glomma, Vormo, Vindan, and Alsteran basins). Besides those listed above, other isolated stations also showing values below the 10% quantile are located in the Horyn (Ukraine), Sambre (Belgium), Rhine (Switzerland), Cherni Lom (Bulgaria), Barland (Romania), and Ohre (Czech Republic).

Verification

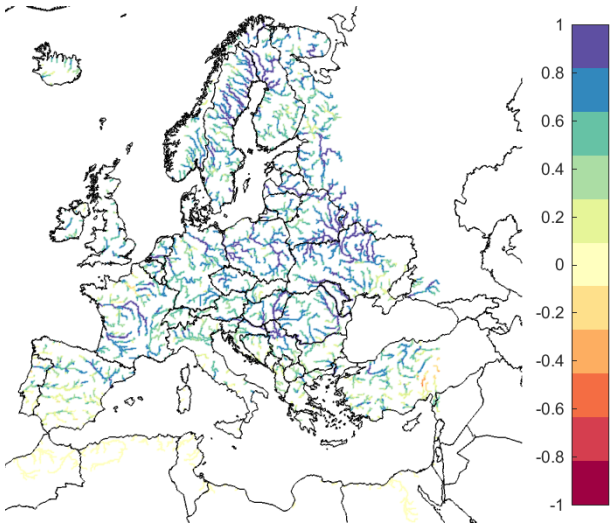


Figure 1. EFAS CRPSS at lead-time 1 day for the June-July 2020 period, for catchments >2000km2. The reference score is persistence of using previous day's forecast.

Figure 1 and Figure 2 shows the EFAS headline score, the Continuous Ranked Probability Skill Score (CRPSS) for lead times 1 and 5 days for the June to July period 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.

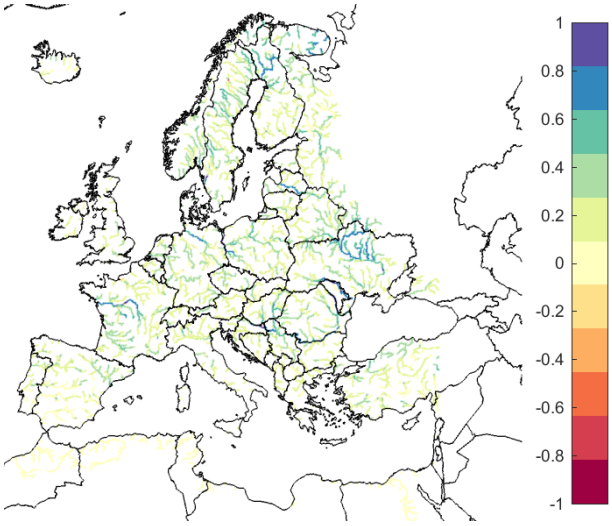


Figure 2. EFAS CRPSS at lead-time 5 days for the June-July 2020 period, for catchments >2000km2. The reference score is persistence of using previous day's forecast.

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 better compared to the same period last year (Figure 3). 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.

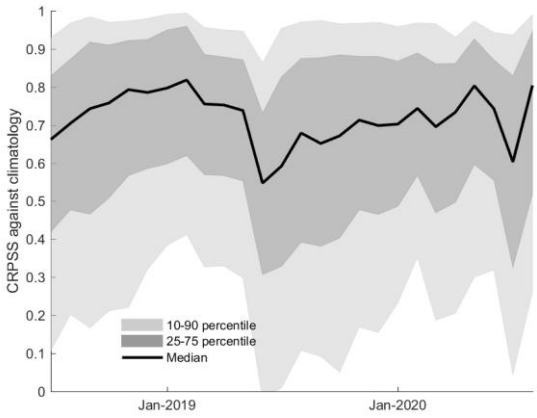


Figure 3. Monthly means of CRPSS the for lead-time 5 days for all the major river points in Europe with ECMWF ENS as forcing. Reference forecast was climatology. The skill is largest during the winter months, when there is less variation in the flow in large parts of Europe.

ARTICLES

Investigating how satellite soil moisture data could improve streamflow predictions

by Calum Baugh, Patricia de Rosnay, Heather Lawrence, Toni Jurlina, Ervin Zsoter, Christel Prudhomme (all ECMWF); Matthias Drusch (European Space Agency - ESA).

In order to make an accurate forecast of streamflow it is necessary to know the quantity of water stored in the catchment at the start of the forecast. These are called the initial hydrological conditions (IHCs) and includes water stored in the snowpack, river channel, lakes, vegetation canopy and soil moisture. Improving the accuracy of the IHCs could improve the accuracy of the subsequent streamflow forecasts.

The IHCs for forecasts of the Global Flood Awareness System of the Copernicus Emergency Management Service, GloFAS, are produced by the European Centre for Medium Range Weather Forecasts Land Data Assimilation System (ECMWF LDAS 2019) which combines (assimilates) observations from in-situ and satellite based sensors (Figure 4) with a first guess of the IHCs from the previous forecast. Meanwhile the IHCs used in the European Flood Awareness System (EFAS) are derived from in-situ observations of temperature, precipitation and wind speed.

Of the IHCs it has been shown that having an accurate estimate of the initial soil moisture conditions can often have the greatest positive impact upon the streamflow predictability. In EFAS, no direct observations of soil moisture are used to estimate its IHC. In GloFAS however, its initial soil moisture conditions produced by the ECMWF LDAS use observations from the Advanced Scatterometer (ASCAT) satellite and in-situ observations of 2 metre temperature and relative humidity. Since the release of ECMWF model cycle 46r1 in June 2019, the ECMWF LDAS estimation of initial soil moisture conditions also included observations from the Soil Moisture Ocean Salinity (SMOS) satellite (Figure 4). This addition of SMOS provided the opportunity to investigate the impact upon the accuracy of the GloFAS streamflow predictions.

The Soil Moisture Ocean Salinity (SMOS) measurements.

SMOS was launched in November 2009 by European Space Agency (ESA). It carries an L-band radiometer which measures brightness temperature emitted by the earth's surface at a frequency (1400-1427 MHz) which is sensitive to soil moisture in the top few centimetres of the soil layer. The measurements are at a spatial resolution of 43 km with a repeat cycle of less than 3 days. Brightness temperature measurements are converted into soil moisture using a neural network processor which has been trained on ECMWF LDAS soil moisture estimates.

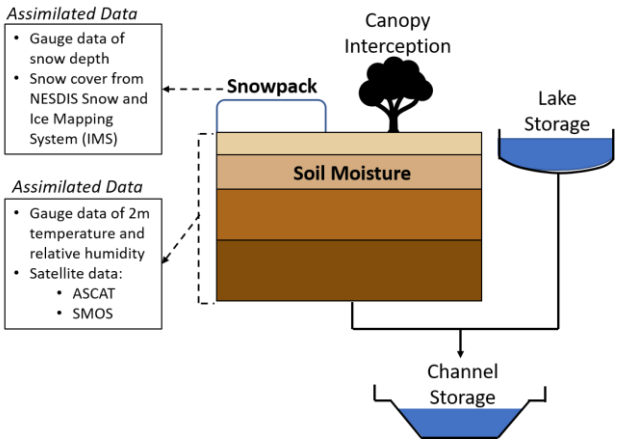


Figure 4: The Initial Hydrological Conditions (IHCs) in GloFAS, the data assimilated as part of the ECMWF LDAS are listed in the boxes.

Investigating the effect of SMOS Soil Moisture data assimilation in GloFAS simulations in Australia and United States of America.

As GloFAS forecasts are initialised using IHCs from the ECMWF LDAS, a partnership between ESA and ECMWF was established to investigate whether the inclusion of SMOS soil moisture data into the LDAS affected streamflow predicted by GloFAS. Two time series of initial soil moisture conditions were produced by the ECMWF LDAS for the period March 2017 to May 2018: one time series was produced by including observations from SMOS within the LDAS, the other time series excluded the SMOS observations. Both time series were then used within GloFAS as the initial soil moisture conditions on each day during the experiment period. They were combined with other IHCs from the ECMWF LDAS and precipitation and temperature forcings from the ECMWF deterministic Numerical Weather Prediction (NWP) forecast to predict streamflow for the next 24 hours.

The GloFAS streamflow predictions were evaluated against in-situ streamflow observations at 283 locations in the United States of America (USA) and 32 in Australia by computing the modified Kling-Gupta efficiency (KGE_{mod}) metric. Throughout the USA KGE_{mod} scores from the GloFAS simulations with and without the assimilation of SMOS soil moisture data were very small. The simulation with SMOS showed a very slight improvement (Table 1). In Australia the differences were also small but there, the simulation with SMOS observations showed a slight decline in the KGE_{mod} score (Table 2).$_{mod}$ score (Table 2).

The differences in the KGE_{mod} scores between the two GloFAS simulations at each gauging station were computed into a skill score, positive values showing an improvement in skill when SMOS data are assimilated. Results in the USA showed no clear spatial trend, with no distinctive clustering of positive or negative values (Figure 5). The strongest skill score values, of both signs, were in the central part of the country. Positive skill scores were found at 40 locations, however 31 of these locations still had a KGE_{mod} score less than 0.40 meaning that care should be taken when interpreting the significance of the improvement. Analysing the results at these 40 locations showed that the greatest differences occurred during periods of high streamflow, for example in the Platte river, USA (Figure 6).

GloFAS Simulation	R (correlation)	Bias	KGE_{mod}
Without SMOS obs	0.428	0.840	-0.504
With SMOS obs	0.420	0.812	-0.472

Table 1: KGE_{mod} evaluation metric and its components of correlation and bias computed across the 283 in-situ gauging stations in the United States of America.

GloFAS Simulation	R (correlation)	Bias	KGE_{mod}
Without SMOS obs	0.410	2.466	-1.248
With SMOS obs	0.356	2.558	-1.340

Table 2: KGE_{mod} evaluation metric and its components of correlation and bias computed across the 32 in-situ gauging stations in the Australia.

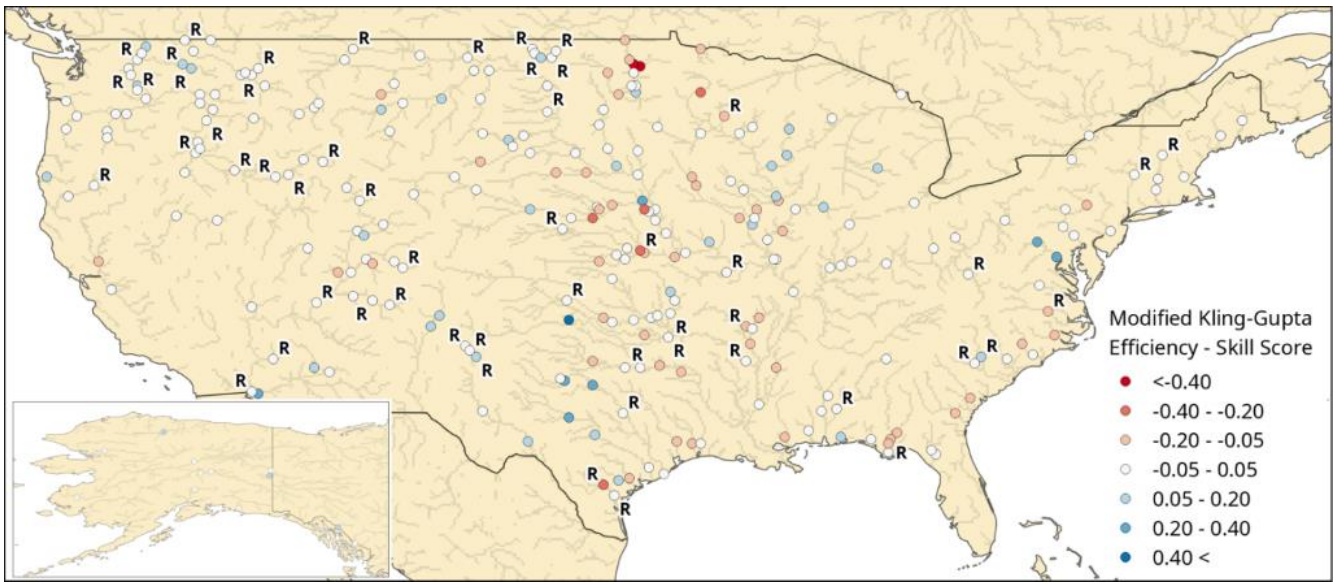


Figure 5: The skill score calculated with the KGE_{mod} from the GloFAS simulation with SMOS data assimilation referenced against the KGE_{mod} from the GloFAS simulation without SMOS data assimilation at the 283 gauging stations in the USA. Blue shows where the assimilation of SMOS soil moisture improves the skill and red where it is degraded GloFAS prediction skill. R shows locations subject to streamflow regulation. The background shows the GloFAS channel network.

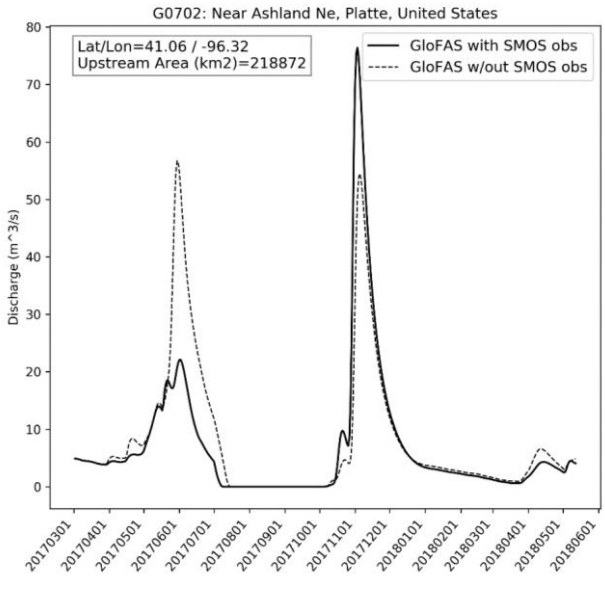


Figure 6: Predicted streamflows from both GloFAS experiments in the Platte river, USA.

Investigating the effect of SMOS Soil Moisture data assimilation in GloFAS simulations over the world.

Globally the impacts of SMOS data assimilation were assessed by comparing the differences in the low and high streamflow of the two GloFAS simulations in every 0.1° model cell. Low and high streamflow were calculated as the 5th and 95th percentiles respectively over the 18-month experiment period in both GloFAS simulations. The discharge values were converted into specific discharge by dividing by the upstream area in each 0.1° GloFAS model cell, this removed the influence of catchment size. High flows showed the greatest impact of the assimilation of SMOS data, especially in the Hudson Bay, central USA, Australia, the Sahel region and to a lesser extent Pakistan/north west India and north eastern China (Figure 7). The Hudson Bay area showed a widespread increase in high flows with the assimilation of SMOS, but the other regions showed no clear spatial trend to the changes.

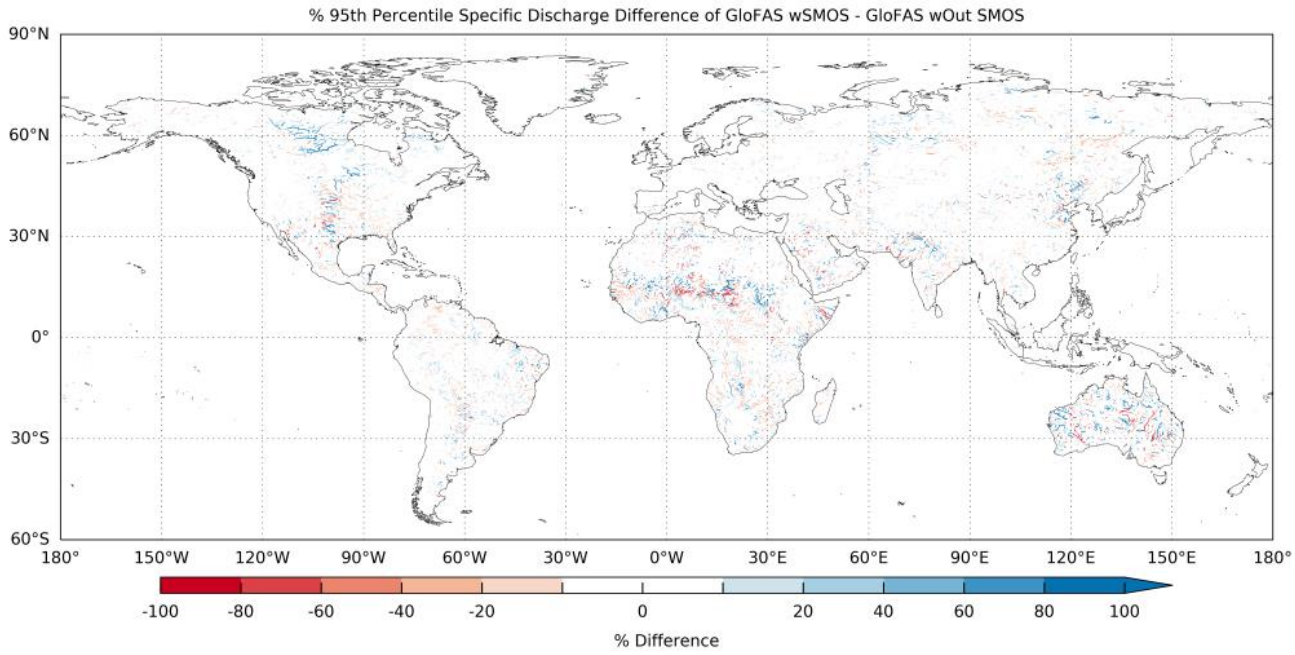


Figure 7: Difference in the 95th percentile (high flow) of specific discharge from the GloFAS simulations with and without SMOS data assimilation. Blue shows where GloFAS simulation with SMOS had a higher flow than the simulation without SMOS data assimilation, red shows the opposite.

Conclusions and next steps

The results from this study found that the assimilation of SMOS soil moisture data did affect the streamflow predictions of GloFAS. The greatest impact was upon predicted high streamflow values. The areas which demonstrated the greatest impacts coincided with areas of open land cover, where the SMOS data are expected to have the greatest accuracy. In other areas the SMOS measurements could be degraded by vegetation cover, mountainous topography or Radio Frequency Interference (RFI). The changes in high flow could be due changes in the soil moisture affecting the generation of surface runoff, with increase possibly due to wetter soil moisture which increases the amount of runoff that is delivered to the river channels. Future work could clarify this by investigating the impacts for specific flood events.

However, the overall impact of assimilating SMOS data upon predicted GloFAS streamflow was small. This is to be expected as the SMOS instrument only measures soil moisture in the top few centimetres of the soil layer, which is a small component of the total water stored in the IHCs. Despite this, the assimilation of SMOS data could still be beneficial for GloFAS predictions, particularly of high flows. ECMWF are now working with ESA to investigate the possibility of using SMOS data to quantify the amount of water used for irrigation purposes, this is currently a poorly known component of the hydrological cycle in GloFAS.

This work has been published as a scientific article: Baugh, C.; de Rosnay, P.; Lawrence, H.; Jurlina, T.; Drusch, M.; Zsoter, E.; Prudhomme, C. The Impact of SMOS Soil Moisture Data Assimilation within the Operational Global Flood Awareness System (GloFAS). Remote Sensing. 2020, 12, 1490. https://doi.org/10.3390/rs12091490

Urban flash flood in Zagreb Croatia, July 2020

by Dr. Tatjana Vujnovic, Head of the Hydrological Forecasting Division, Croatian Meteorological and Hydrological Service (DHMZ).

Figure 8: Zagreb city centre under water, 24/25th July 2020.

Zagreb is the capital city of Croatia, with estimated population of 804,507. It is located in the northwest, along the Sava river, at the southern slopes of Medvednica mountain. Average precipitation for July at Zagreb-Gric meteorological station (in the city centre) is 81.7mm (based on 1981-2010 climatology).

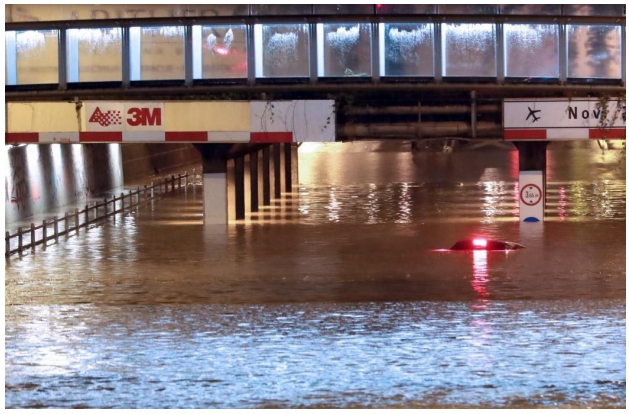


Figure 9: A flooded underpass in Zagreb city centre, 24th July 2020. Photo by Sanjin Strukic/PIXELL

Numerical weather models successfully forecasted heavy rainfall, which occurred on the late evening of 24 July 2020. The Croatian Meteorological and Hydrological service (DHMZ) issued red warnings for precipitation and thunderstorms (including flash flood warnings) in Meteoalarm for central and north-western parts of the country. Hydrological forecasters of DHMZ also issued urban flood warnings for the Zagreb city area, since the signals from the two hydrological flash flood forecasting systems operationally used in DHMZ (EFAS ERIC and Southeast Europe Flash Flood Guidance System) were consistent and showed a significant possibility of severe flash flooding as shown in the figure below.

Figure 10: ERIC forecast return period and reporting points for Zagreb, 23 July 2020. Source: EFAS

The EFAS ERIC flash flood forecast from 23 July at 00 UTC indicated significant risk of severe flash flooding for Zagreb and surrounding areas. The graph shows the ERIC flash flood forecast time series in Zagreb where peak flows were expected during the night between the 24th to the 25th July 2020. The map shows red and purple triangles indicating the reporting points from the ERIC flash flood forecast, the red and purple shading shows the river channels which could be affected, the blue triangles are where EFAS flash flood notifications were issued (Figure 10).

On the late evening of 24 July 2020, Zagreb-Gric meteorological station recorded 80.1 mm of rain within a 3-hour period, causing urban flash flooding all over the city. The flooding was most severe in the city centre, where people are still struggling with the effects of the earthquake that occurred on 22 March 2020. Numerous streets became impassable, public transport was

disrupted, multiple structures and basements were flooded, and fire departments responded to over 350 interventions during the night of the 24/25 July 2020. Tragically, one firefighter passed away during an intervention.

Figure 11: Trams were out of service in Zagreb, 24/25th July 2020. Photo by 24sata.hr

In addition to the huge amount of water accumulated from the storm over a short period of time, one of causes of the urban flooding was a poor evacuation of water within the urban drainage network. The sewerage system in Zagreb was established in 1892. It is a mixed type system which collects sewage from households, excess rainwater, and from streams that come from Medvednica mountain. The system will have to be renewed as the city of Zagreb expands and becomes more urbanized. In its current state, the values used for the sewerage system's dimensions are outdated and not fit for purpose. In addition, the system needs to be adapted to mitigate the effects of climate change as more frequent extreme precipitation events become increasingly likely.

Flooding in western Ukraine, June 2020

by Richard Davies, floodlist

Ukraine's western regions were ravaged by heavy rainfalls and flooding in late June 2020. The hardest hit areas were in Ivano-Frankivsk, Chernivtsi, Zakarpattia, Ternopil and Lviv regions. Thousands of homes were damaged, along with bridges and roads. Three people sadly lost their lives in the flooding.

Figure 12: A flood damaged bridge in western Ukraine, June 2020. Source: National State Emergency Service of Ukraine

Rivers and Rainfall

Figures from the Ukrainian Hydrometeorological Center show some areas recorded more than 200mm of rain during the period 20 to 24 June.

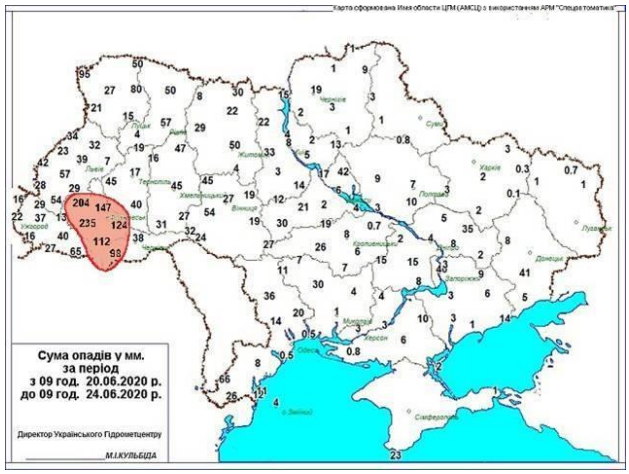


Figure 13: Rainfall map, June 2020 Ukraine. Source: Ukrainian Hydrometeorological Center

According to the State Agency of Water Resources of Ukraine, levels of the Siret and Prut rivers in Chernivtsi region rose rapidly. As of 24 June, the Prut river at Tarasivtsi reached 8.04 metres. Ukrainian Hydrometeorological Center reports showed the Dniester river at Sambir in Lviv Region stood at 4.4 metres as of 24 June.

Flood Damage

Reports from the State Emergency Service of Ukraine (SESU) said over 14,000 homes were damaged by the floods across 342 settlements. Hundreds of people were rescued or evacuated from flooded areas by emergency services, including by helicopter. Around

1,500 people were moved to temporary accommodation in public buildings.

Figure 14: Extensive flooding in western Ukraine. Source: National State Emergency Service of Ukraine

Swollen rivers washed away bridges and roads, flooded several dozen villages and cities, destroyed power lines and dams. Over 270 settlements were left without electricity.

Figure 15: Flood response services on site in western Ukraine. Source: National State Emergency Service of Ukraine.

Copernicus Mapping

After the situation proved critical, the Copernicus Emergency Management Service (CEMS) Rapid Mapping service was activated on 25 June by the European Emergency Response Coordination Centre (ERCC) to map the areas located in the south-west of Ukraine. Maps of flood extent in western Ukraine for this event can be viewed on CEMS Mapping website.

Acknowledgements

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

- DG GROW - 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: A flooded underpass in Zagreb city centre, 24th July 2020. Source: Sanjin Strukic/PIXELL

Appendix - figures

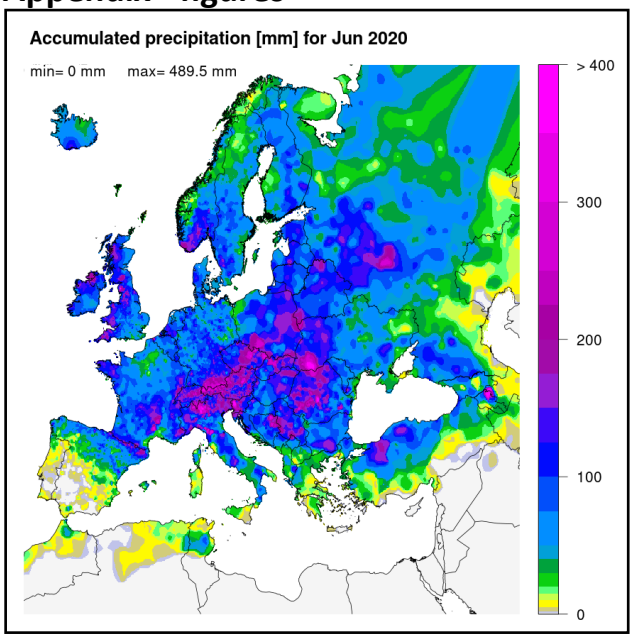


Figure 16. Accumulated precipitation [mm] for June 2020.

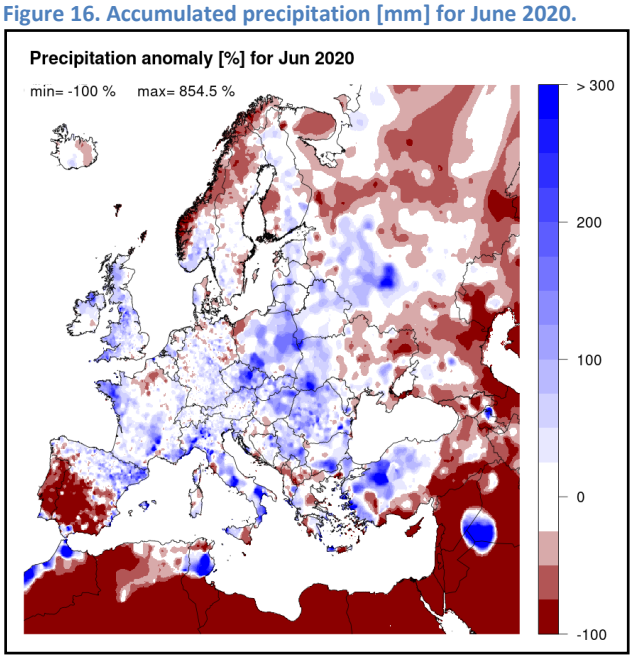


Figure 17. Precipitation anomaly [%] for June 2020, relative to a long-term average (1990-2013). Blue (red) denotes wetter (drier) conditions than normal.

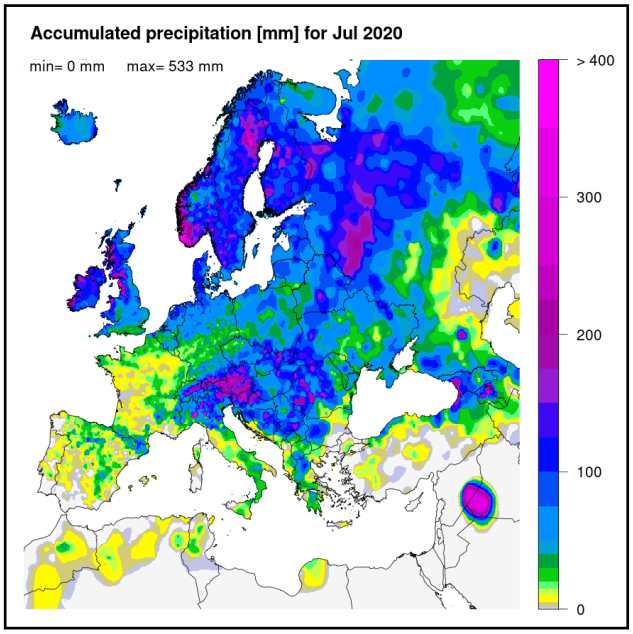


Figure 18. Accumulated precipitation [mm] for July 2020.

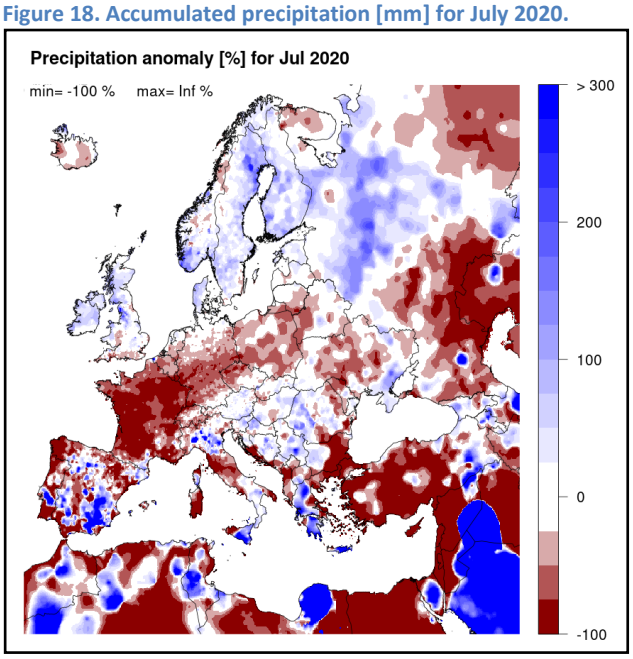


Figure 19. Precipitation anomaly [%] for July 2020, relative to a long-term average (1990-2013). Blue (red) denotes wetter (drier) conditions than normal.

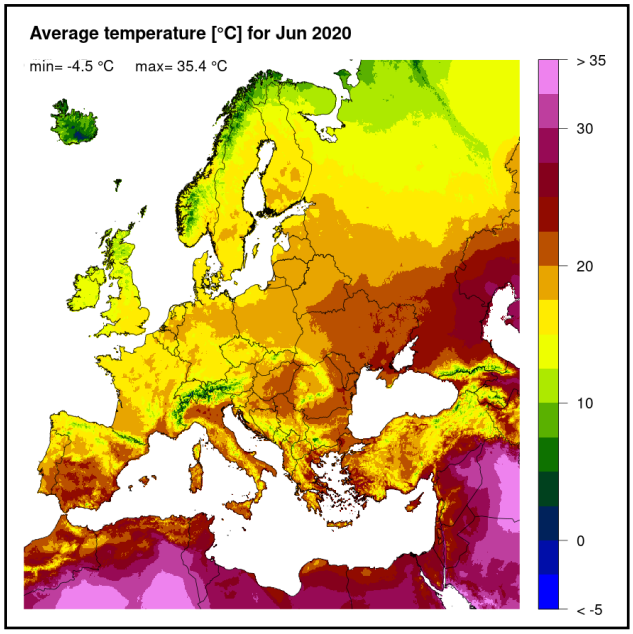


Figure 20. Mean temperature [°C] for June 2020.

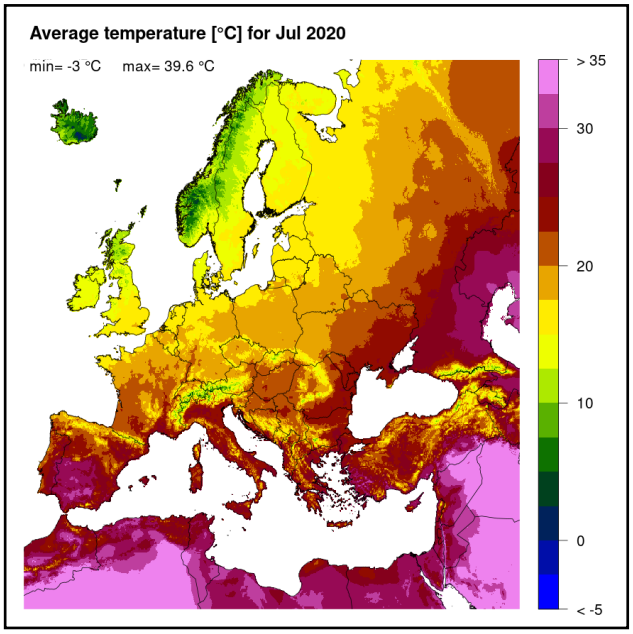


Figure 22. Mean temperature [°C] for July 2020.

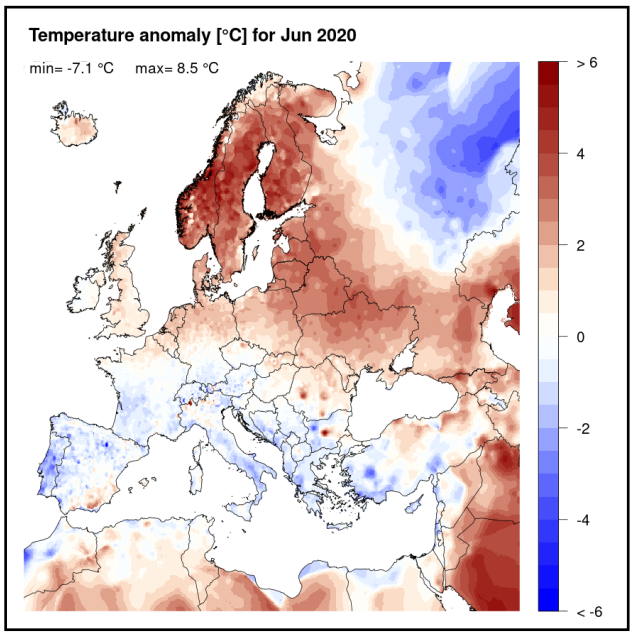


Figure 21. Temperature anomaly [°C] for June 2020, relative to a long-term average (1990-2013). Blue (red) denotes colder (warmer) temperatures than normal.

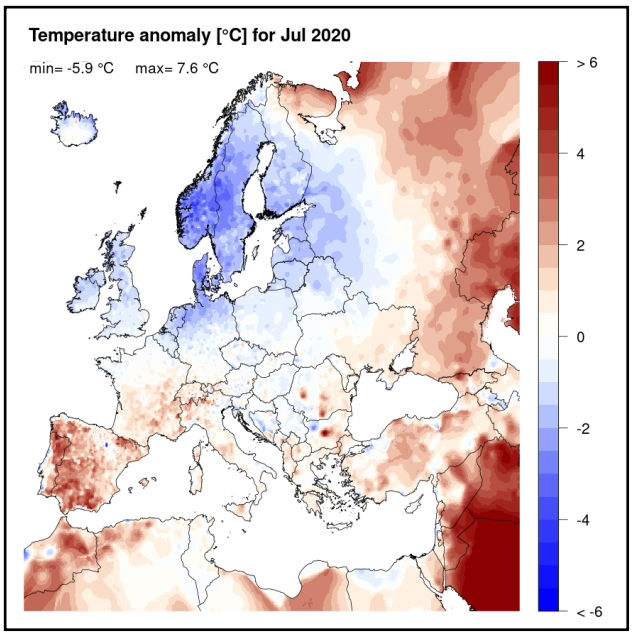


Figure 23. Temperature anomaly [°C] for July 2020, relative to a long-term average (1990-2013). Blue (red) denotes colder (warmer) temperatures than normal.

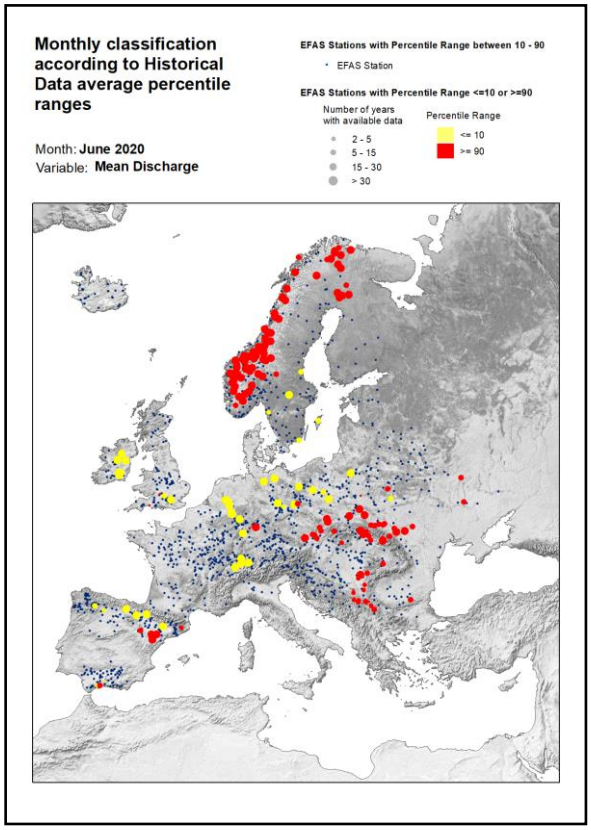


Figure 24. Monthly discharge anomalies June 2020.

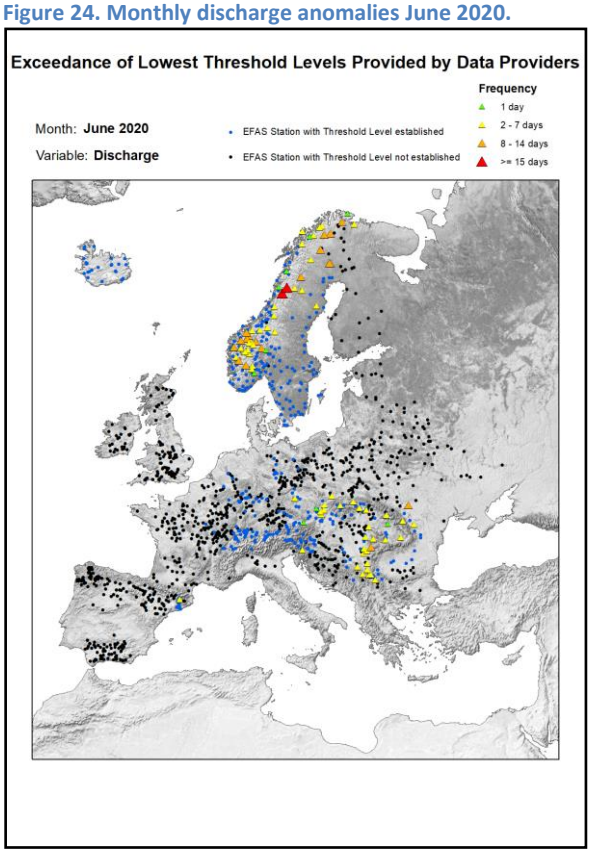


Figure 25. Lowest alert level exceedance for June 2020.

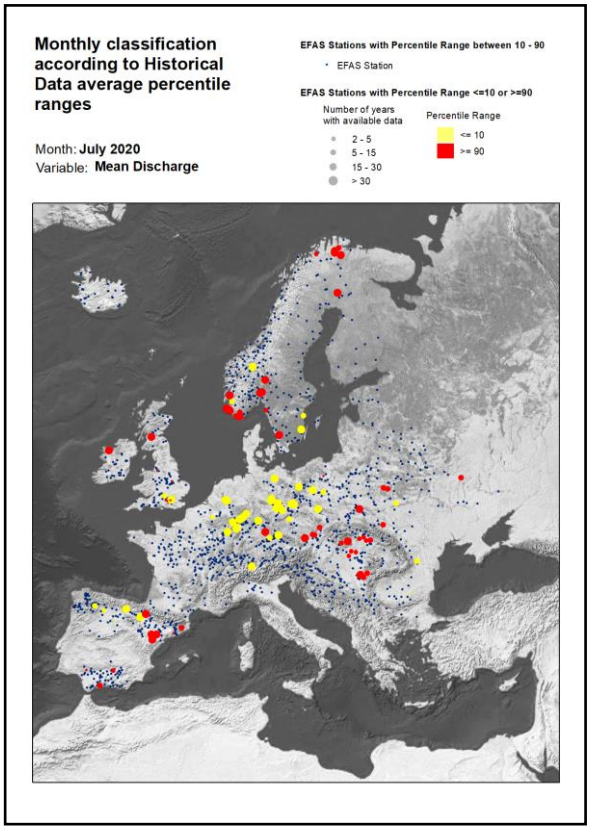


Figure 26. Monthly discharge anomalies July 2020.

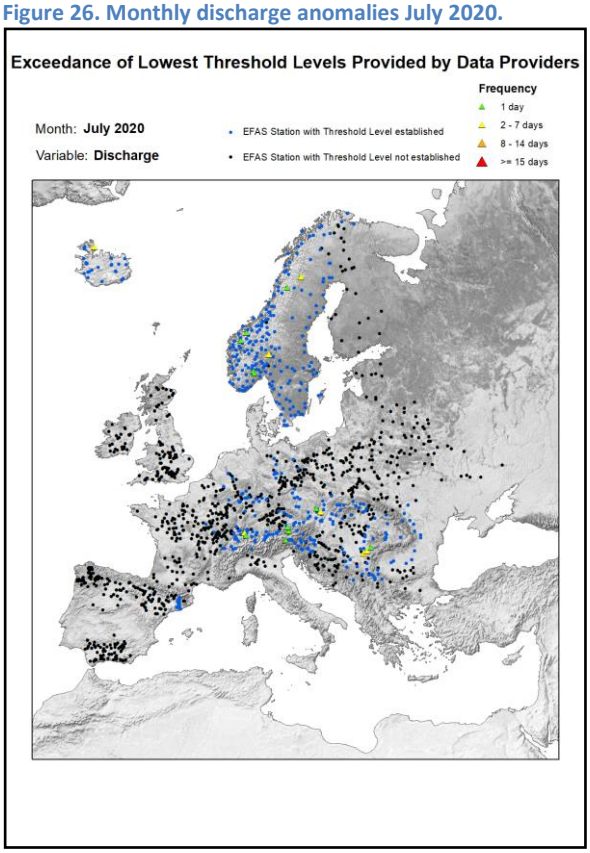


Figure 27. Lowest alert level exceedance for July 2020.

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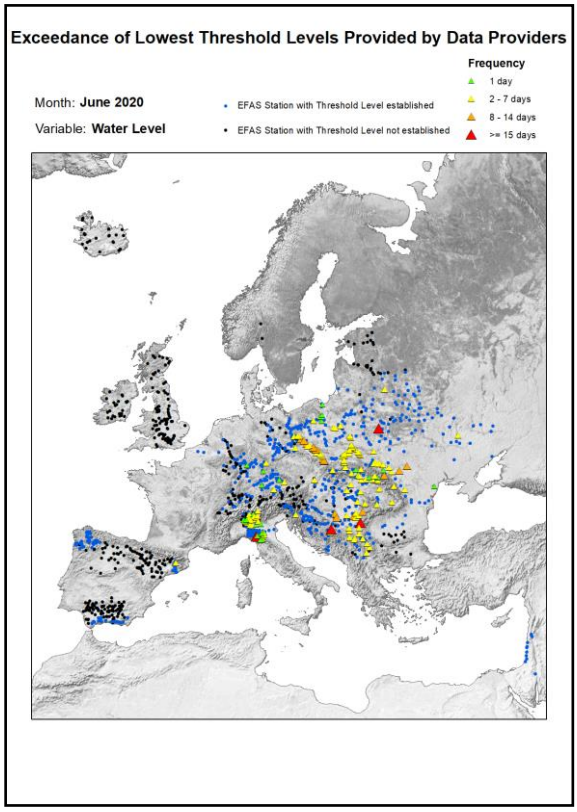

Figure 28. Lowest threshold exceedance for June 2020.

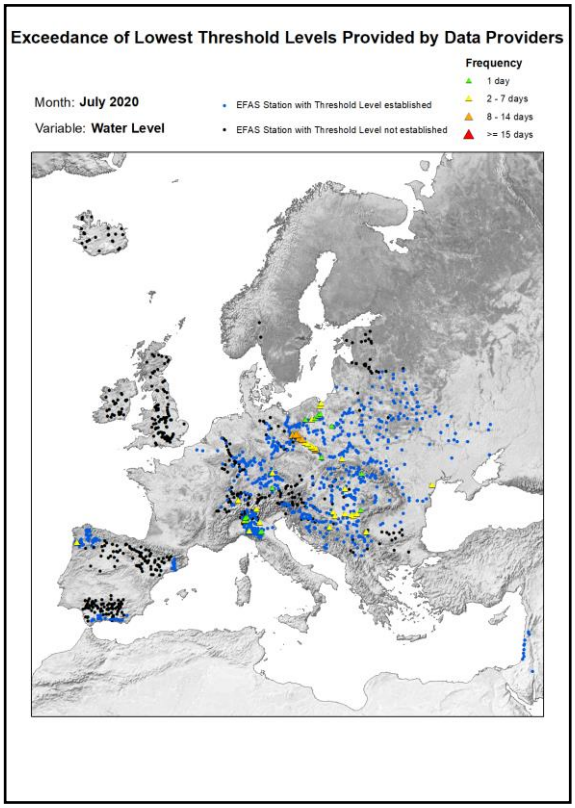

Figure 29. Lowest threshold exceedance for July 2020.

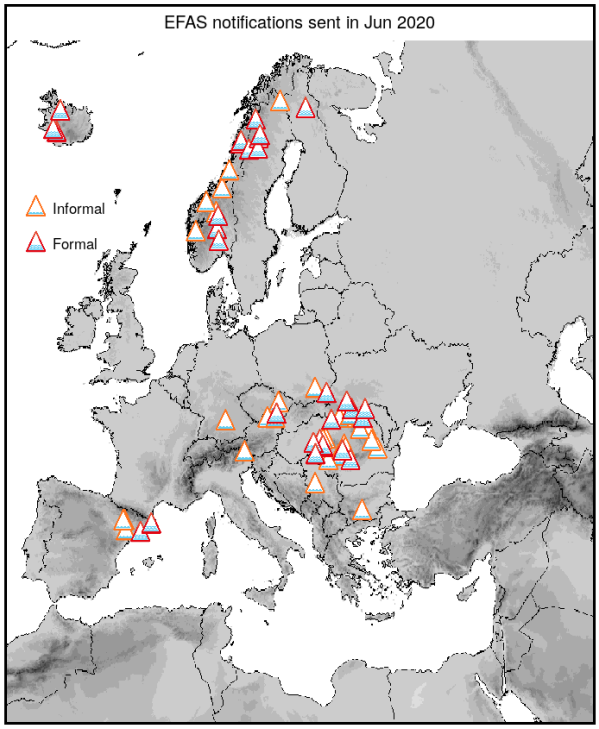

Figure 30. EFAS flood notifications sent for June.

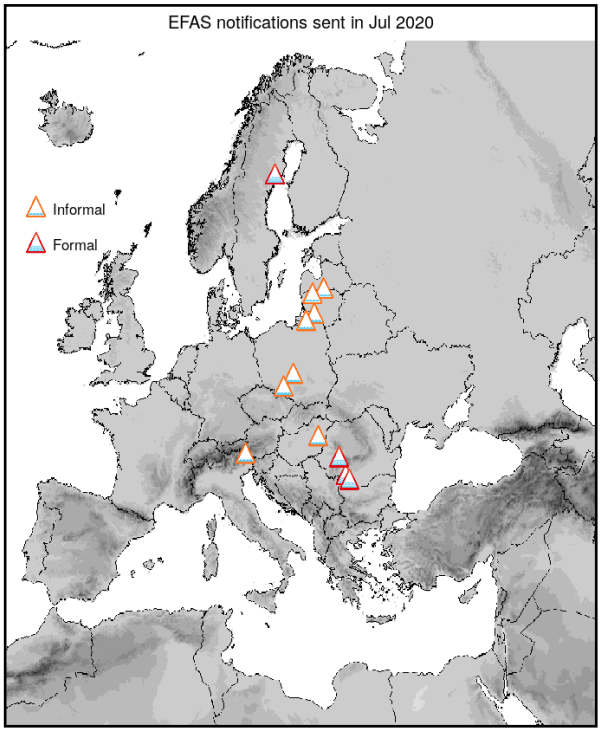

Figure 32. EFAS flood notifications sent for July 2020.

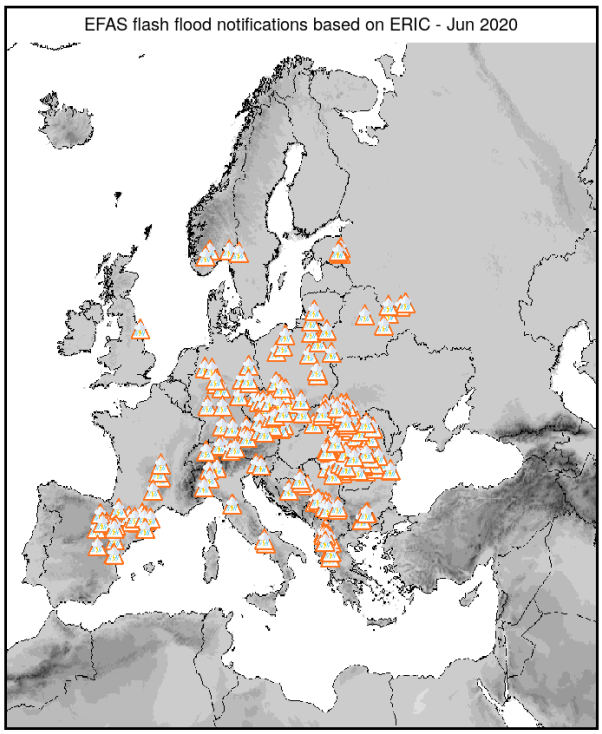

Figure 31. Flash flood notifications sent for June.

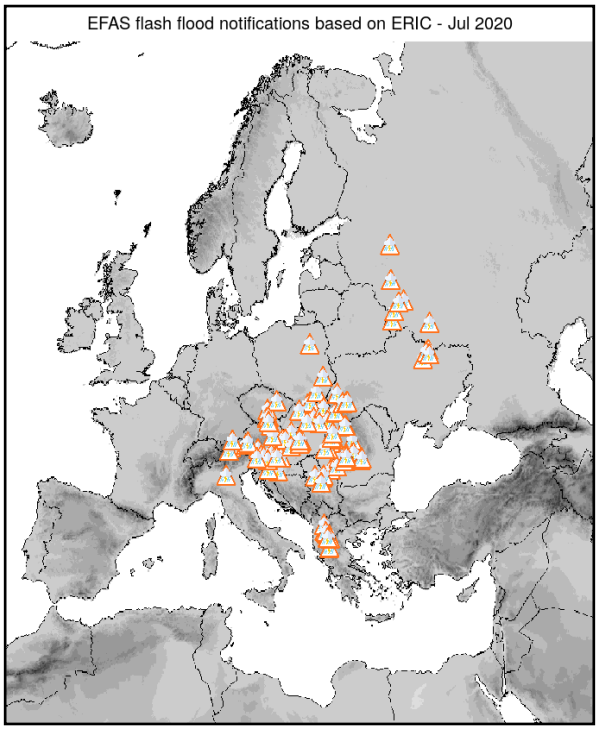

Figure 33. Flash flood notifications sent for July 2020.

Appendix - tables

Table 3. EFAS flood notifications sent in June - July 2020

Type	Forecast Date	Issue Date	Lead Time	River	Country
Informal	01/06/2020 12UTC	02/06/2020	0	Segre	Spain
Formal	02/06/2020 12UTC	03/06/2020	3	Begna	Norway
Formal	02/06/2020 12UTC	03/06/2020	2	Llobregat	Spain
Informal	03/06/2020 12UTC	04/06/2020	0	Ter	Spain
Informal	03/06/2020 12UTC	04/06/2020	0	Lagen	Norway
Informal	04/06/2020 00UTC	04/06/2020	0	Nea	Norway
Formal	03/06/2020 12UTC	04/06/2020	5	Coastal zone	Norway
Formal	04/06/2020 00UTC	04/06/2020	4	Ter	Spain
Informal	05/06/2020 00UTC	05/06/2020	1	Muonio	Finland
Informal	05/06/2020 12UTC	06/06/2020	6	Rauma	Norway
Formal	05/06/2020 12UTC	06/06/2020	5	Rana	Norway
Formal	06/06/2020 12UTC	07/06/2020	6	Umealven	Sweden
Formal	07/06/2020 00UTC	07/06/2020	2	Sog and Hvita	Iceland
Formal	07/06/2020 00UTC	07/06/2020	4	Pjorsa	Iceland
Informal	07/06/2020 12UTC	08/06/2020	5	Vosso	Norway
Formal	07/06/2020 12UTC	08/06/2020	6	Vatnsdalsa	Iceland
Formal	07/06/2020 12UTC	08/06/2020	7	Lagen	Norway
Formal	08/06/2020 00UTC	08/06/2020	7	Skellefte	Sweden
Formal	10/06/2020 00UTC	10/06/2020	4	Tjeggelvas	Sweden
Formal	10/06/2020 00UTC	10/06/2020	3	Stora Lule	Sweden
Informal	11/06/2020 00UTC	11/06/2020	1	Crisul Repede	Hungary
Informal	11/06/2020 00UTC	11/06/2020	2	Trotus	Romania
Informal	11/06/2020 00UTC	11/06/2020	3	Crisul Repede	Romania
Informal	11/06/2020 00UTC	11/06/2020	2	Strei	Romania
Formal	11/06/2020 00UTC	11/06/2020	1	Olt	Romania
Informal	12/06/2020 00UTC	12/06/2020	1	Putna	Romania
Informal	13/06/2020 12UTC	14/06/2020	2	Mures	Romania
Informal	14/06/2020 00UTC	14/06/2020	1	Timis	Romania
Formal	13/06/2020 12UTC	14/06/2020	6	Sebes Koros	Hungary
Informal	14/06/2020 12UTC	15/06/2020	0	Wrnitz	Germany
Informal	15/06/2020 12UTC	16/06/2020	1	Maritsa	Bulgaria
Formal	16/06/2020 00UTC	16/06/2020	1	Prut	Ukraine
Formal	16/06/2020 00UTC	16/06/2020	2	Dnister	Ukraine
Formal	16/06/2020 00UTC	16/06/2020	6	Vindel	Sweden
Formal	16/06/2020 00UTC	16/06/2020	3	Crisul Alb	Romania
Formal	16/06/2020 00UTC	16/06/2020	3	Crisul Negru	Romania
Formal	16/06/2020 00UTC	16/06/2020	2	Harmas-Koros	Hungary
Informal	16/06/2020 12UTC	17/06/2020	0	Tisza	Ukraine
Informal	17/06/2020 00UTC	17/06/2020	1	Namsen	Norway
Formal	16/06/2020 12UTC	17/06/2020	2	Mures	Romania
Informal	19/06/2020 00UTC	19/06/2020	1	Teresva	Ukraine
Informal	19/06/2020 00UTC	19/06/2020	2	Cheremosh	Ukraine
Formal	18/06/2020 12UTC	19/06/2020	4	Siret	Romania
Informal	19/06/2020 12UTC	20/06/2020	1	Moldova	Romania
Informal	20/06/2020 00UTC	20/06/2020	1	Trotus	Romania
Formal	19/06/2020 12UTC	20/06/2020	4	Prut	Romania

Formal	20/06/2020 00UTC	20/06/2020	3	Tisza	Hungary
Formal	20/06/2020 00UTC	20/06/2020	3	Snarum	Norway
Formal	20/06/2020 00UTC	20/06/2020	5	Mures	Hungary
Informal	20/06/2020 12UTC	21/06/2020	1	Kolubara	Serbia
Informal	21/06/2020 00UTC	21/06/2020	1	Bistrita	Romania
Informal	23/06/2020 12UTC	24/06/2020	0	Wisoka	Poland
Formal	25/06/2020 00UTC	25/06/2020	3	Mure?	Hungary
Informal	25/06/2020 12UTC	26/06/2020	1	Tirnava	Romania
Formal	25/06/2020 12UTC	26/06/2020	2	San	Poland
Informal	27/06/2020 00UTC	27/06/2020	2	Isel	Austria
Informal	27/06/2020 00UTC	27/06/2020	2	Isel	Austria
Informal	27/06/2020 12UTC	28/06/2020	1	Thaya	Austria
Informal	27/06/2020 12UTC	28/06/2020	0	Gllego	Spain
Informal	27/06/2020 12UTC	28/06/2020	0	Gllego	Spain
Informal	28/06/2020 00UTC	28/06/2020	1	Morava	Czechia
Informal	28/06/2020 00UTC	28/06/2020	1	Thaya	Czechia
Formal	27/06/2020 12UTC	28/06/2020	1	Svratka	Czechia
Formal	28/06/2020 12UTC	29/06/2020	2	Tjeggelvas	Sweden
Formal	28/06/2020 12UTC	29/06/2020	2	Luiro	Finland
Informal	30/06/2020 12UTC	01/07/2020	0	Nysa Klodzka	Poland
Informal	30/06/2020 12UTC	01/07/2020	0	Widawka	Poland
Informal	30/06/2020 12UTC	01/07/2020	0	Musa	Latvia
Informal	30/06/2020 12UTC	01/07/2020	0	Pregolya	Russia
Informal	30/06/2020 12UTC	01/07/2020	0	Sheshule	Russia
Informal	30/06/2020 12UTC	01/07/2020	0	Venta	Lithuania
Informal	06/07/2020 00UTC	06/07/2020	0	Barcu	Hungary
Informal	08/07/2020 00UTC	08/07/2020	3	Drava	Austria
Formal	11/07/2020 12UTC	12/07/2020	2	Umeliven	Sweden
Formal	16/07/2020 12UTC	17/07/2020	2	Jiu	Romania
Formal	18/07/2020 00UTC	18/07/2020	2	Jiu	Romania
Informal	21/07/2020 12UTC	22/07/2020	4	Strei	Romania
Formal	21/07/2020 12UTC	22/07/2020	3	Mures	Romania
Informal	27/07/2020 00UTC	27/07/2020	0	Strei	Romania

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

Table 4. EFAS flash flood notifications sent in June - July 2020

Type	Forecast Date	Issue Date	Lead Time	Region	Country
Flash Flood	01/06/2020 00UTC	01/06/2020	42	Pelagoniski	North Macedo-
Flash Flood	01/06/2020 00UTC	01/06/2020	18	Ipeiros	Greece
Flash Flood	01/06/2020 12UTC	02/06/2020	54		
Flash Flood	01/06/2020 12UTC	02/06/2020	72	Pyrenees-Orientales	France
Flash Flood	01/06/2020 12UTC	02/06/2020	66		
Flash Flood	01/06/2020 12UTC	02/06/2020	66		
Flash Flood	01/06/2020 12UTC	02/06/2020	66	Huesca	Spain
Flash Flood	01/06/2020 12UTC	02/06/2020	66	Girona	Spain
Flash Flood	01/06/2020 12UTC	02/06/2020	72		
Flash Flood	01/06/2020 12UTC	02/06/2020	78	Barcelona	Spain
Flash Flood	01/06/2020 12UTC	02/06/2020	30	Jugozapaden	North Macedo-

Flash Flood	01/06/2020 12UTC	02/06/2020	66	Lleida	Spain
Flash Flood	02/06/2020 00UTC	02/06/2020	60	Aude	France
Flash Flood	02/06/2020 00UTC	02/06/2020	60	Soria	Spain
Flash Flood	02/06/2020 00UTC	02/06/2020	42	Pyrenees-Atlantiques	France
Flash Flood	03/06/2020 00UTC	03/06/2020	24	Ariege	France
Flash Flood	03/06/2020 00UTC	03/06/2020	78	Telemark	Norway
Flash Flood	03/06/2020 12UTC	04/06/2020	48	Pskov	Russia
Flash Flood	03/06/2020 12UTC	04/06/2020	48	Louna-Eesti	Estonia
Flash Flood	03/06/2020 12UTC	04/06/2020	60	Aust-Agder	Norway
Flash Flood	03/06/2020 12UTC	04/06/2020	24		
Flash Flood	03/06/2020 12UTC	04/06/2020	60	Poloski	North Macedo-
Flash Flood	03/06/2020 12UTC	04/06/2020	48	Campania	Italy
Flash Flood	03/06/2020 12UTC	04/06/2020	60	Jugozapaden	North Macedo-
Flash Flood	04/06/2020 00UTC	04/06/2020	54	Diber	Albania
Flash Flood	04/06/2020 00UTC	04/06/2020	60	Varmlands lan	Sweden
Flash Flood	04/06/2020 00UTC	04/06/2020	60	Ostfold	Norway
Flash Flood	04/06/2020 00UTC	04/06/2020	36		
Flash Flood	04/06/2020 00UTC	04/06/2020	30		
Flash Flood	04/06/2020 00UTC	04/06/2020	36	Molise	Italy
Flash Flood	04/06/2020 00UTC	04/06/2020	54	Korce	Albania
Flash Flood	04/06/2020 00UTC	04/06/2020	60	Dytiki Makedonia	Greece
Flash Flood	04/06/2020 00UTC	04/06/2020	60	Ipeiros	Greece
Flash Flood	04/06/2020 00UTC	04/06/2020	30	Toscana	Italy
Flash Flood	04/06/2020 12UTC	05/06/2020	48	Pelagoniski	North Macedo-
Flash Flood	05/06/2020 00UTC	05/06/2020	18	Aust-Agder	Norway
Flash Flood	05/06/2020 00UTC	05/06/2020	42	Elbasan	Albania
Flash Flood	05/06/2020 12UTC	06/06/2020	48	Lleida	Spain
Flash Flood	05/06/2020 12UTC	06/06/2020	42		
Flash Flood	05/06/2020 12UTC	06/06/2020	48	Huesca	Spain
Flash Flood	05/06/2020 12UTC	06/06/2020	48		
Flash Flood	05/06/2020 12UTC	06/06/2020	48	Ariege	France
Flash Flood	05/06/2020 12UTC	06/06/2020	48	Pyrenees-Orientales	France
Flash Flood	06/06/2020 00UTC	06/06/2020	48	Barcelona	Spain
Flash Flood	06/06/2020 00UTC	06/06/2020	42	Lombardia	Italy
Flash Flood	06/06/2020 00UTC	06/06/2020	48	Piemonte	Italy
Flash Flood	06/06/2020 12UTC	07/06/2020	24		
Flash Flood	06/06/2020 12UTC	07/06/2020	36	Teruel	Spain
Flash Flood	06/06/2020 12UTC	07/06/2020	36	Castellon / Castello	Spain
Flash Flood	07/06/2020 00UTC	07/06/2020	30		
Flash Flood	07/06/2020 00UTC	07/06/2020	48	Lombardia	Italy
Flash Flood	07/06/2020 12UTC	08/06/2020	24	Dolnoslaskie	Poland
Flash Flood	07/06/2020 12UTC	08/06/2020	54	Jugozapaden	North Macedo-
Flash Flood	07/06/2020 12UTC	08/06/2020	54	Pelagoniski	North Macedo-
Flash Flood	08/06/2020 00UTC	08/06/2020	36	Dytiki Makedonia	Greece
Flash Flood	08/06/2020 00UTC	08/06/2020	42	Korce	Albania
Flash Flood	08/06/2020 12UTC	09/06/2020	42	Bratislavsky kraj	Slovakia
Flash Flood	08/06/2020 12UTC	09/06/2020	42	Jihomoravsky kraj	Czech Republic
Flash Flood	08/06/2020 12UTC	09/06/2020	42	Niederosterreich	Austria
Flash Flood	09/06/2020 12UTC	10/06/2020	48	Arges	Romania
Flash Flood	09/06/2020 12UTC	10/06/2020	54		
Flash Flood	10/06/2020 00UTC	10/06/2020	60	Brasov	Romania

Flash Flood	10/06/2020 00UTC	10/06/2020	30	Lubelskie	Poland
Flash Flood	10/06/2020 00UTC	10/06/2020	60	Dambovita	Romania
Flash Flood	10/06/2020 00UTC	10/06/2020	54	Bihor	Romania
Flash Flood	10/06/2020 00UTC	10/06/2020	54		
Flash Flood	10/06/2020 00UTC	10/06/2020	54	Sibiu	Romania
Flash Flood	10/06/2020 00UTC	10/06/2020	54	Valcea	Romania
Flash Flood	10/06/2020 00UTC	10/06/2020	60	Prahova	Romania
Flash Flood	10/06/2020 00UTC	10/06/2020	30		
Flash Flood	10/06/2020 12UTC	11/06/2020	66		
Flash Flood	10/06/2020 12UTC	11/06/2020	24	Caras-Severin	Romania
Flash Flood	10/06/2020 12UTC	11/06/2020	54		
Flash Flood	10/06/2020 12UTC	11/06/2020	54		
Flash Flood	10/06/2020 12UTC	11/06/2020	60	Haute-Loire	France
Flash Flood	10/06/2020 12UTC	11/06/2020	48	Puy-de-Dome	France
Flash Flood	11/06/2020 00UTC	11/06/2020	48	Allier	France
Flash Flood	11/06/2020 00UTC	11/06/2020	30	Buzau	Romania
Flash Flood	11/06/2020 00UTC	11/06/2020	30		
Flash Flood	11/06/2020 00UTC	11/06/2020	36		
Flash Flood	11/06/2020 00UTC	11/06/2020	24	Ialomita	Romania
Flash Flood	11/06/2020 00UTC	11/06/2020	48	Aveyron	France
Flash Flood	11/06/2020 12UTC	12/06/2020	24	North Yorkshire	United Kingdom
Flash Flood	12/06/2020 00UTC	12/06/2020	36	Covasna	Romania
Flash Flood	12/06/2020 12UTC	13/06/2020	42		
Flash Flood	12/06/2020 12UTC	13/06/2020	66	Thuringen	Germany
Flash Flood	12/06/2020 12UTC	13/06/2020	24		
Flash Flood	12/06/2020 12UTC	13/06/2020	42		
Flash Flood	12/06/2020 12UTC	13/06/2020	36	Kaluga	Russia
Flash Flood	12/06/2020 12UTC	13/06/2020	36		
Flash Flood	12/06/2020 12UTC	13/06/2020	60		
Flash Flood	12/06/2020 12UTC	13/06/2020	60		
Flash Flood	12/06/2020 12UTC	13/06/2020	60	Kassel	Germany
Flash Flood	12/06/2020 12UTC	13/06/2020	36		
Flash Flood	12/06/2020 12UTC	13/06/2020	42	Smolensk	Russia
Flash Flood	12/06/2020 12UTC	13/06/2020	36	Luzern	Switzerland
Flash Flood	12/06/2020 12UTC	13/06/2020	42	Mahilyow	Belarus
Flash Flood	13/06/2020 00UTC	13/06/2020	54		
Flash Flood	13/06/2020 12UTC	14/06/2020	60	Caras-Severin	Romania
Flash Flood	13/06/2020 12UTC	14/06/2020	30	Minsk	Belarus
Flash Flood	13/06/2020 12UTC	14/06/2020	54		
Flash Flood	13/06/2020 12UTC	14/06/2020	42		
Flash Flood	13/06/2020 12UTC	14/06/2020	48	Dambovita	Romania
Flash Flood	13/06/2020 12UTC	14/06/2020	60	Alba	Romania
Flash Flood	13/06/2020 12UTC	14/06/2020	60	Arad	Romania
Flash Flood	13/06/2020 12UTC	14/06/2020	36	Weser-Ems	Germany
Flash Flood	13/06/2020 12UTC	14/06/2020	30	Detmold	Germany
Flash Flood	13/06/2020 12UTC	14/06/2020	18		
Flash Flood	13/06/2020 12UTC	14/06/2020	60	Cluj	Romania
Flash Flood	13/06/2020 12UTC	14/06/2020	54	Salaj	Romania
Flash Flood	13/06/2020 12UTC	14/06/2020	24		
Flash Flood	14/06/2020 00UTC	14/06/2020	54	Gorj	Romania
Flash Flood	14/06/2020 00UTC	14/06/2020	42	Arges	Romania

Flash Flood	14/06/2020 00UTC	14/06/2020	30	Jihomoravsky kraj	Czech Republic
Flash Flood	14/06/2020 00UTC	14/06/2020	24		
Flash Flood	14/06/2020 12UTC	15/06/2020	54		
Flash Flood	14/06/2020 12UTC	15/06/2020	24	Kassel	Germany
Flash Flood	14/06/2020 12UTC	15/06/2020	54		
Flash Flood	15/06/2020 00UTC	15/06/2020	54	Piemonte	Italy
Flash Flood	15/06/2020 00UTC	15/06/2020	54		
Flash Flood	15/06/2020 00UTC	15/06/2020	54		
Flash Flood	15/06/2020 00UTC	15/06/2020	36		
Flash Flood	15/06/2020 12UTC	16/06/2020	48	Ivano-Frankivs'k	Ukraine
Flash Flood	15/06/2020 12UTC	16/06/2020	54		
Flash Flood	16/06/2020 00UTC	16/06/2020	36		
Flash Flood	16/06/2020 00UTC	16/06/2020	54		
Flash Flood	16/06/2020 00UTC	16/06/2020	36		
Flash Flood	16/06/2020 00UTC	16/06/2020	36	Satu Mare	Romania
Flash Flood	16/06/2020 00UTC	16/06/2020	36		
Flash Flood	16/06/2020 12UTC	17/06/2020	42	Oberbayern	Germany
Flash Flood	16/06/2020 12UTC	17/06/2020	42	Salzburg	Austria
Flash Flood	16/06/2020 12UTC	17/06/2020	30	Valcea	Romania
Flash Flood	16/06/2020 12UTC	17/06/2020	48	Caras-Severin	Romania
Flash Flood	16/06/2020 12UTC	17/06/2020	24		
Flash Flood	16/06/2020 12UTC	17/06/2020	24	Alba	Romania
Flash Flood	16/06/2020 12UTC	17/06/2020	24	Salaj	Romania
Flash Flood	16/06/2020 12UTC	17/06/2020	24	Bihor	Romania
Flash Flood	17/06/2020 00UTC	17/06/2020	30		
Flash Flood	17/06/2020 00UTC	17/06/2020	60	Hlavni mesto Praha	Czech Republic
Flash Flood	17/06/2020 00UTC	17/06/2020	60	Thuringen	Germany
Flash Flood	17/06/2020 00UTC	17/06/2020	60	Stredocesky kraj	Czech Republic
Flash Flood	17/06/2020 00UTC	17/06/2020	60	Ustecky kraj	Czech Republic
Flash Flood	17/06/2020 00UTC	17/06/2020	60	Transcarpathia	Ukraine
Flash Flood	17/06/2020 00UTC	17/06/2020	54		
Flash Flood	17/06/2020 00UTC	17/06/2020	60	Chemnitz	Germany
Flash Flood	17/06/2020 12UTC	18/06/2020	24		
Flash Flood	17/06/2020 12UTC	18/06/2020	48	Brandenburg	Germany
Flash Flood	17/06/2020 12UTC	18/06/2020	60	Berlin	Germany
Flash Flood	17/06/2020 12UTC	18/06/2020	48	Dresden	Germany
Flash Flood	17/06/2020 12UTC	18/06/2020	48	Leipzig	Germany
Flash Flood	17/06/2020 12UTC	18/06/2020	48	Sachsen-Anhalt	Germany
Flash Flood	17/06/2020 12UTC	18/06/2020	42	Maramures	Romania
Flash Flood	17/06/2020 12UTC	18/06/2020	30		
Flash Flood	18/06/2020 00UTC	18/06/2020	30	Bistrita-Nasaud	Romania
Flash Flood	18/06/2020 00UTC	18/06/2020	36		
Flash Flood	18/06/2020 00UTC	18/06/2020	12		
Flash Flood	18/06/2020 12UTC	19/06/2020	48	Eszak-Magyarorszag	Hungary
Flash Flood	18/06/2020 12UTC	19/06/2020	42		
Flash Flood	18/06/2020 12UTC	19/06/2020	24		
Flash Flood	18/06/2020 12UTC	19/06/2020	24		
Flash Flood	18/06/2020 12UTC	19/06/2020	24		
Flash Flood	19/06/2020 00UTC	19/06/2020	60	Transcarpathia	Ukraine
Flash Flood	19/06/2020 00UTC	19/06/2020	60		
Flash Flood	19/06/2020 00UTC	19/06/2020	60		

Flash Flood	19/06/2020 12UTC	20/06/2020	96	Chernivtsi	Ukraine
Flash Flood	19/06/2020 12UTC	20/06/2020	60	Neamt	Romania
Flash Flood	19/06/2020 12UTC	20/06/2020	60		
Flash Flood	19/06/2020 12UTC	20/06/2020	54	Bacau	Romania
Flash Flood	19/06/2020 12UTC	20/06/2020	54	Jugozapaden	North Macedo-
Flash Flood	19/06/2020 12UTC	20/06/2020	54	Maramures	Romania
Flash Flood	19/06/2020 12UTC	20/06/2020	60	Mures	Romania
Flash Flood	19/06/2020 12UTC	20/06/2020	60	Pelagoniski	North Macedo-
Flash Flood	20/06/2020 00UTC	20/06/2020	24	Kralovehradecky kraj	Czech Republic
Flash Flood	20/06/2020 00UTC	20/06/2020	48		
Flash Flood	20/06/2020 00UTC	20/06/2020	60	Zilinsky kraj	Slovakia
Flash Flood	20/06/2020 00UTC	20/06/2020	60	Zilinsky kraj	Slovakia
Flash Flood	20/06/2020 00UTC	20/06/2020	30		
Flash Flood	20/06/2020 00UTC	20/06/2020	48		
Flash Flood	20/06/2020 00UTC	20/06/2020	24		
Flash Flood	20/06/2020 00UTC	20/06/2020	12		
Flash Flood	20/06/2020 00UTC	20/06/2020	42	Dytiki Makedonia	Greece
Flash Flood	20/06/2020 12UTC	21/06/2020	30		
Flash Flood	20/06/2020 12UTC	21/06/2020	24	Suceava	Romania
Flash Flood	20/06/2020 12UTC	21/06/2020	48	Malopolskie	Poland
Flash Flood	20/06/2020 12UTC	21/06/2020	42	Wielkopolskie	Poland
Flash Flood	20/06/2020 12UTC	21/06/2020	42	Kujawsko-pomorskie	Poland
Flash Flood	20/06/2020 12UTC	21/06/2020	24	Bistrita-Nasaud	Romania
Flash Flood	20/06/2020 12UTC	21/06/2020	24	Iasi	Romania
Flash Flood	20/06/2020 12UTC	21/06/2020	48		
Flash Flood	20/06/2020 12UTC	21/06/2020	54	Republika Srpska	Bosnia And Her-
Flash Flood	20/06/2020 12UTC	21/06/2020	60		
Flash Flood	21/06/2020 00UTC	21/06/2020	60	Dambovita	Romania
Flash Flood	21/06/2020 00UTC	21/06/2020	36	Presovsky kraj	Slovakia
Flash Flood	21/06/2020 00UTC	21/06/2020	60	Hunedoara	Romania
Flash Flood	21/06/2020 00UTC	21/06/2020	60	Valcea	Romania
Flash Flood	21/06/2020 00UTC	21/06/2020	48	Federacija Bosna i Herce-	Croatia
Flash Flood	21/06/2020 00UTC	21/06/2020	48	Brcko	Bosnia And Her-
Flash Flood	21/06/2020 00UTC	21/06/2020	36	Podkarpackie	Poland
Flash Flood	21/06/2020 12UTC	22/06/2020	54	Sibiu	Romania
Flash Flood	21/06/2020 12UTC	22/06/2020	42	Bacau	Romania
Flash Flood	21/06/2020 12UTC	22/06/2020	42		
Flash Flood	21/06/2020 12UTC	22/06/2020	42	Ivano-Frankivs'k	Ukraine
Flash Flood	21/06/2020 12UTC	22/06/2020	42	Transcarpathia	Ukraine
Flash Flood	21/06/2020 12UTC	22/06/2020	42	Suceava	Romania
Flash Flood	21/06/2020 12UTC	22/06/2020	48	Maramures	Romania
Flash Flood	21/06/2020 12UTC	22/06/2020	48	Bistrita-Nasaud	Romania
Flash Flood	21/06/2020 12UTC	22/06/2020	54	Mures	Romania
Flash Flood	21/06/2020 12UTC	22/06/2020	48		
Flash Flood	21/06/2020 12UTC	22/06/2020	36	Neamt	Romania
Flash Flood	21/06/2020 12UTC	22/06/2020	60	Buzau	Romania
Flash Flood	21/06/2020 12UTC	22/06/2020	60	Brasov	Romania
Flash Flood	21/06/2020 12UTC	22/06/2020	60	Iasi	Romania
Flash Flood	21/06/2020 12UTC	22/06/2020	60	Arges	Romania
Flash Flood	21/06/2020 12UTC	22/06/2020	54	Covasna	Romania
Flash Flood	21/06/2020 12UTC	22/06/2020	54	Alba	Romania

Flash Flood	21/06/2020 12UTC	22/06/2020	54	Dytiki Makedonia	Greece
Flash Flood	22/06/2020 00UTC	22/06/2020	30	Zlatiborska oblast	Serbia
Flash Flood	22/06/2020 00UTC	22/06/2020	36	Gorj	Romania
Flash Flood	22/06/2020 00UTC	22/06/2020	42	Cluj	Romania
Flash Flood	22/06/2020 00UTC	22/06/2020	36	Raska oblast	Serbia
Flash Flood	22/06/2020 00UTC	22/06/2020	30		
Flash Flood	22/06/2020 12UTC	23/06/2020	24		
Flash Flood	22/06/2020 12UTC	23/06/2020	30	Jugozapaden	North Macedo-
Flash Flood	22/06/2020 12UTC	23/06/2020	24		
Flash Flood	22/06/2020 12UTC	23/06/2020	30	Pristina	Kosovo*
Flash Flood	22/06/2020 12UTC	23/06/2020	30		
Flash Flood	22/06/2020 12UTC	23/06/2020	30	Pelagoniski	North Macedo-
Flash Flood	22/06/2020 12UTC	23/06/2020	24	Kosovska Mitrovica	Kosovo*
Flash Flood	22/06/2020 12UTC	23/06/2020	30	Ipeiros	Greece
Flash Flood	23/06/2020 00UTC	23/06/2020	30		
Flash Flood	23/06/2020 00UTC	23/06/2020	30		
Flash Flood	23/06/2020 00UTC	23/06/2020	30	Transcarpathia	Ukraine
Flash Flood	23/06/2020 00UTC	23/06/2020	18		
Flash Flood	23/06/2020 00UTC	23/06/2020	18		
Flash Flood	23/06/2020 12UTC	24/06/2020	54	Dytiki Makedonia	Greece
Flash Flood	23/06/2020 12UTC	24/06/2020	30	Opolskie	Poland
Flash Flood	24/06/2020 00UTC	24/06/2020	42	Korce	Albania
Flash Flood	24/06/2020 00UTC	24/06/2020	18	Sibiu	Romania
Flash Flood	27/06/2020 00UTC	27/06/2020	60	Stredocesky kraj	Czech Republic
Flash Flood	27/06/2020 00UTC	27/06/2020	48	Oberbayern	Germany
Flash Flood	27/06/2020 00UTC	27/06/2020	54		
Flash Flood	27/06/2020 00UTC	27/06/2020	60		
Flash Flood	27/06/2020 00UTC	27/06/2020	60		
Flash Flood	27/06/2020 00UTC	27/06/2020	60	Tirol	Austria
Flash Flood	27/06/2020 12UTC	28/06/2020	42		
Flash Flood	27/06/2020 12UTC	28/06/2020	42		
Flash Flood	27/06/2020 12UTC	28/06/2020	48		
Flash Flood	27/06/2020 12UTC	28/06/2020	48	Jihomoravsky kraj	Czech Republic
Flash Flood	27/06/2020 12UTC	28/06/2020	48	Kraj Vysocina	Czech Republic
Flash Flood	27/06/2020 12UTC	28/06/2020	60		
Flash Flood	27/06/2020 12UTC	28/06/2020	60		
Flash Flood	28/06/2020 00UTC	28/06/2020	54		
Flash Flood	28/06/2020 00UTC	28/06/2020	54		
Flash Flood	28/06/2020 00UTC	28/06/2020	54		
Flash Flood	28/06/2020 00UTC	28/06/2020	54		
Flash Flood	28/06/2020 00UTC	28/06/2020	48	Presovsky kraj	Slovakia
Flash Flood	28/06/2020 00UTC	28/06/2020	48	Kosicky kraj	Slovakia
Flash Flood	28/06/2020 12UTC	29/06/2020	36		
Flash Flood	28/06/2020 12UTC	29/06/2020	36		
Flash Flood	28/06/2020 12UTC	29/06/2020	42		
Flash Flood	28/06/2020 12UTC	29/06/2020	24		
Flash Flood	29/06/2020 00UTC	29/06/2020	30	Transcarpathia	Ukraine
Flash Flood	29/06/2020 00UTC	29/06/2020	30	Maramures	Romania
Flash Flood	29/06/2020 00UTC	29/06/2020	24		
Flash Flood	29/06/2020 00UTC	29/06/2020	30		
Flash Flood	29/06/2020 00UTC	29/06/2020	42	Louna-Eesti	Estonia

Flash Flood	01/07/2020 00UTC	01/07/2020	60	Malopolskie	Poland
Flash Flood	01/07/2020 00UTC	01/07/2020	60	Presovsky kraj	Slovakia
Flash Flood	01/07/2020 00UTC	01/07/2020	54	Niederosterreich	Austria
Flash Flood	01/07/2020 12UTC	02/07/2020	48	Kosicky kraj	Slovakia
Flash Flood	01/07/2020 12UTC	02/07/2020	48	Podkarpackie	Poland
Flash Flood	01/07/2020 12UTC	02/07/2020	36	Steiermark	Austria
Flash Flood	01/07/2020 12UTC	02/07/2020	48	Eszak-Magyarorszag	Hungary
Flash Flood	01/07/2020 12UTC	02/07/2020	42	Zilinsky kraj	Slovakia
Flash Flood	01/07/2020 12UTC	02/07/2020	54	Lubelskie	Poland
Flash Flood	01/07/2020 12UTC	02/07/2020	36	Karnten	Austria
Flash Flood	01/07/2020 12UTC	02/07/2020	54		
Flash Flood	02/07/2020 00UTC	02/07/2020	30	Salzburg	Austria
Flash Flood	02/07/2020 00UTC	02/07/2020	36		
Flash Flood	02/07/2020 00UTC	02/07/2020	36	Transcarpathia	Ukraine
Flash Flood	02/07/2020 00UTC	02/07/2020	42	Presovsky kraj	Slovakia
Flash Flood	02/07/2020 00UTC	02/07/2020	42		
Flash Flood	02/07/2020 00UTC	02/07/2020	54		
Flash Flood	02/07/2020 00UTC	02/07/2020	24		
Flash Flood	02/07/2020 12UTC	03/07/2020	54	Jugozapaden	North Macedo-
Flash Flood	02/07/2020 12UTC	03/07/2020	54	Pelagoniski	North Macedo-
Flash Flood	02/07/2020 12UTC	03/07/2020	18	Eszak-Magyarorszag	Hungary
Flash Flood	02/07/2020 12UTC	03/07/2020	54	Korce	Albania
Flash Flood	02/07/2020 12UTC	03/07/2020	54	Dytiki Makedonia	Greece
Flash Flood	03/07/2020 00UTC	03/07/2020	36	Bistrita-Nasaud	Romania
Flash Flood	03/07/2020 12UTC	04/07/2020	30	Sibiu	Romania
Flash Flood	03/07/2020 12UTC	04/07/2020	36		
Flash Flood	03/07/2020 12UTC	04/07/2020	6		
Flash Flood	05/07/2020 00UTC	05/07/2020	60	Ivano-Frankivs'k	Ukraine
Flash Flood	05/07/2020 00UTC	05/07/2020	60	Maramures	Romania
Flash Flood	05/07/2020 12UTC	06/07/2020	60		
Flash Flood	05/07/2020 12UTC	06/07/2020	6	Dytiki Makedonia	Greece
Flash Flood	05/07/2020 12UTC	06/07/2020	54	Jugozapaden	North Macedo-
Flash Flood	05/07/2020 12UTC	06/07/2020	54	Pelagoniski	North Macedo-
Flash Flood	05/07/2020 12UTC	06/07/2020	54	Sibiu	Romania
Flash Flood	05/07/2020 12UTC	06/07/2020	54	Brasov	Romania
Flash Flood	09/07/2020 00UTC	09/07/2020	60		
Flash Flood	09/07/2020 12UTC	10/07/2020	48	Kraj Vysocina	Czech Republic
Flash Flood	09/07/2020 12UTC	10/07/2020	48		
Flash Flood	09/07/2020 12UTC	10/07/2020	54	Salzburg	Austria
Flash Flood	09/07/2020 12UTC	10/07/2020	48	Niederosterreich	Austria
Flash Flood	09/07/2020 12UTC	10/07/2020	48	Jihomoravsky kraj	Czech Republic
Flash Flood	10/07/2020 00UTC	10/07/2020	30	Oberbayern	Germany
Flash Flood	12/07/2020 12UTC	13/07/2020	18	Bryansk	Russia
Flash Flood	12/07/2020 12UTC	13/07/2020	18	Smolensk	Russia
Flash Flood	13/07/2020 12UTC	14/07/2020	36		
Flash Flood	13/07/2020 12UTC	14/07/2020	36		
Flash Flood	13/07/2020 12UTC	14/07/2020	30		
Flash Flood	13/07/2020 12UTC	14/07/2020	42		
Flash Flood	13/07/2020 12UTC	14/07/2020	36	Kaluga	Russia
Flash Flood	13/07/2020 12UTC	14/07/2020	48		
Flash Flood	13/07/2020 12UTC	14/07/2020	54		

Flash Flood	13/07/2020 12UTC	14/07/2020	36		
Flash Flood	13/07/2020 12UTC	14/07/2020	36		
Flash Flood	16/07/2020 00UTC	16/07/2020	30		
Flash Flood	16/07/2020 12UTC	17/07/2020	48		
Flash Flood	16/07/2020 12UTC	17/07/2020	54	Cluj	Romania
Flash Flood	16/07/2020 12UTC	17/07/2020	54	Jugozapaden	North Macedo-
Flash Flood	16/07/2020 12UTC	17/07/2020	54	Dytiki Makedonia	Greece
Flash Flood	16/07/2020 12UTC	17/07/2020	54	Pelagoniski	North Macedo-
Flash Flood	16/07/2020 12UTC	17/07/2020	60	Gorj	Romania
Flash Flood	16/07/2020 12UTC	17/07/2020	48		
Flash Flood	16/07/2020 12UTC	17/07/2020	60		
Flash Flood	16/07/2020 12UTC	17/07/2020	54	Poloski	North Macedo-
Flash Flood	16/07/2020 12UTC	17/07/2020	42	Arad	Romania
Flash Flood	17/07/2020 00UTC	17/07/2020	54	Valcea	Romania
Flash Flood	17/07/2020 00UTC	17/07/2020	42	Korce	Albania
Flash Flood	17/07/2020 12UTC	18/07/2020	24	Banskobystricky kraj	Slovakia
Flash Flood	18/07/2020 00UTC	18/07/2020	30	Sibiu	Romania
Flash Flood	19/07/2020 00UTC	19/07/2020	30	Dambovita	Romania
Flash Flood	19/07/2020 00UTC	19/07/2020	30	Prahova	Romania
Flash Flood	23/07/2020 00UTC	23/07/2020	48	Koroska	Slovenia
Flash Flood	23/07/2020 00UTC	23/07/2020	54	Krapinsko-zagorska zupan-	Croatia
Flash Flood	23/07/2020 00UTC	23/07/2020	60		
Flash Flood	23/07/2020 00UTC	23/07/2020	54		
Flash Flood	23/07/2020 00UTC	23/07/2020	54	Sisacko-moslavacka zupan-	Croatia
Flash Flood	23/07/2020 00UTC	23/07/2020	54	Zagrebacka zupanija	Croatia
Flash Flood	23/07/2020 00UTC	23/07/2020	54	Pomurska	Slovenia
Flash Flood	23/07/2020 00UTC	23/07/2020	54	Steiermark	Austria
Flash Flood	23/07/2020 00UTC	23/07/2020	60		
Flash Flood	23/07/2020 00UTC	23/07/2020	48	Karnten	Austria
Flash Flood	23/07/2020 12UTC	24/07/2020	48	Del-Dunantul	Hungary
Flash Flood	23/07/2020 12UTC	24/07/2020	48	Varazdinska zupanija	Croatia
Flash Flood	23/07/2020 12UTC	24/07/2020	48	Koprivnicko-krizevacka	Croatia
Flash Flood	23/07/2020 12UTC	24/07/2020	42		
Flash Flood	23/07/2020 12UTC	24/07/2020	54	Kozep-Dunantul	Hungary
Flash Flood	23/07/2020 12UTC	24/07/2020	54	Nitriansky kraj	Slovakia
Flash Flood	23/07/2020 12UTC	24/07/2020	48	Podravska	Slovenia
Flash Flood	24/07/2020 00UTC	24/07/2020	30		
Flash Flood	24/07/2020 00UTC	24/07/2020	42	Medjimurska zupanija	Croatia
Flash Flood	24/07/2020 00UTC	24/07/2020	24		
Flash Flood	24/07/2020 00UTC	24/07/2020	30	Jugovzhodna Slovenija	Slovenia
Flash Flood	24/07/2020 00UTC	24/07/2020	30		
Flash Flood	24/07/2020 12UTC	25/07/2020	36		
Flash Flood	24/07/2020 12UTC	25/07/2020	36		
Flash Flood	24/07/2020 12UTC	25/07/2020	36	Arad	Romania
Flash Flood	25/07/2020 00UTC	25/07/2020	36		
Flash Flood	25/07/2020 00UTC	25/07/2020	30		
Flash Flood	25/07/2020 00UTC	25/07/2020	30		
Flash Flood	25/07/2020 00UTC	25/07/2020	36		
Flash Flood	26/07/2020 12UTC	27/07/2020	24	Salaj	Romania
Flash Flood	26/07/2020 12UTC	27/07/2020	30	Sibiu	Romania
Flash Flood	26/07/2020 12UTC	27/07/2020	24	Bihor	Romania

Flash Flood	27/07/2020 12UTC	28/07/2020	42	Jihomoravsky kraj	Czech Republic
Flash Flood	27/07/2020 12UTC	28/07/2020	42	Niederosterreich	Austria

* 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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