European Flood Awareness System

EFAS *Bulletin*

August – September 2021

Issue 2021(5)

NEWS

Event Reminder

Copernicus Emergency Management Service Week

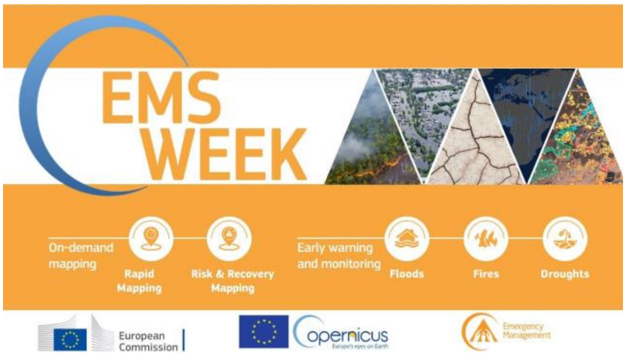

Figure 1: CEMS Week 2021

The European Commission is organising the virtual event CEMS Week on the 25 – 29 Oct, 2021. The morning sessions will take place at 9:00-12:45 and the afternoon session at 14:00-17:15 CET.

CEMS Week brings together experts, users and policy makers to participate in a discussion about the future of our service and user community.Take part in live virtual-sessions and -workshops from each of our service components, including the launch of the Global Flood Monitoring product and the adoption of the Global Human Settlement Layer as new service component.

The presentations on Day 1 (Monday, 25 October) are **open to the public**. Please follow this link to join the event. Participation for the other days is by invitation only. Ton find out more about the event, including the agenda, click here. Keep a lookout and follow our activities on Twitter @CopernicusEMS. We hope you can join us for this virtual event!

New features

Three new EFAS partners

We gladly welcome the Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency, Germany as new EFAS full partner as well as the Civil protection Emilia Romagna, Italy and the Swiss Federal Railway Company, Switzerland as new EFAS third party partners.

RESULTS

Summary of EFAS Flood and Flash Flood Notifications

The three formal and 23 informal EFAS flood notifications issued in August - September are summarised in Table 1. The locations of all notifications are shown in Figure 48 and Figure 50 in the appendix.

47 Flash flood notifications were issued in August - September. They are summarised in Table 2. The locations of all notifications are shown in Figure 49 and Figure 51 in the appendix.

Meteorological situation

by EFAS Meteorological Data Collection Centre

August

August 2021 was characterized by higher than normal sea surface pressure over the northern Atlantic Ocean and Russia, and close to normal sea surface pressure anywhere else across the EFAS domain. Monthly precipitation totals were above the long-term mean in central and eastern Europe and mainly below in the other parts of the EFAS domain. Monthly mean temperatures were below the long-term mean in northern and central Europe and above over the remaining part of the EFAS domain.

At the beginning of August, the Azores high was around its typical location and an upper-level trough extended from the Artic Ocean via Scandinavia over the Bay of Biscay with weak low-pressure cores at the surface over southern Scandinavia and northeast Russia. Surface pressure gradients in the southern and eastern parts of the EFAS domain were weak and conditions were normal. Within the next days, the trough shifted eastward and a low-pressure system developed over the Baltic Sea. It intensified along its north-eastward track and disappeared reaching the Barents Sea. Another low-pressure system developed over the Atlantic Ocean and moved towards Great Britain and Ireland. It remained active for several days until it disappeared. At the same time, a weak upper-level low-pressure system developed over South-eastern Europe and Anatolia. It is associated with heavy rainfalls at the southern coast of the Black Sea, which caused flash floods. Another low-pressure system developed in the lee of Greenland and it moved north of Great Britain and Ireland to Scandinavia. One more low-pressure system moved along a slightly southward track from the Atlantic Ocean to southern Scandinavia. It caused, forced by orography, heavy precipitation and flash floods at the Alps. Again, a weak upper-level low-pressure system was cut-off and moved to the Black Sea. Another low-pressure system, mainly visible in the upper levels, moved from the Atlantic Ocean via central to eastern Europe. In the next days, the Azores high extended northwards reaching the Norwegian Sea and was later located over Great Britain and Ireland. A low-pressure system developed at the eastern edge of this high-pressure system over northern Scandinavia. It moved slightly southwards, but the associated upper-level trough extended to the western Mediterranean region and caused heavy rainfalls in France and Spain. The low-pressure system moved further to central and eastern Europe and remained active in this region until the end of the month. Another low-pressure system developed over the Atlantic Ocean and arrived at the Iberian Peninsula at the end of August, so it became more prevalent in September.

The highest precipitation totals were observed in the Alps, western Carpathian Mountains, across most of eastern Europe, and in localised areas surrounding Black Sea (Figure 34). No or almost no precipitation fell north of the Caspian Sea, in western Anatolia, over the eastern and southern parts of the Mediterranean Basin (except for the Atlas Mountains), Cyprus, Crete, Sicily, and southern Iberian Peninsula. Monthly precipitation totals above the long-term mean occurred in central and eastern Europe and Scandinavia (excluding southern Norway), central and eastern Anatolia, eastern Atlas Mountains and southeast Iberian Peninsula (Figure 35). Monthly totals below the long-term mean were reported over Iceland, southern Norway, to the north of the Caspian Sea and around the Mediterranean Sea except the above-mentioned regions.

The monthly mean air temperature ranged from -0.5°C to 38.8°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 of the domain (Figure 38). Air temperature anomalies ranged from -10.9°C to 9.3°C (Figure 39). Monthly mean air temperature values below the long-term mean occurred in central Europe and in Scandinavia, while positive air temperature anomalies appeared in the remaining part of the EFAS domain.

September

September 2021 was characterized by higher than normal sea surface pressure over Scandinavia and close to normal sea surface pressure anywhere else across the EFAS domain. Monthly precipitation totals were above the long-term mean in the western and eastern regions, and mainly below the long-term mean in the central and southern parts of the EFAS domain. Monthly mean temperatures were below the long-term mean in the northern and eastern parts, and above the long-term mean over the southern and western parts of the EFAS domain.

At the beginning of September, a high-pressure system was located over Great Britain and Ireland. A low-pressure system was situated over the Barents Sea and other weak systems over eastern Europe and westward of the Iberian Peninsula. The last-mentioned low-pressure system moved to the central Mediterranean Sea and brought intense rainfall, associated with floods, along its track. The low-pressure system located over the Barents Sea moved to northwest Russia and remained active for a few more days. A new high-pressure system formed over southern Scandinavia and moved south-eastwards to the Caspian Sea. A low-pressure system developed over the Atlantic Ocean and moved to the west of the Iberian Peninsula. Then, it changed its direction to move across Great Britain and Ireland to Scandinavia, where it disappeared. Another low-pressure system moved from the Atlantic Ocean to the Iberian Peninsula and went up in an existing weak trough. This trough was associated with several heavy precipitation events over central and southwest Europe. One more low-pressure system developed over Jutland and moved to eastern Europe. At the same time, the Azores high formed around its usual position. Another high-pressure system was established over the Kola Peninsula. An upper-level low-pressure system was cut off over the Bay of Biscay and moved to the Iberian Peninsula, again associated with heavy precipitation. The low-pressure system located over eastern Europe moved over the northern Baltic Sea and intensified there. It weakens soon as it moved towards Russia. A strong low-pressure system developed over the Greenland Sea and moved to Iceland, associated with strong winds. A new high-pressure system developed over northeast Europe. A trough extended from a low-pressure system located over Iceland towards Great Britain and Ireland. A small low-pressure system was cut-off and moved to Jutland by the end of the month.

The Azores high was around its usual position and another high-pressure system was located over northeast Europe. A weak upper-level low-pressure system was located over the Black Sea.

The highest precipitation totals were observed over Iceland, the Norwegian coast, central France, eastwards of the Black Sea, and over eastern Europe (Figure 36). No or almost no precipitation fell over western Anatolia as well as the southern and south-eastern parts of the EFAS domain. Monthly precipitation totals above the long-term mean occurred mainly over eastern and northern Europe but also southwestern Europe and Anatolia (Figure 37). Monthly totals below the long-term mean were reported mainly over central and southeast Europe, as well as over the southern and south-eastern parts of the EFAS domain.

The monthly mean air temperature ranged from -5.0°C to 36.9°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 40). Air temperature anomalies ranged from -7.6°C to 10.0°C (Figure 41). Monthly mean air temperature values above the long-term mean occurred in western and southern parts of the EFAS domain, while negative air temperature anomalies appeared in the eastern and northern parts of the EFAS domain.

Hydrological situation

by EFAS Hydrological Data Collection Centre

August

In August, the highest concentration of stations exceeding their low threshold level is located in central Europe in the Po and Danube basins. Firstly, 20 per cent of stations which exceeded at least the first threshold levels were in the Po river basin (northern Italy). Regarding the Danube river basin, the highest concentration of stations with exceedances are located in its western regions (southern Germany and western Austria), but there are some other isolated stations located in Slovakia, Hungry, Serbia, Romania, and Croatia too. In Poland, some stations along the Vistula and the Oder river exceeded their thresholds also. Lastly, in a more dispersed way, we can find one station in the Elbe river basin and another in the Neman basin (Belarus), in the centre of Norway, central and southern Sweden, Iceland, Ireland, eastern Spain (around the Jucar river basin and Catalonia) and Tiber basin (central Italy).

Regarding stations registering values above the 90% quantile,115 stations exceeded this value during August. The majority of these stations were located in central Europe throughout France, Germany, Luxembourg, Switzerland, Belgium, and the Netherlands, where the Rhine and Seine basins stood out with nearly 33% of the total stations exceeding the 90% quantile. Other basins surpassing this quantile were the Scheldt, Rhône, Meuse, and Elbe. Another portion of stations also exceeding the 90% quantile (just over 22%) can be seen in the Vistula and Oder basins in Poland, and in the Danube basin through Germany, Austria, Slovakia, Serbia, and Bosnia and Herzegovina. To a lesser degree, other stations over their 90% quantile were in Spanish basins (Guadalquivir, Minho and Ebro) and in England where a many of the stations were located in the Thames basin. Isolated stations exceeding the 90% quantile occurred in basins in Sweden, Norway, and in Ukraine (Dnieper basin).

Finally, according to those stations registering values below the 10% quantile (41 in total), the highest concentration is located in southern Norway, where 13 stations reached these values. Secondly, and with a more dispersed pattern, we have several locations in the western Ukraine (5 stations), in the centre of the Danube basin (5 stations located in Serbia, Romania, and Hungary), in the Oder basin in Poland (4 stations) and in eastern Spain (4 stations). A lower density of stations occurred in Belarus, the Rhine basin, northern Scandinavia, and England with 2 stations each. At last, we can also find isolated stations with values under the 10% quantile in the Esla river (Spain) and the Muonio river (Finland).

September

In September, Poland was the country with the highest concentration of stations exceeding their threshold level (36 stations), with stations distributed in the Vistula and Oder basins. In Spain, 18 stations exceeded their threshold, specifically in the east of the country (Llobregat, Ebro, Jucar, Turia, Seco, Algar, Barranc de Torrent, and Serpis basins). Also remarkable is the situation in the Po river basin in Italy, with exceedances in 16 stations, and the situation in central Italy, with one station in the Garigliano river basin. In Germany, the exceedances occurred in nine stations located in the Danube river basin and one in the Elbe. In a more dispersed way, the Danube basin contains three other stations distributed across Austria and Croatia, and along the border between Croatia and Serbia. Norway, Iceland, Belarus, and Ukraine also experienced some isolated stations exceeding thresholds.

Regarding stations registering values above the 90% quantile, 160 stations exceeded this value in September. The majority of these stations were located in central Europe. Nearly 26% of these stations were in the Danube basin throughout Austria, Serbia, Slovakia, Germany, Czech Republic, Bulgaria, Hungary, Romania, Serbia, and Ukraine. This is followed by the Rhine basin with 18 stations in Switzerland, France, and Luxembourg. It was also noteworthy in Spain, where the following basins have stations which values are above the 90% quantile: Ebro (13 stations), Guadalquivir, Minho, and Jucar. France is also notable with 19 stations surpassing the 90% quantile, mainly located in the Loire basin. Another considerable number of stations also exceeding the 90% quantile can be seen in the Elbe, Dnieper, Oder, and Vistula basins. To a lesser degree, other stations over their 90% quantile were in basins located in Norway, Finland, Sweden, and England. Isolated stations exceeding the 90% quantile occurred in other stations in Ukraine, Italy, Slovenia, Switzerland, and Ireland.

Finally, and according to those stations registering values below the 10% quantile (36 in total), the highest concentration of them corresponded to southern Norway where 12 stations reached these values. In a more dispersed pattern, we can find 7 stations across the western and central Danube basin, located in Hungary, Slovenia, Austria, Bosnia-Herzegovina, Serbia, and 7 more stations along the Loire, Dordogne, Adour, Aude, and Rhône basins in France. A lower density of stations occurred in Spain (where 5 stations are spread throughout the entire country), the Trent basin in England (2 stations), and Luxemburg (2 stations). Lastly, we can also find an isolated station with values under the 10% quantile in the Vipava river in Slovenia.

Verification

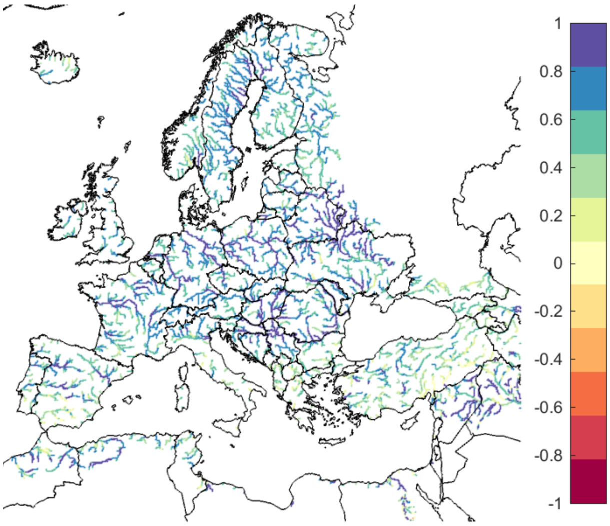

Figure 2: EFAS CRPSS at lead-time 1 day for August-September 2021, for catchments >2000km2. The reference score is persistence of using previous day's forecast.

Figure 2 and Figure 3 shows the EFAS headline score, the continuous ranked probability skill score (CRPSS) for lead times 1 and 5 days for August-September 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.

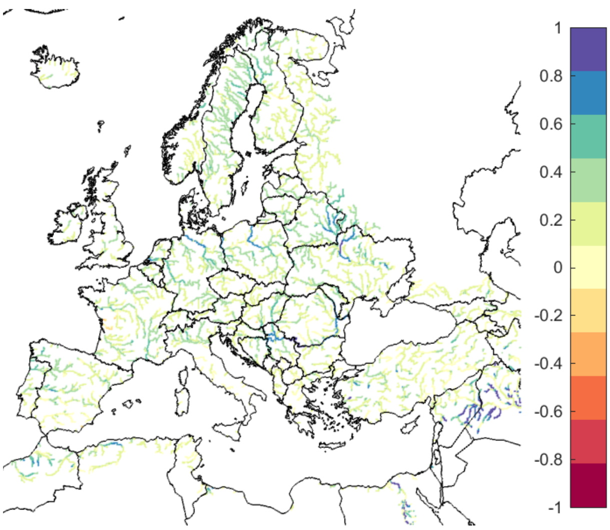

Figure 3. EFAS CRPSS at lead-time 5 days for August-September 2021 for catchments >2000km2. The reference score is persistence of using previous day's forecast.

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

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

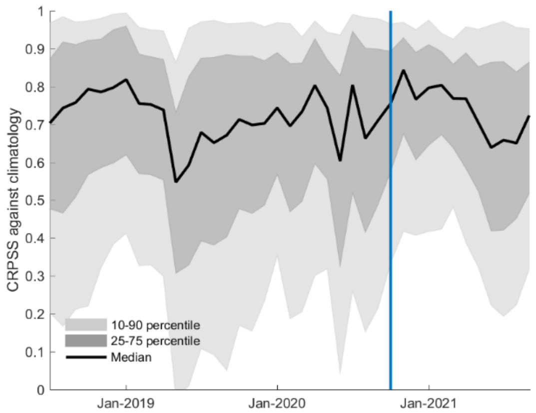

Figure 4. Monthly means of CRPSS the for lead-time 5 days for all the major river points in Europe with ECMWF ENS as forcing. Reference forecast was climatology. The skill is largest during the winter months, when there is less variation in the flow in large parts of Europe. The blue line indicates the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

Publications

Skøien, J. O; Bogner, K; Salamon, P & Wetterhall, F. (2021). On the Implementation of Postprocessing of Runoff Forecast Ensembles. *Journal of Hydrometeorology*, Volume 22 (10), 2731-2749. DOI: https://doi.org/10.1175/JHM-D-21-0008.1

ARTICLES

Flash Floods in Southern Germany, Austria, and Northern Italy - August 2021

by Richard Davies, floodlist

Flash flooding caused severe damage and prompted numerous high-water rescues in Alpine regions of Germany, Austria, and northern Italy in mid-August.

Figure 5: The Krimml station, track and a train of the Pinzgauer local railway in Wald im Pinzgau were completely buried. Photo Wald Municipality

Germany

In Germany, heavy rain on 16 August triggered floods in Grainau in Garmisch-Partenkirchen district, southern Bavaria. Police reported 12 hikers were swept away or stranded after the flooding. Hammersbach stream swept through the narrow Höllental gorge situated at the foot of the Zugspitze, the highest peak of the Wetterstein Mountains.

A team of around 150 rescue workers was deployed to the area. As of 16 August, eight people had been rescued, while the body of one person had been found and one was still missing.

Austria

Heavy rain in parts of Salzburg State in Austria from 16 August caused mudslides and flash floods in the Pongau and Pinzgau regions. The small city of Sankt

Johann im Pongau recorded 36 mm of rain in one hour and 51 mm in two hours on 16 August 2021.

Figure 6: Floods in St Johann Austria, 16 August 2021. Photo: St Johann Feuerwehr

Emergency teams including 1,400 firefighters and around 70 high water rescue specialists carried out around 500 interventions. Salzburg Water Rescue Service said it was lucky nobody was killed considering the severity of the situation.

In Dienten municipality in Pinzgau, three people were rescued by firefighters after a bus and a car were both swept into a stream by a mudslide. All three people suffered injuries, one of them was eriously injured. Approximately 90 people were rescued in areas around Sankt Johann im Pongau.

The Krimml train station, track, and a train of the Pinzgauer local railway in Wald im Pinzgau were completely buried in rocks and flood debris. Areas of the town were also badly affected, and residents had to evacuate with the assistance of the Federal Army.

Parts of the states of Lower Austria, Styria, and Tyrol also reported storm damage.

Austria

The severe weather also caused damage in parts of South Tyrol Province of northern Italy on 16 August. The communes of Ahrntal and Pflersch were the worst affected. Firefighters responded to 200 incidents, including flooded buildings and roads. Thirty people were evacuated after floods and mudslides in areas of Pflersch.

Sankt Johann im Ahrntal recorded 43mm of rain in one hour on 16 August 2021.

Figure 7: Floods in Pflersch, South Tyrol, Italy, 16 August 2021 Vigili Del Fuoco Volontari Fleres (Freiwillige Feuerwehr Pflersch)

Feedback on EFAS Notifications for 2020

by Marc Girons Lopez, EFAS Dissemination Centre

Formal Flood Notifications are the core of EFAS and it is therefore important that they are as accurate and relevant to the EFAS partners as possible. To this end, partner feedback is collected and analysed yearly. This way, potential weak spots can be identified and future developments of EFAS prioritised. The feedback submitted during 2020 is presented and analysed here together with feedback statistics from previous years (2016 – 2019).

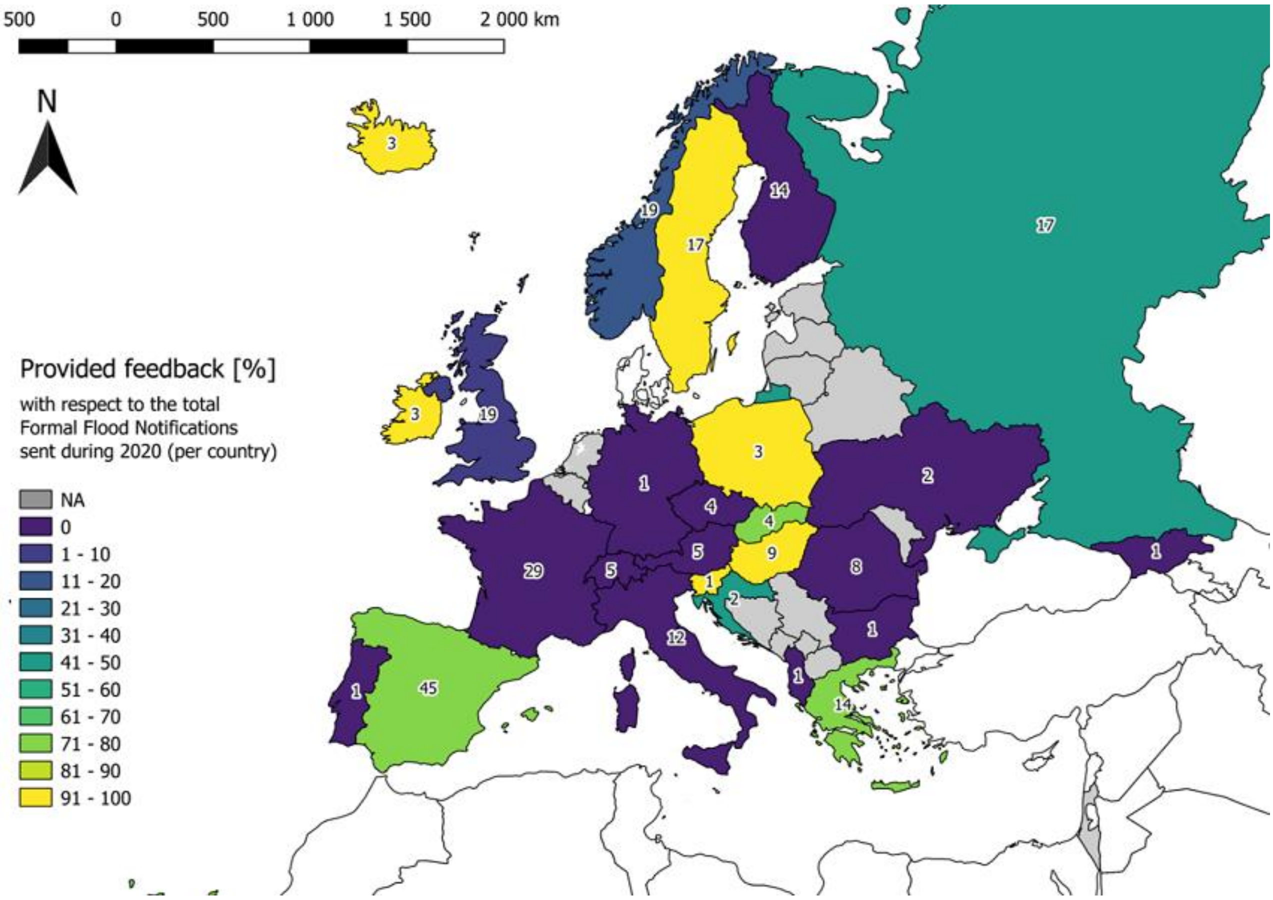

Figure 8: Percentage of EFAS Formal Flood Notifications for which feedback was provided for 2020, aggregated per country (in colour). The total number of Formal Flood Notifications sent for each country during 2020 is shown on the map. EFAS partner countries for which no Formal Flood Notifications were issued during 2020 are shaded in grey.

With the implementation of the new system in 2019, the entire feedback collection system is now integrated in the EFAS-IS platform and partners may submit feedback directly from the link embedded in Formal Flood Notifications. If no feedback is provided within a reasonable time, a reminder is sent to the relevant partner. Quality control managers at Rijksvaterstaat (RWS), Slovak hydrometeorological institute (SHMU), and Swedish Meteorological and Hydrological Institute (SMHI) are responsible for monitoring the collection of feedback for Formal Flood Notifications.

Even if the following analysis focuses on feedback provided for Formal Flood Notifications sent during 2020, it builds up on feedback statistics since 2016. However, since feedback collection has been continuously improving throughout the years, the completeness of some questions in this analysis may vary. Additionally, since some of the questions in the feedback form are not mandatory, some statistics may be based on a lower number of responses.

Summary of received feedback during 2020

A total of 240 Formal Flood Notifications were sent out during 2020 and 99 feedback reports were received, which accounts for 41% of all issued Formal Flood Notifications. This is the same percentage as for 2019 but a decrease compared to the year before (71%). Even if no detailed survey was performed on the reasons why partners did (not) provide feedback, it is conceivable that the decrease and following stagnation in feedback reporting was due to, first, the transition to a new feedback reporting system and, second, the significant increase in the number of Formal Flood Notifications being sent, which puts more load on partners. Even so, the provided feedback rate varied significantly among EFAS partners.

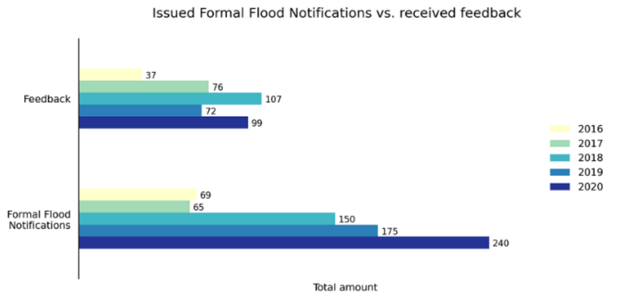

Figure 9: Issued EFAS Formal Flood Notifications and received feedback reports.

The initial question in the feedback form is whether or not a flood event was observed in connection with a given Formal Flood Notification. The definition of a flood event is included in the question to help partners assess the event (i.e. return period equal or larger than 2 years). The 2-year return period was chosen as a definition for flood here as it allows to differentiate between correct rejections and flood events that happened but did not reach the 5-year return period threshold used in EFAS. In total, 38 out of 99 participants (38%) answered that a flood event was observed after a Formal Flood Notification had been sent out. This value is significantly lower than that from 2019 (61%), indicating an increased number of false alarms.

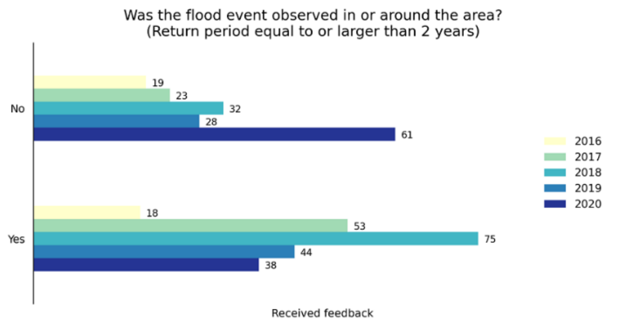

Figure 10: Participants responses to the question "Was the flood event observed?" of the feedback form.

The feedback form is adapted to whether a flood event was observed in connection to a given Formal Flood Notification or not, so relevant information for each case can be collected. Next, we are going to cover the feedback from those notifications for which a flood event was observed.

Feedback from observed flood events

Most of the participants who answered that a flood event had indeed occurred in connection to an issued Formal Flood Notification rated the accuracy of the EFAS information in terms of location as "As indicated in EFAS information" (76%). This is an improvement from 2019 (61%) and is related to a decrease in reported events being "In the wider region". Overall, the location accuracy during 2020 was comparable to that of 2017 and 2018, and significantly better than that of 2016 and 2019.

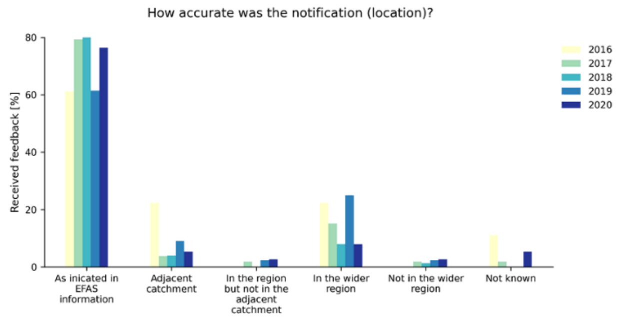

Figure 11: EFAS performance in terms of accurately predicting the location of an event.

Regarding the timing of the onset of the event, 34% of the participants stated that the start of the flood event happened on the day predicted by EFAS. This represents a significant decrease with respect to 2019 (61%) and 2016 (66%), which corresponds to an increase in those events that started 1-2 days earlier than predicted and ≥ 3 days later than predicted. Even if no clear pattern in forecast timing can be identified for the reported events in 2020 as a whole, the increase in the number of events that started earlier than EFAS predicted may limit reaction time, especially since Formal Flood Notifications may be sent with relatively short notice (at least with 48 hours in advance of the predicted start of an event).

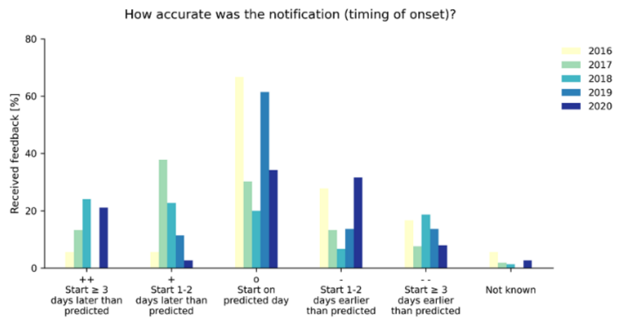

Figure 12: EFAS performance in terms of accurately predicting the onset time of an event.

Looking instead at the timing of the peak flow, the difference is in this case not so large with respect to 2019. Indeed, a similar number of participants stated that the flood peak was observed on the predicted day (40%) or 1-2 days earlier than predicted (25%). Nevertheless, while in 2019 EFAS had a clear tendency to predict the peak flow too late, under 2020 EFAS predicted the peak too early for a significant number of reported events (21%), which corresponds well with the statistics shown for the timing of onset. This question was first introduced with the new integrated feedback reporting system and no data is therefore available prior to 2019.

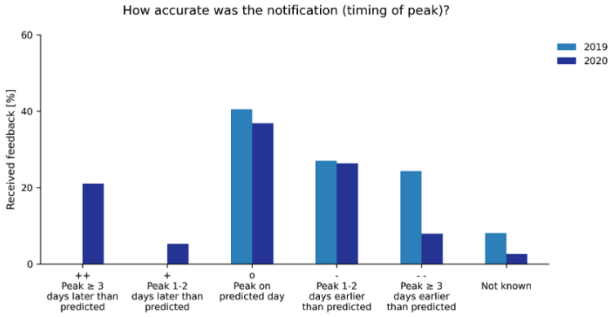

Figure 13: EFAS performance in terms of accurately predicting the peak time of an event.

In terms of the peak magnitude of predicted events, 24% of participants reported that the actual flood magnitude was comparable to the EFAS predicting. Additionally, 45% answered that the magnitude was less or much less severe than the EFAS prediction, and 22% stated that the flood was more or much more severe than the EFAS prediction. While the distribution is, at large, comparable to that of 2019, during 2020 there was a significant increase of events whose peaks were significantly overestimated by EFAS predictions. While it can be considered positive that EFAS does not tend to underestimate the peak flow magnitude, the values for 2020 are far from those from 2018, where close to 60% of participants reported that the peak magnitude was comparable to the EFAS prediction.

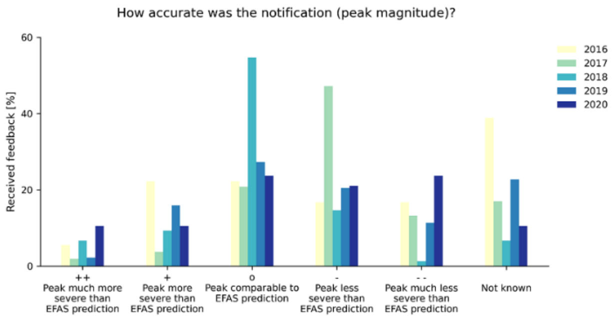

Figure 14: EFAS performance in terms of accurately predicting the peak magnitude of an event.

The lead time of EFAS notifications varied greatly between the different flood events, with most notifications being sent up to three days before the actual start of the event. This should not come to a surprise given the large differences in predictability of different weather patterns leading to flooding in different parts of Europe. Nevertheless, considering that one of the criteria for issuing Formal Flood Notifications is that the lead time to the onset of an event needs to be longer than 48 hours, it is significant that so many notifications result in much shorter lead times, giving very little reaction time in some cases. This change from previous years may be correlated with the increase number of events that were predicted 1-2 days too late (see previous figure regarding timing of onset). It is also important to notice here the significant fraction of events that were predicted with 9 or more lead days.

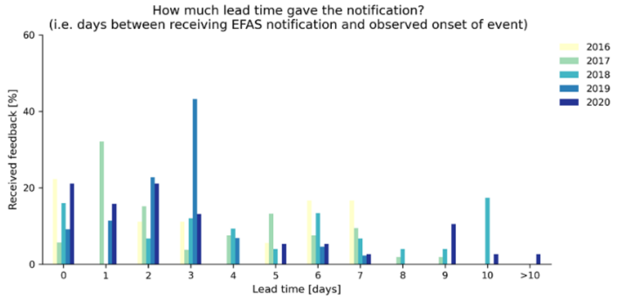

Figure 15: Participants response to the question "What was the actual lead time?" of the feedback form.

Regarding the severity of the reported flood events, 42% of participants stated that the return period of the event was less than a 5-year flood. Since the criterion for sending out a Formal Flood Notification requires an exceedance of a 5-year return period for runoff, it is remarkable that so many events were reported to be less severe than that. Additionally, when compared to previous years, during 2020 there was a significant increase in severe floods (return periods between 20 and 99 years, 21%).

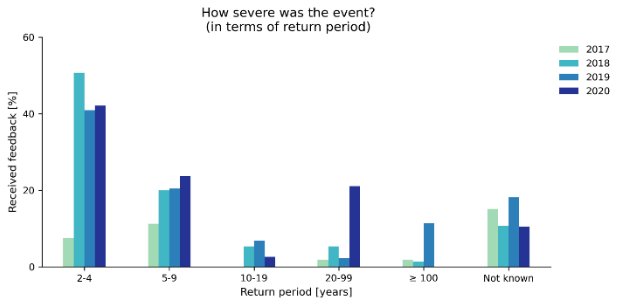

Figure 16: Participants response to the question "What is the return period of the observed flood event?" of the feedback form.

It is however important to notice here that the time periods that partners use to calculate return periods may vary significantly from EFAS. For instance, the 5-year return period in EFAS is often lower than the 5-year return period threshold that is used in Sweden by the SMHI. This may be due to the quality of historical forcing data, the hydrological model performance, and the different time periods used in the return period analysis. In addition, EFAS based return periods are calculated based on simulated discharges, whereas partners are more likely to base their thresholds on discharge observations. Calculating return periods from simulated discharge values may lead to systematic biases between observed and simulated discharge values at certain locations. Consequently, it would be better for the partners to evaluate the Formal Flood Notifications including also a comparison between simulated discharge in EFAS and their recorded observed discharge values.

The main drivers behind flood events in 2020 (highest ranked causes) were reported to be extreme rainfall (47% of participants), long-lasting rainfall (37% of participants), and snow melt (16%). These causes were, together with soil saturation, also the most important secondary drivers. Extreme rainfall is the only driver that has been reported as being relevant for a significant percentage of reported flood events throughout the different reporting periods. The percentage of reported events mainly caused by long-lasting rainfall during 2020 was comparable to that of 2019, and significantly larger than for previous years. Finally, soil saturation was a relevant secondary driver of many reported events throughout the different reporting periods.

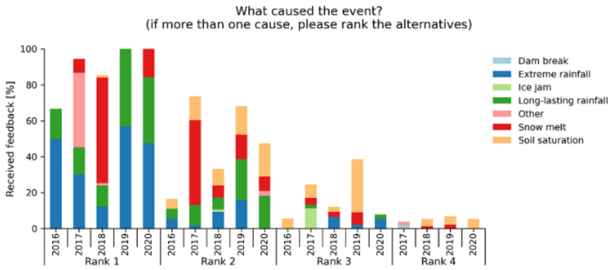

Figure 17: Participants response to the question "What caused the flood event?" of the feedback form.

Finally, partners were asked about the perceived added value they got from the EFAS Formal Flood Notification. Most participants reported that the EFAS Formal Flood Notification conveyed an added value to their activity. Indeed, about 80% of participants considered that notifications conveyed medium to significant added value, hinting to a positive reception of EFAS predictions by their users. This question was introduced in 2017 and no data is therefore available for 2016.

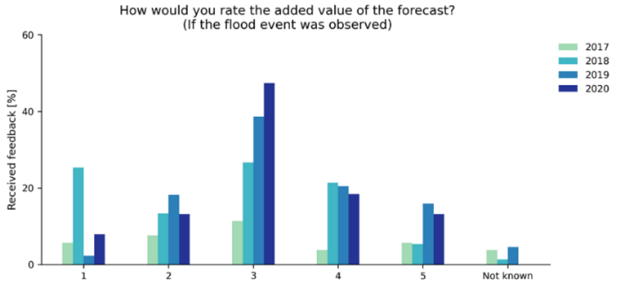

Figure 18: Participants response to the question "How would you rate the added value of the forecast?" of the forecast form. A value of 1 corresponds to little to no added value while a value of 5 corresponds to a significant added value.

Feedback from non-observed flood events

If no flood was observed in connection with a given Formal Flood Notification, partners were asked if they had any explanation why the forecasted flood event did not actually take place. Possible reasons were listed: reservoir operation, ice jam, forecasted precipitation did not occur or fell in a different area, and not enough snowpack melt. No responses were unfortunately obtained to this question for the events reported during 2020 (this is not a mandatory question). Nevertheless, out of those who responded in previous years, which were not many either, the most common answer was "other", followed by "not enough precipitation". Overall, the limited number of responses to this question by point to the difficulty of attributing specific causes to false alarms.

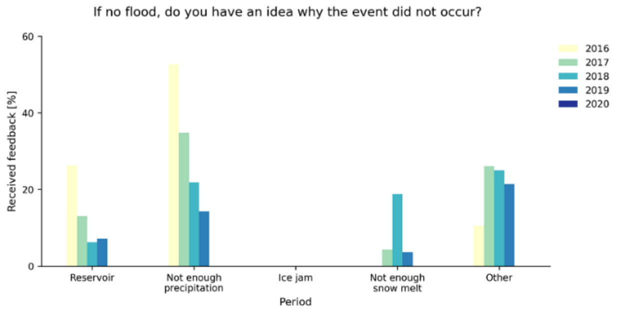

Figure 19: Participants response to the question "If no flood, do you have an idea why the event did not occur?" of the feedback form.

The added value of false alarms was obviously low, but there were anyway partners that appreciated receiving such notifications. No responses to this question for false alarms were recorded prior to the transition to the new integrated feedback collection system and therefore no data is available prior to 2019.

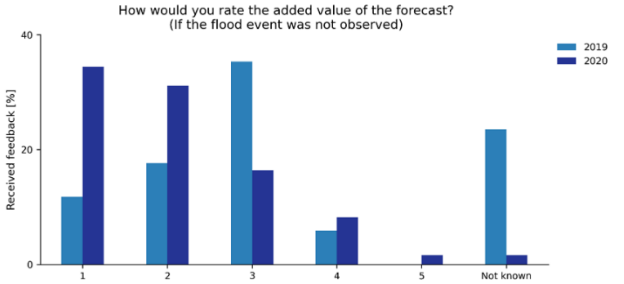

Figure 20: Participants response to the question "How would you rate the added value of the forecast?" of the feedback form. A value of 1 corresponds to little to no added value and a value of 5 corresponds to a significant added value.

Summary

The above analysis allows drawing some key messages as follows:

- Feedback was provided for about a third of all the disseminated Formal Flood Notifications during 2020. This was a similar percentage than that of 2019 and a decrease from previous years and might be attributed to the increased number of Formal Flood Notifications in recent years.
- Formal Flood Notifications were generally perceived to convey an added value to the partners.
- An increased percentage of the Formal Flood Notifications sent out during 2020 resulted in false alarms when compared to previous years.
- The accuracy of the Formal Flood Notifications sent out during 2020 was perceived to be good and to a general degree comparable to previous years.
- The return period of the majority of the observed flood events in connection with a Formal Flood Notification was less than 5 years, which is below the lowest EFAS threshold.
- The main drivers behind flood events in 2020 were extreme rainfall and long-lasting rainfall and, to a lesser extent, snow melt.
- Based on the lack of responses to why certain forecasted events did not occur, it may be deduced that establishing causes to false alarms is not obvious.

EFAS partner survey 2020

by Marc Girons Lopez and Diana Fuentes Andino, EFAS Dissemination Centre

The 15th EFAS Annual Meeting took place online on the 22nd of October 2020 and the participants were invited to answer the yearly survey regarding the satisfaction with the EFAS performance, services and products. A link for the web-based survey was made available to all EFAS partners and a total of 54 responses were received, compared to 36 in 2019 and 43 in 2018. The survey was, as in previous years, anonymous.

Overall satisfaction

No major changes in the overall satisfaction were reported in 2020 with respect to the previous three years. The satisfaction in the overall performance of EFAS, however, increased slightly with respect to 2019. Even so, there was still a small percentage of participants who rated the EFAS performance as being low.

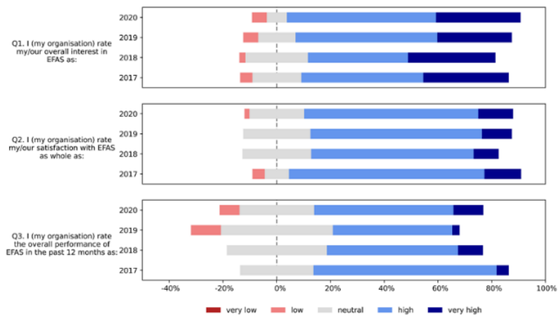

Figure 21: Average user response on overall satisfaction with EFAS.

According to most participants, the main benefit of being an EFAS member were the forecasts. Other important benefits according to participants were receiving flood notifications, the learning practices during annual meetings, and getting access to observed and forecasted precipitation.

The Operational EFAS consists of four different centres: the computational centre, dissemination centre, hydrological data collection centre, and meteorological data collection centre. The satisfaction of the participants with each of the EFAS centres in 2020 decreased slightly when compared to that of 2019. Nevertheless, it was still very good and, in general, higher than that of 2018.

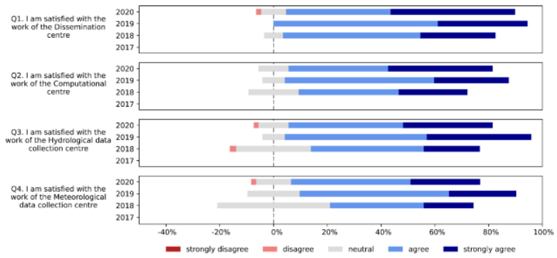

Figure 22: Average user response about the satisfaction of the work of the different EFAS centres

Skill, model performance and trust

The use of model skill scores provided in the EFAS bulletin increased for the year 2020. Most participants used the EFAS model skill scores provided both in the bulletin and in the skill layers in the EFAS-IS. Conversely, the skill scores provided on the wiki page were only used by a small percentage of participants.

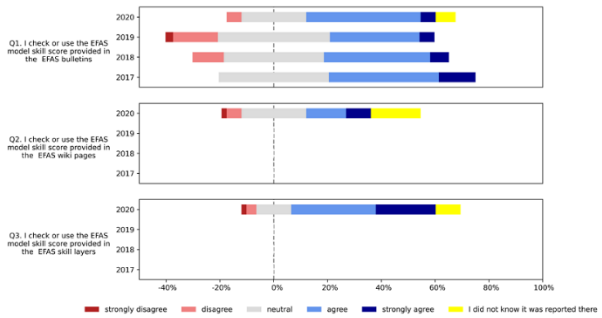

Figure 23: Average user response about the use of model skill score.

In general, there were no major differences in the perceived added value of the three different types of EFAS notifications (i.e. Formal Flood Notifications, Informal Flood Notifications, and Flash Flood Notifications) with respect to previous years. Nevertheless, a slight increase could be observed in the added value of Informal Flood Notifications and Flash Flood Notifications with respect to 2019.

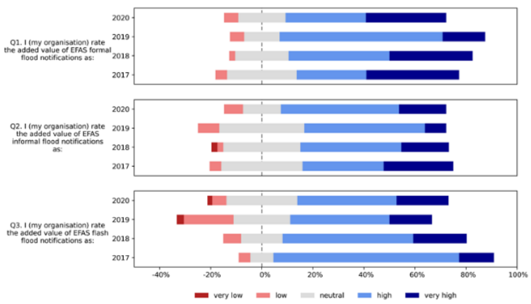

Figure 24: Average user response to the added value of notifications.

Focusing on the flash flood forecast products, more than half of the participants used EFAS flash flood forecasts on a daily/weekly basis while about 30% of the participants used them on a monthly basis. Around 10% of participants reported that they never used them.

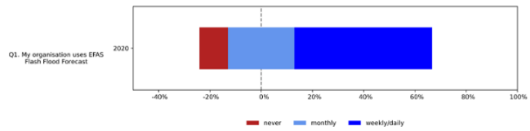

Figure 25: Average user response about the use of EFAS flash flood forecasts

Participants tended to use flash flood forecast products when significant rainfall was to be expected and to get alerts from likely events. Nevertheless, several participants commented on the large number of flash flood notifications they received and their uncertainties, and some of them did not find these products useful. In general, there was a demand for further development and refinement of flash flood forecast products, such as increased coverage, and presenting more information about precipitation, among others.

Regarding the use of alternative sources of information, 61% of participants compared EFAS forecasts with other providers, while 13% of them did not. The remaining percent did not answer this question. Most of the participants who answered positively reported that they compared EFAS with national and/or regional forecasts and some of the participants also compared them directly against outputs from other meteorological/hydrological models.

EFAS training and resources

EFAS provides training to partners on a variety of topics and in different formats. When asked about which topics they would like to receive training about in the future, most participants responded EFAS skill and EFAS layers and products, followed by flash flood forecasts and notifications. Other popular topics where the models used by EFAS (e.g. LISFLOOD), new products, and uncertainty and its communication.

Regarding the preferred training format, participants favoured having regular webinars (42 votes), followed by short online tutorials (36). Online documentation and workshops during the annual meeting were the least preferred methods, with 26 and 23 votes respectively.

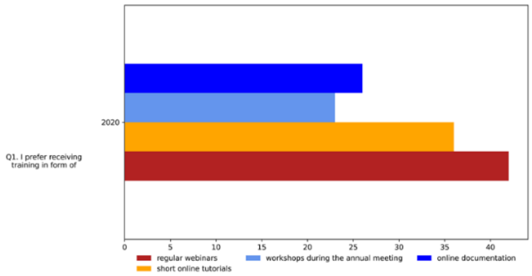

Figure 26:Average user response about the preferences for receiving training.

Relevant information on the EFAS system is provided online in different formats such as the bulletin, wiki page, annual hydrological report, and annual performance report. Out of these sources of information, most participants reported that they read the bulletin, annual hydrological report, and annual performance report, at least sometimes. The EFAS wiki page was the least used of these sources of information. In fact, the EFAS wiki, together with the annual performance report, where the least known documents among participants.

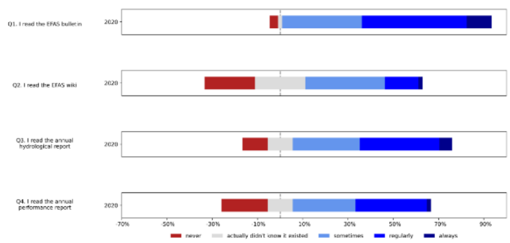

Figure 27: Average user response to EFAS informative resources.

In addition to the aforementioned information sources about EFAS, partners have the opportunity to use a number of resources from EFAS. However, the participants' awareness of the existence of the different EFAS resources differed significantly. On the one side, the possibility to activate EMS Mapping for satellite imagery, the fact LISFLOOD model is now open source, and the availability of training material on the EFAS-IS platform was well-known among participants. On the other side, the participants' awareness on the possibility to request training from the EFAS Dissemination Centre and of downloading EFAS hydrological forecasts from the Climate Data Store was somewhat limited. The most unknown EFAS resource were the Jupyter notebooks.

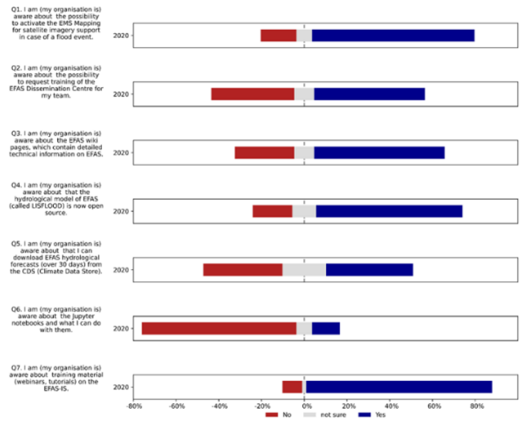

Figure 28: Average user response to awareness about some EFAS products/features.

EFAS products

In general, participants were positive about the usability and added value of all EFAS products. The highest rated product was the 6-hourly flood forecast information while the lowest rated ones were the risk assessment layer and the sub-seasonal forecasts.

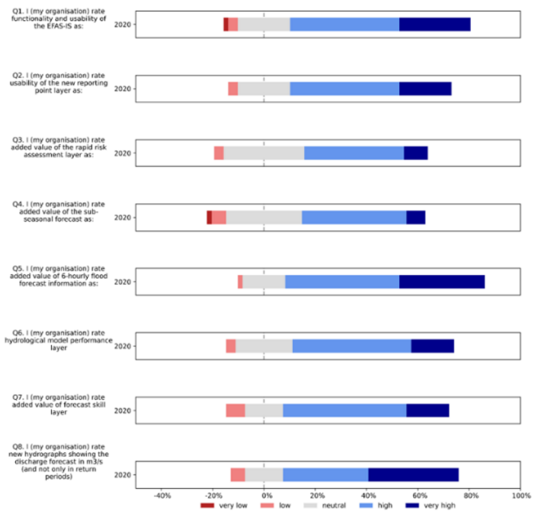

Figure 29: Average user response to the functionality/added value for some of the EFAS products/features.

Only a minor percentage of participants stated that their organisations were using some of the EFAS data (runoff, snow and soil moisture) available through the Sensor Observation Service (SOS) and The Climate Data Store (CDS) web services, and about 20% of them stated that their organisations were planning on using these data in the future. What's more, nearly half of the participants reported that their organisations did not use these data and another 25% of the participants were not sure about it. The least used variable was simulated snow and the most used was runoff.

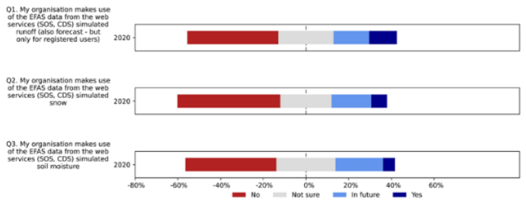

Figure 30: Average user response to the use of some EFAS products.

Regarding data quality and standardization, most participants stated that the would like to receive both quality flags for their meteorological and/or hydrological data, and their data in a standard format (i.e. harmonised time step and units, and quality controlled).

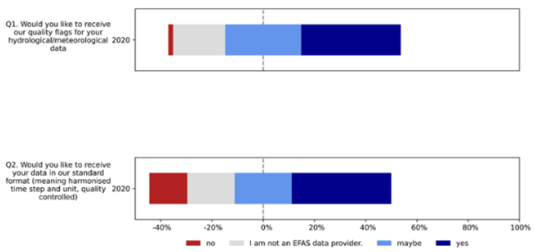

Figure 31: Average user response about obtaining specific EFAS product/data.

Feedback and contributions

Most participants stated that providing feedback to EFAS Formal Notifications with the built-in feedback form on EFAS-IS was easier than with the old system, following the same trend as in previous years. Nevertheless, some partners pointed out the existence of bugs in the system that hindered the reporting of feedback and the lack of resources available to provide feedback to all notifications.

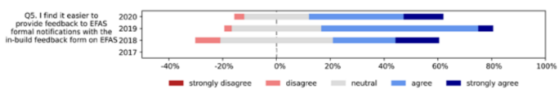

Figure 32: Average user response about the ease of providing feedback.

Even so, more than half of the participants were willing to provide feedback also for Informal Flood Notifications and Flash Flood Notifications. Most participants were however not sure about writing short articles to be published on the EFAS website or conducting verifications analyses.

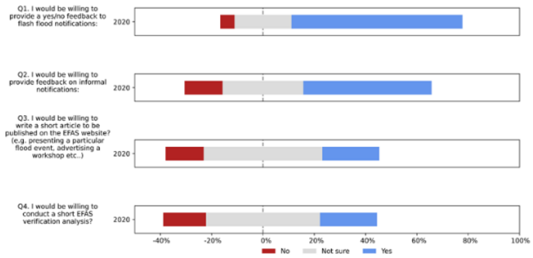

Figure 33: Average user response about the willingness to provide feedback or analyses/articles for EFAS.

Concluding remarks

Overall, partners were satisfied with the performance and added value of EFAS service as well as in its products and resources. However, a number of remarks were also provided on aspects of the system that need be further improved, such as on the performance of flash flood forecasts and notifications or the need to promote and provide training for some of the EFAS products and resources (e.g. EFAS wiki, Jupyter notebooks). Additionally, other suggestions include the expansion of the EFAS domain, and the increased resolution of certain variables (initial conditions, forecasted accumulated precipitation).

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

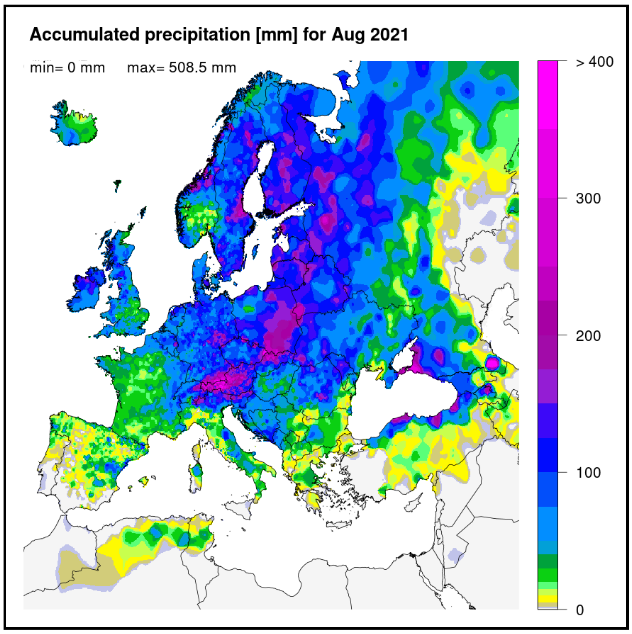

Figure 34: Accumulated precipitation [mm] for August 2021.

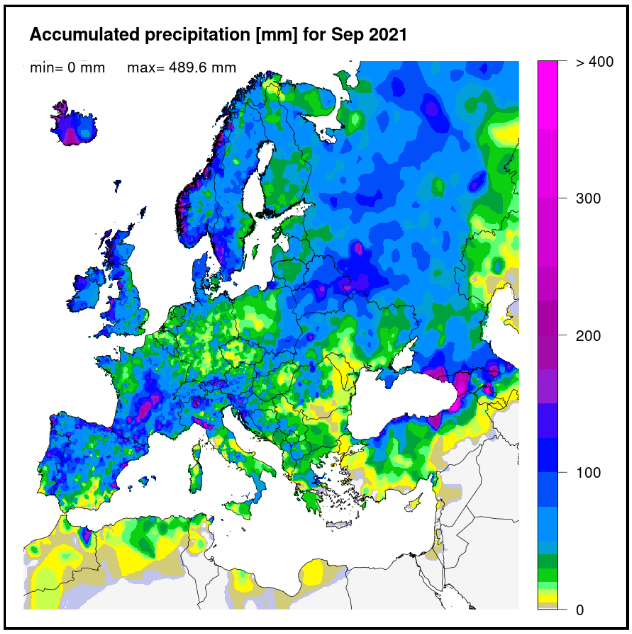

Figure 36: Accumulated precipitation [mm] for September 2021.

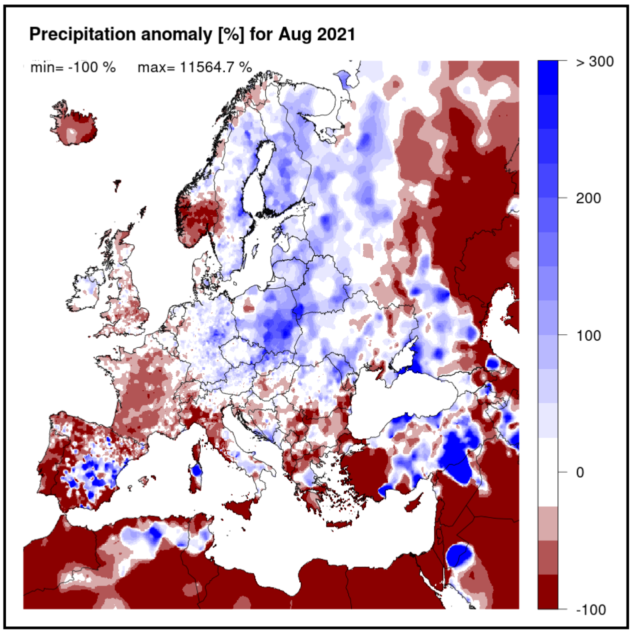

Figure 35: Precipitation anomaly [%] for August 2021, relative to a long-term average (1990-2013). Blue (red) denotes wetter (drier) conditions than normal.

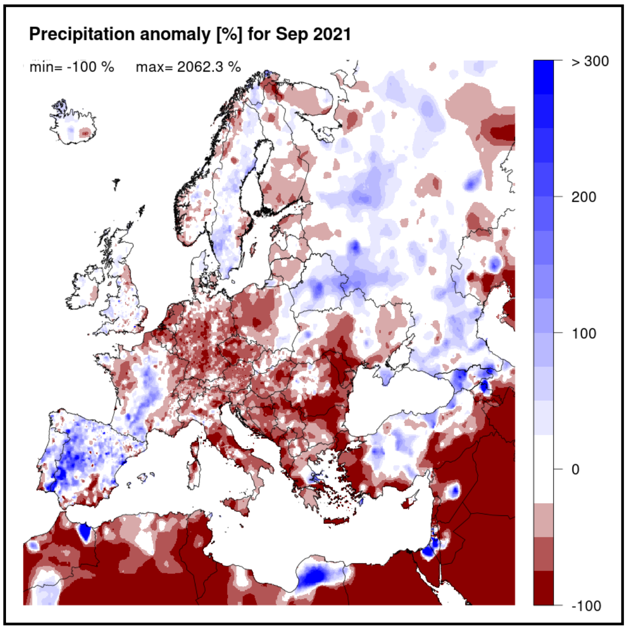

Figure 37: Precipitation anomaly [%] for September 2021, relative to a long-term average (1990-2013). Blue (red) denotes wetter (drier) conditions than normal.

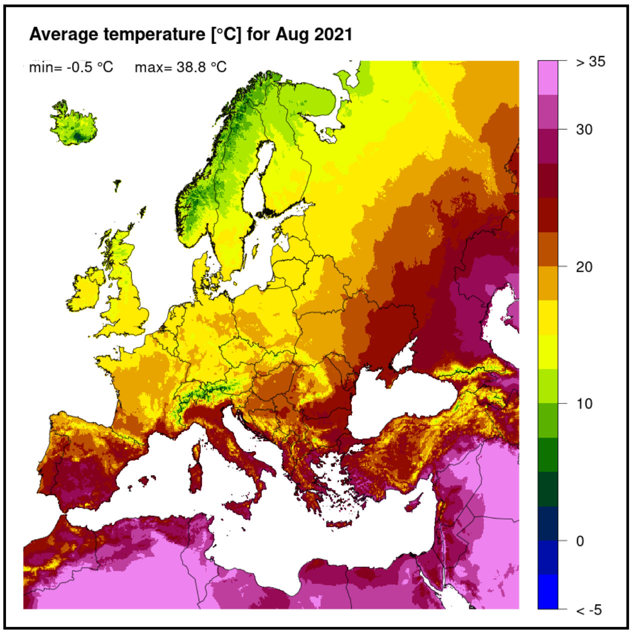

Figure 38: Mean temperature [°C] for August 2021.

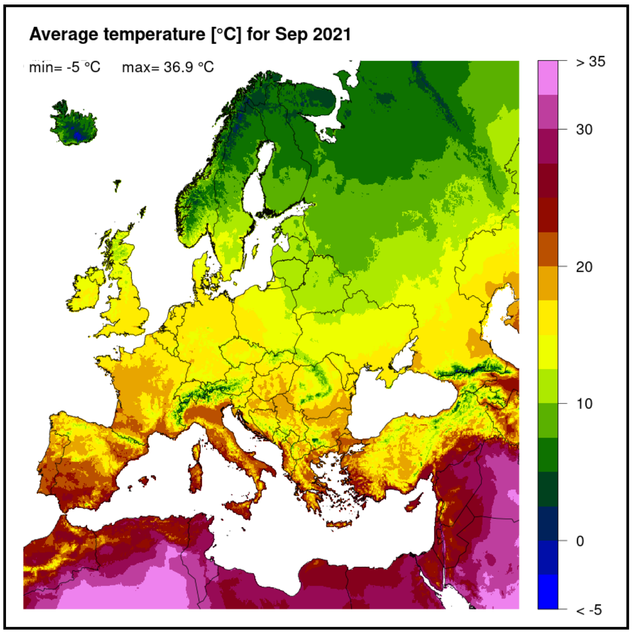

Figure 40: Mean temperature [°C] for September 2021.

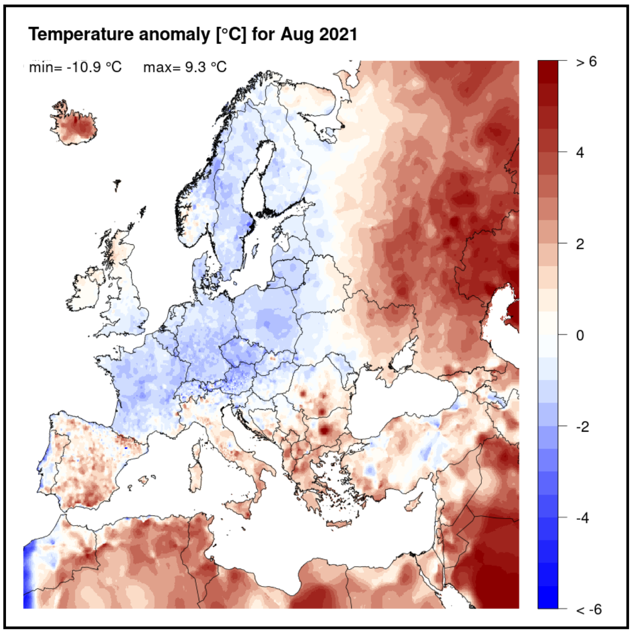

Figure 39: Temperature anomaly [°C] for August 2021, relative to a long-term average (1990-2013). Blue (red) denotes colder (warmer) temperatures than normal

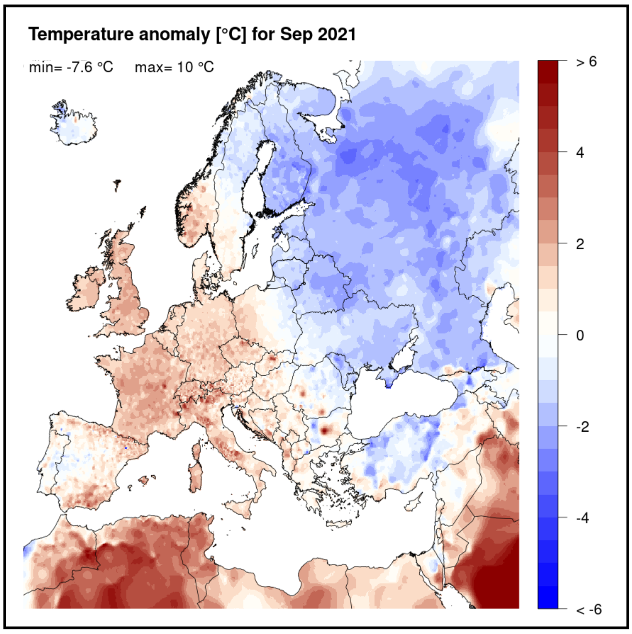

Figure 41: Temperature anomaly [°C] for September 2021, relative to a long-term average (1990-2013). Blue (red) denotes colder (warmer) temperatures than normal.

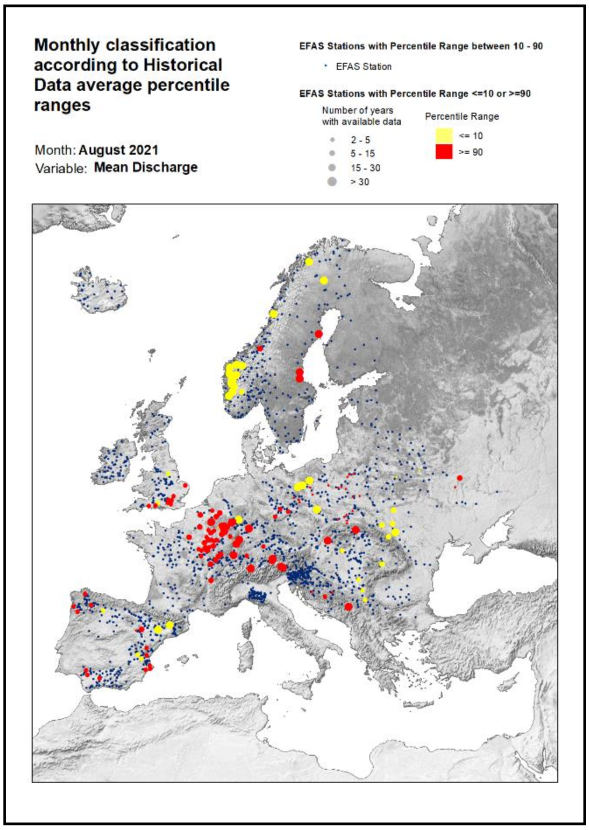

Figure 42: Monthly discharge anomalies August 2021.

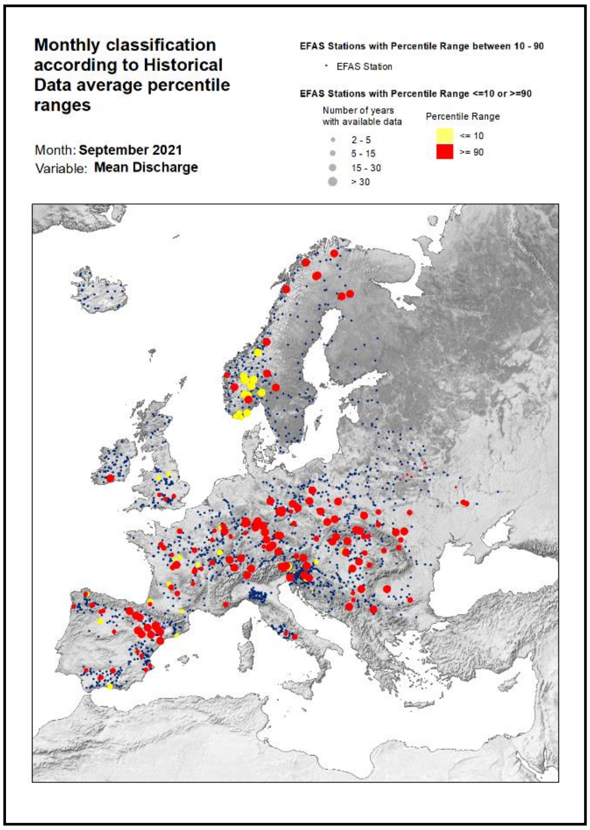

Figure 44: Monthly discharge anomalies September 2021.

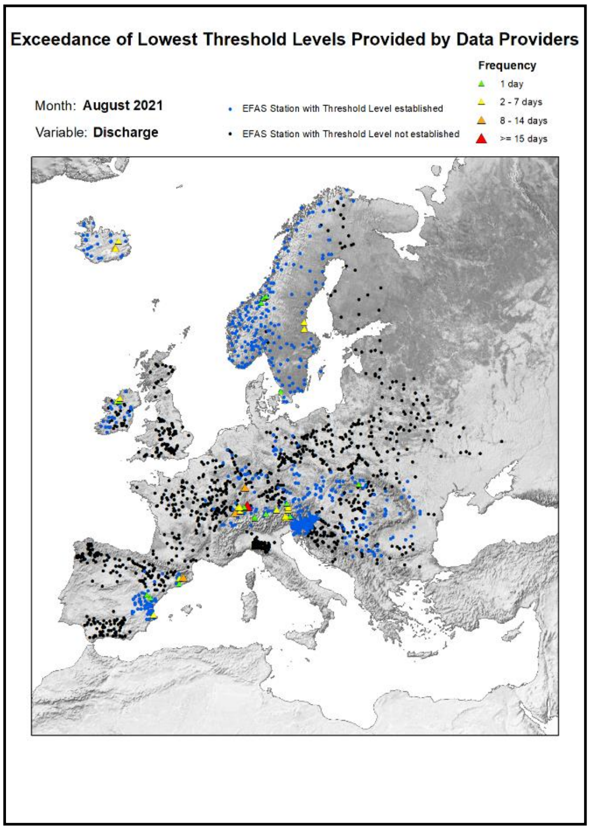

Figure 43: Lowest alert level exceedance for August 2021.

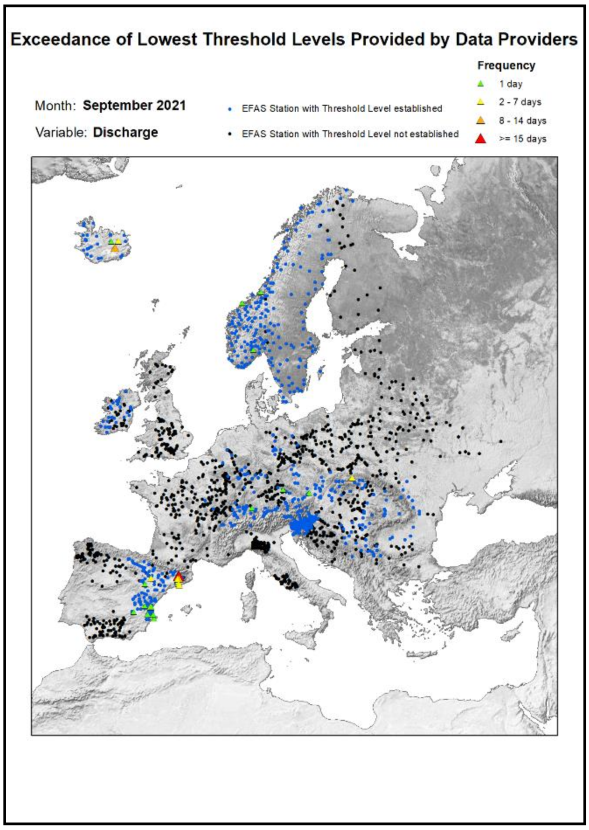

Figure 45: Lowest alert level exceedance for September 2021.

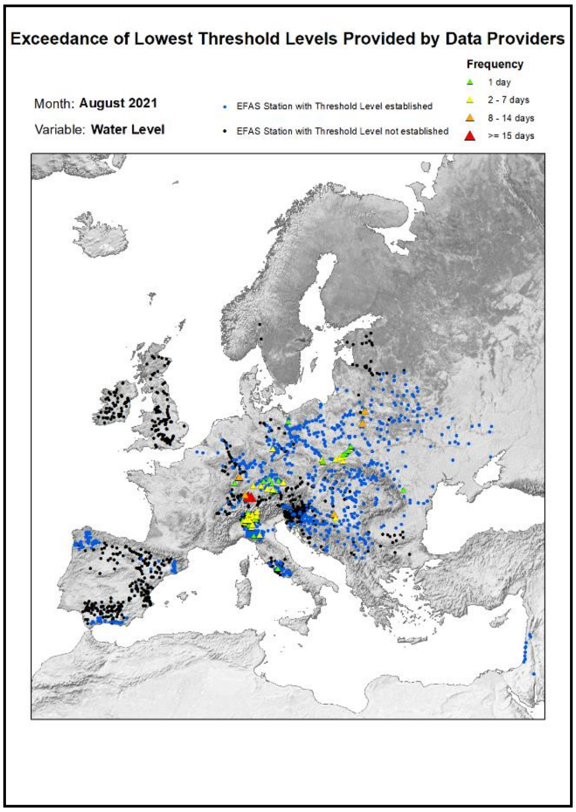

Figure 46: Lowest threshold exceedance for August 2021.

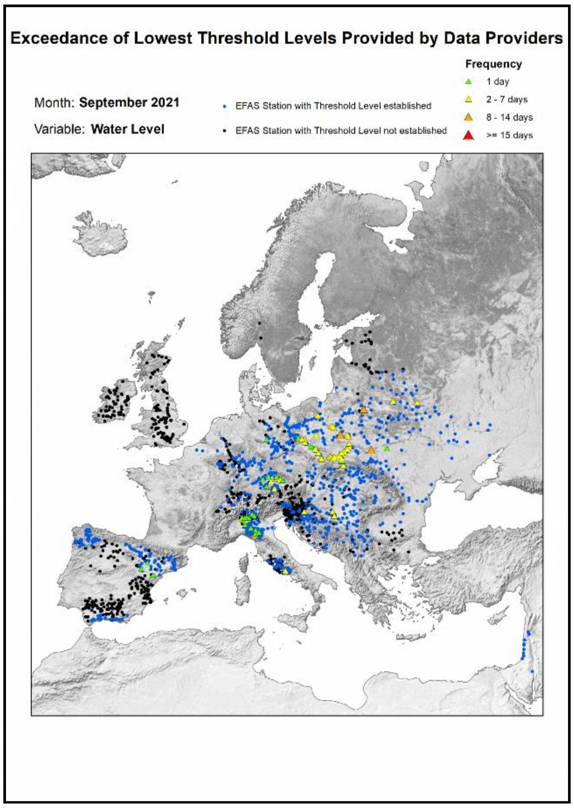

Figure 47: Lowest threshold exceedance for September 2021.

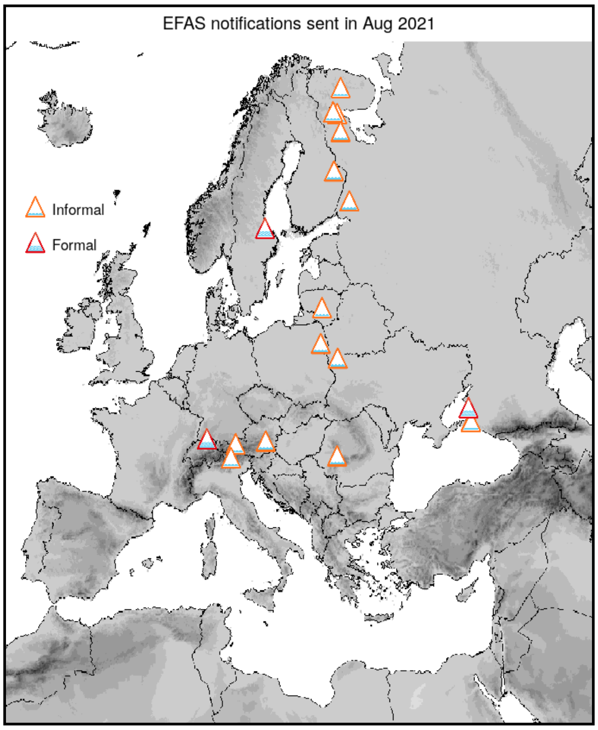

Figure 48: EFAS flood notifications sent for August 2021.

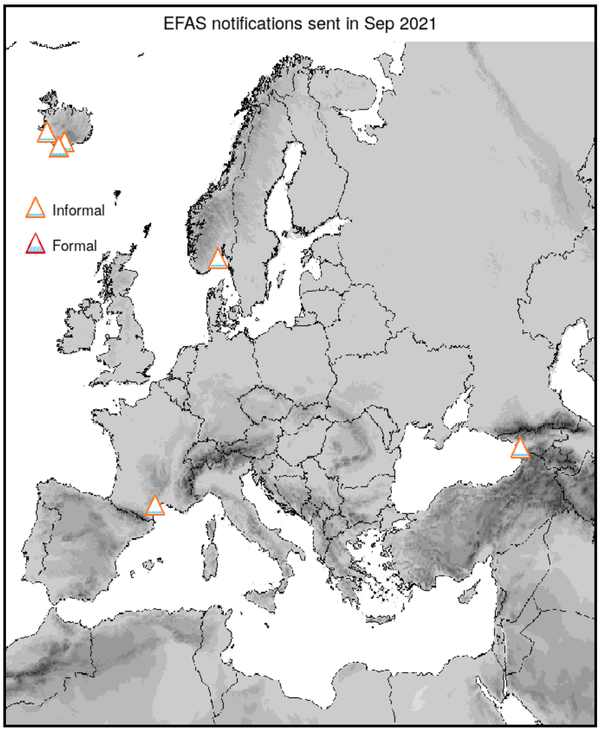

Figure 50: EFAS flood notifications sent for September 2021.

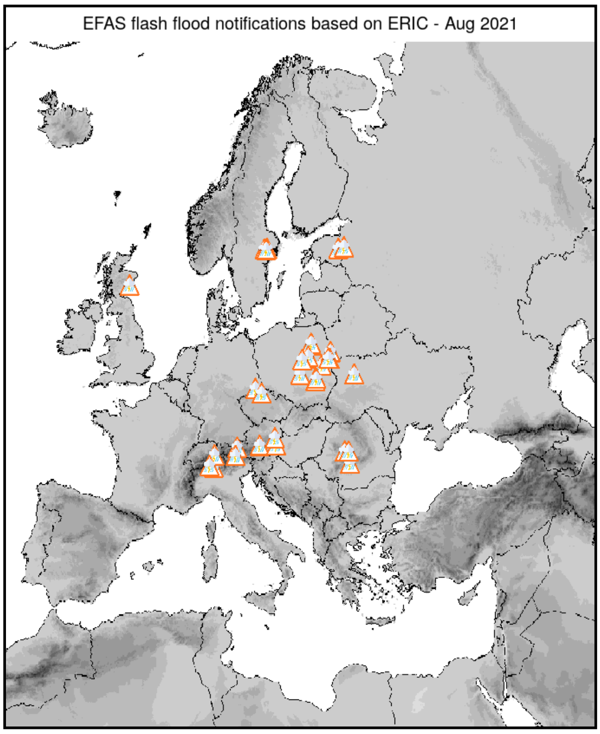

Figure 49: Flash flood notifications sent for August 2021.

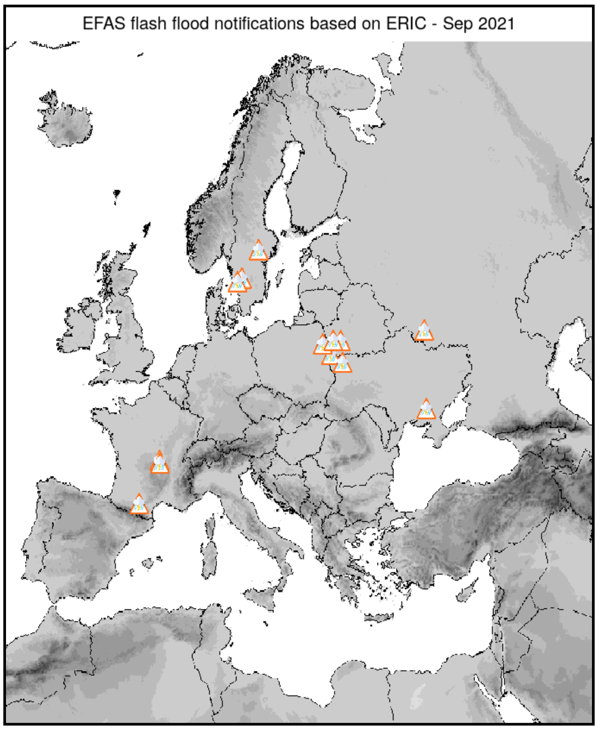

Figure 51: Flash flood notifications sent for September 2021.

Appendix - tables

Table 1: EFAS flood notifications sent in August – September 2021

Type	Forecast date	Issue date	Lead time	River	Country
Informal	01/08/2021 00UTC	01/08/2021	30	NEVEZIS	Lithuania
Informal	02/08/2021 00UTC	02/08/2021	42	KOVDA	Russia
Informal	02/08/2021 00UTC	02/08/2021	30	Pielisjoki section	Finland
Informal	02/08/2021 00UTC	02/08/2021	30	Lake Ladoga sub-catchment	Russia
Informal	02/08/2021 00UTC	02/08/2021	42	Voronja	Russia
Informal	02/08/2021 00UTC	02/08/2021	42	Coastal zone	Russia
Informal	02/08/2021 12UTC	03/08/2021	18	BOLSHOY KEMCHUG	Poland
Informal	03/08/2021 00UTC	03/08/2021	42	Ziller	Austria
Informal	03/08/2021 00UTC	03/08/2021	12	Oulankajoki	Russia
Informal	03/08/2021 12UTC	04/08/2021	66	Rhine	Switzerland
Informal	03/08/2021 12UTC	04/08/2021	36	Adige	Italy
Formal	04/08/2021 00UTC	04/08/2021	66	Rhine	Switzerland
Formal	09/08/2021 00UTC	09/08/2021	54	Coastal Catchment Black Sea	Russia
Informal	11/08/2021 00UTC	11/08/2021	6	Abin, Adagum	Russia
Formal	17/08/2021 00UTC	17/08/2021	18	Testeboån	Sweden
Informal	19/08/2021 00UTC	19/08/2021	0	Abin, Adagum	Russia
Informal	22/08/2021 12UTC	23/08/2021	12	Mur	Austria
Informal	24/08/2021 00UTC	24/08/2021	6	Pripyat, above Yaselda	Ukraine
Informal	27/08/2021 12UTC	28/08/2021	42	Mures, below Tirnava	Romania
Informal	01/09/2021 12UTC	02/09/2021	24	Rioni	Georgia
Informal	07/09/2021 00UTC	07/09/2021	48	ORB	France
Informal	08/09/2021 00UTC	08/09/2021	120	Coastal zone	Iceland
Informal	08/09/2021 00UTC	08/09/2021	114	Djupa	Iceland
Informal	09/09/2021 00UTC	09/09/2021	90	OELFUSA	Iceland
Informal	22/09/2021 12UTC	23/09/2021	84	Coastal zone	Iceland
Informal	27/09/2021 00UTC	27/09/2021	36	Skien	Norway

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

Table 2: EFAS flash flood notifications sent in August – September 2021

Type	Forecast date	Issue date	Lead time	Region	Country
Flash Flood	01/08/2021 00UTC	01/08/2021	24	Mazowiecki regionalny	Poland
Flash Flood	01/08/2021 12UTC	02/08/2021	36	Pskov	Russia
Flash Flood	01/08/2021 12UTC	02/08/2021	36	Louna-Eesti	Estonia
Flash Flood	03/08/2021 00UTC	03/08/2021	48	Lombardia	Italy
Flash Flood	04/08/2021 12UTC	05/08/2021	42	Lodzkie	Poland
Flash Flood	04/08/2021 12UTC	05/08/2021	48	Warszawski stoleczny	Poland
Flash Flood	04/08/2021 12UTC	05/08/2021	48	Mazowiecki regionalny	Poland
Flash Flood	05/08/2021 00UTC	05/08/2021	42	Eastern Scotland	United Kingdom
Flash Flood	05/08/2021 00UTC	05/08/2021	48	Podlaskie	Poland
Flash Flood	05/08/2021 00UTC	05/08/2021	30	Lubelskie	Poland
Flash Flood	06/08/2021 12UTC	07/08/2021	36	Graubunden	Switzerland
Flash Flood	07/08/2021 00UTC	07/08/2021	24	Ticino	Switzerland

Flash Flood	07/08/2021 00UTC	07/08/2021	24	Stredocesky kraj	Czech Republic
Flash Flood	07/08/2021 00UTC	07/08/2021	24	Ustecky kraj	Czech Republic
Flash Flood	15/08/2021 12UTC	16/08/2021	42	Brest	Belarus
Flash Flood	15/08/2021 12UTC	16/08/2021	36	Swietokrzyskie	Poland
Flash Flood	16/08/2021 00UTC	16/08/2021	18	Tirol	Austria
Flash Flood	17/08/2021 00UTC	17/08/2021	42	Uppsala lan	Sweden
Flash Flood	17/08/2021 00UTC	17/08/2021	30	Vastmanlands lan	Sweden
Flash Flood	17/08/2021 00UTC	17/08/2021	36	Sodermanlands lan	Sweden
Flash Flood	21/08/2021 00UTC	21/08/2021	48	Provincia Autonoma di Bolzano/Bozen	Italy
Flash Flood	21/08/2021 00UTC	21/08/2021	48	Steiermark	Austria
Flash Flood	22/08/2021 00UTC	22/08/2021	30	Burgenland	Austria
Flash Flood	22/08/2021 12UTC	23/08/2021	48	Lubelskie	Poland
Flash Flood	22/08/2021 12UTC	23/08/2021	42	Warszawski stoleczny	Poland
Flash Flood	22/08/2021 12UTC	23/08/2021	42	Mazowiecki regionalny	Poland
Flash Flood	22/08/2021 12UTC	23/08/2021	18	Niederosterreich	Austria
Flash Flood	22/08/2021 12UTC	23/08/2021	48	Brest	Belarus
Flash Flood	24/08/2021 00UTC	24/08/2021	24	Swietokrzyskie	Poland
Flash Flood	28/08/2021 00UTC	28/08/2021	36	Sibiu	Romania
Flash Flood	28/08/2021 00UTC	28/08/2021	36	Alba	Romania
Flash Flood	28/08/2021 00UTC	28/08/2021	36	Valcea	Romania
Flash Flood	28/08/2021 12UTC	29/08/2021	48	Rivne	Ukraine
Flash Flood	30/08/2021 00UTC	30/08/2021	36	Mazowiecki regionalny	Poland
Flash Flood	09/09/2021 00UTC	09/09/2021	24	Haute-Garonne	France
Flash Flood	17/09/2021 00UTC	17/09/2021	36	Brest	Belarus
Flash Flood	17/09/2021 00UTC	17/09/2021	42	Podlaskie	Poland
Flash Flood	17/09/2021 00UTC	17/09/2021	30	Volyn	Ukraine
Flash Flood	17/09/2021 12UTC	18/09/2021	48	Kursk	Russia
Flash Flood	17/09/2021 12UTC	18/09/2021	30	Hrodna	Belarus
Flash Flood	17/09/2021 12UTC	18/09/2021	24	Brest	Belarus
Flash Flood	18/09/2021 00UTC	18/09/2021	24	Allier	France
Flash Flood	18/09/2021 00UTC	18/09/2021	30	Kherson	Ukraine
Flash Flood	19/09/2021 12UTC	20/09/2021	24	Puy-de-Dome	France
Flash Flood	22/09/2021 00UTC	22/09/2021	36	Vastra Gotalands lan	Sweden
Flash Flood	27/09/2021 00UTC	27/09/2021	30	Vastra Gotalands lan	Sweden
Flash Flood	28/09/2021 12UTC	29/09/2021	24	Vastmanlands lan	Sweden

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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