European Flood Awareness System

EFAS *Bulletin*

August – September 2022

Issue 2022(5)

NEWS

In Memoriam

Passing away of Ad de Roo, founding father of EFAS

With deep sadness in our hearts we have to inform that on Monday 26th September, our colleague and the founding father of EFAS, Ad de Roo, passed away after a long and courageous fight with illness.

Figure 1: Ad de Roo, a founding father of EFAS

Ad joined the European Commission Joint Research Centre in 1997. He was a scientist and educator to his core and during an exceptional career, he published numerous high quality scientific papers, provided first-class mentoring to generations of PhD and post-doctoral fellows (at the JRC and at Utrecht University, where he was Professor of Physical Geography, Hazards and Impacts), and was at the centre of applied science projects with profound policy relevance and impact.

Ad's ability to push the boundaries of science and to see the applications of said science has been at the heart of his activities. In particular, the LISFLOOD model he developed with colleagues in JRC and the wider academic community, serves hydrologists worldwide for their research. LISFLOOD is also the core of the European and Global Flood Awareness Systems, EFAS and GloFAS. While these started as research projects under his leadership and guidance, they have become cornerstones of the operational Copernicus Emergency Management Service. As such, Ad's science regularly serves to improve Europeans abilities to tackle flood related disasters.

Ad leaves a big gap not only at the JRC but also in the wider academic world, particularly the hydrological research community and within the EFAS community.

New features

17th EFAS Annual Meeting

The 17th EFAS Annual Meeting was held as a hybrid meeting on 27-28 September 2022. The meeting was organized by the Joint Research Centre (JRC) with the support of all EFAS operational centres. The physical meeting was held in Ispra (Italy) at the European Commission's Joint Research Centre to which 76 joined in person and another 47 followed online. A full summary of the event will be shared soon. In the meantime all presentations can be viewed on the EFAS website here

Figure 2: Attendees of the 17th Annual EFAS Meeting at the JRC, Ispra, Italy.

Release of New EFAS version 4.5

The latest version of EFAS v4.5, was released operationally on Tuesday 13 September 2022.

EFAS v4.5 introduces minor changes to the system, as well as some general bug fixes. Here is a summary of the main changes:

- **Updates to Post-Processing**: Temporal resolution increased from daily to 6-hourly timesteps, where 6-hourly river discharge observations are available for at least two years and in near real-time. Recalibration of all 1606 station models using the most up-to-date data available (1419 at 6-hourly, 187 at daily). A new hydrological database set up by EFAS Hydrological Data Collection Centre (HYDRO) is now used to obtain river discharge observations.
- Introducing new **TAMIR layers** with 4 new flash flood products displayed on EFAS-IS: Impact Catchment Summaries (0-120h), Flash Flood Impact Forecasts, Past 24-h

Precipitation, Total Precipitation 80th Percentile. These products are produced by the blending of ensemble radar nowcasts from the pan-European OPERA network and the ECMWF ensemble weather forecasts. The products, with the exception of the past 24-h precipitation, are updated every hour with the latest radar information.

For more technical information on the release of EFAS version 4.5 please see the dedicated wiki page following the date of release.

CEMS MDCC integrated meteorological station data from Météo-France

1709 Météo-France active stations have been integrated in the data collection

In September 2022, the CEMS MDCC team integrated the meteorological station data from Météo-France into the operational processing routines. Météo-France provides precipitation, temperature, dewpoint temperature, relative air humidity, sunshine duration, solar radiation as well as wind speed and direction data on an hourly or daily basis. Data of 1709 active meteorological stations are loaded into the CEMS MDCC database in the daily routine. The data are processed and included into the gridded precipitation, temperature, solar radiation and wind speed fields produced every day in the early morning as input for the EFAS forecasts as well as for EFFIS. Temperature and precipitation data are used for the SPI (Standard Precipitation Index) and HCWI (Heat and Cold Wave Index) calculated for EDO.

CEMS MDCC would like to thank Météo-France very much for providing their data and for assisting in answering questions.

RESULTS

Summary of EFAS Flood and Flash Flood Notifications

The 18 formal and 29 informal EFAS flood notifications issued in August – September 2022 are summarised in Table 1. The locations of all notifications are shown in Figure 34 and Figure 36 in the appendix.

28 Flash flood notifications were issued in August – September 2022. They are summarised in Table 2. The locations of all notifications are shown in Figure 35 and Figure 37 in the appendix.

Meteorological situation

As of February 2022, reporting of the meteorological situation by the Meteorological Data Collection Centre (MDCC) will no longer be published in the EFAS bulletin. Instead, the state of recent meteorology will be conducted by the Copernicus Climate Change Service (C3S) and published as monthly Climate Bulletins.

Hydrological situation

by EFAS Hydrological Data Collection Centre

August

During the month of August, there were 34 stations with exceedances. Most of them are in Spain (17), in Italy (7), and Norway (4). In Spain, where almost all exceedances are related to the discharge threshold, the stations are mainly located in north-east of the Iberian Peninsula. The Minho river basin is the only one in Spain with exceedance related with water level. In Italy all exceedances are centered on the Po river and are related to the water level threshold. On the other hand, in Norway, all exceedances are related to the discharge threshold, and stations are dispersed in 4 different basins in the west of the country.

In addition, there are two stations with exceedance in Poland and Germany, and the rest of the countries with exceedance this month only show one each (Switzerland and Czech Republic).

In terms of river basins, the main one with values above the threshold is the Llobregat, with seven exceedances. The Po River in Italy is another basin that can be highlighted, with six exceedances.

Regarding the stations that recorded values above the 90% quantile, 51 exceeded this threshold in August. Once again this month, Spain is the country with the highest number of stations. The Spanish basins have 22 stations, with the Júcar river being the most numerous (6). In the south of the Iberian Peninsula the Guadalhorce, the Guadalquivir and the Guadiaro are

the basins with stations recording values above the 90% quantile, and in the eastern area the Júcar stands out. In Norway there are 12 stations exceeding this quantile, with four in Italy and five in Ukraine.

Other stations exceeded the 90% quantile value in England, Iceland, Austria, Germany, Romania and Serbia.

By basins, in addition to the aforementioned Jucar (with 6 stations), the Dnieper river also stands out with five stations and the Guadalhorce river with three stations.

Finally, and according to the number of stations recording mean values below the 10% quantile, we find a decreased of around 10%. In the month of August, there are 352 stations with average values below this cliff, which covers river basin areas in 24 different countries.

Also this month, Germany is the country with the most stations (64), followed by France (59) stations, and Spain and Austria have 24 stations each below the threshold.

In terms of basins, it is again the Danube river the one with the highest number of stations, reaching 113 station with average discharge below the 10% quantile. The Rhine basin has 79 stations in the same situation. In total, as many as 52 different basins have values below this limit.

September

During the month of September, there were 89 stations with exceedances, the majority of which are in Slovenia (29) and in Italy (20). In Slovenia, the exceedances are related to the water level threshold and discharge threshold. The Danube river basin has the most exceedances, with 23 stations, and six stations are located in the Soca-Lsonzo river basin. In Italy, all exceedances are related to the water level threshold, and stations are centered on the west-north and center of the country, with the Po river having the highest number of stations (15), followed by the Tiber river basin with only three stations.

In addition, there are 15 stations in Croatia (along the Danube river) and 14 stations with exceedance in Spain (the Llobregat river stands out). Norway shows six stations with exceedance, the only country in the Scandinavian Peninsula this month, and the rest of the countries with exceedance only show one each.

As for the river basins, the main one with values above the threshold is the Danube, with 38 stations in four countries. It also highlights the aforementioned Po basin in Italy.

In terms of the stations that recorded values above the 90% quantile, 60 exceeded this threshold in September. For yet another month, Spain is the country with the highest number of stations (19). In the south of the Iberian Peninsula, the Guadalhorce, the Guadalquivir and the Guadiaro are the basins with stations recording values above the 90% quantile, and in the eastern area the Jucar stands out with seven stations. In Romania, there are eight stations that exceed this cliff, while in Ukraine, Slovenia, and Serbia there are five stations.

Other stations exceeded the 90% quantile value in Croatia, France, Hungary, Italy, and Norway on more than one occasion.

By river basin, the Danube river again stands out with 25 stations, with exceedances along eight countries, with Romania having the highest number of stations. The sum of 24 different river basins shows exceedance over the 90% quantile.

Finally, and according to the number of stations recording average values below the 10% quantile, the trend has become more marked and we can find a decrease of around 65%. In the month of September, there are 114 stations with average values below this cliff, which implies 18 different countries.

This month, France is the country with the most stations (32), followed by Spain (19). Germany has ten stations below this threshold, followed by Sweden and Norway with eight stations each.

In terms of basins, it is again the Danube river the one with the highest number of stations (21), with an average discharge below the 10% quantile, mainly in Austria, Germany, and Hungary. The Loire river basin in France has 13 stations in the same situation. In total, as many as 45 different basins have values below this limit.

Verification

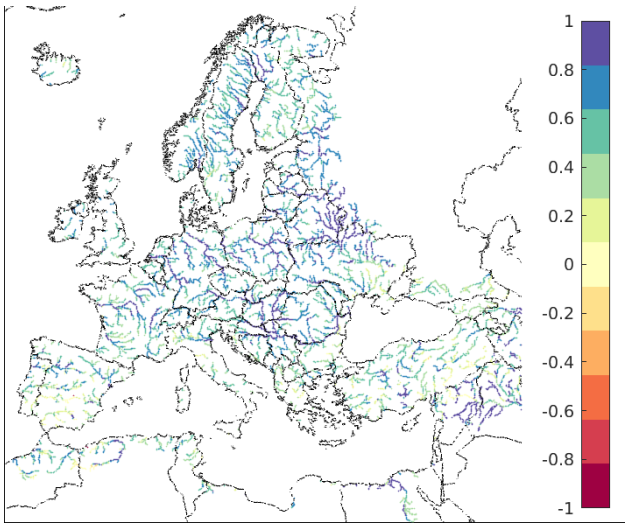

Figure 3: EFAS CRPSS at lead-time 1 day for August-September 2022, for catchments >2000km2. The reference score is persistence of using previous day's forecast.

Figure 3 and Figure 4 shows the EFAS headline score, the continuous ranked probability skill score (CRPSS) for lead times 1 and 5 days for August-September 2022 across the EFAS domain for catchments larger than 2000km^2. A CRPSS of 1 indicates perfect skill, 0 indicates that the performance is equal to that of the reference, and any value <0 (shown in orange-red on the maps) indicates the skill is worse than the reference. The reference score is using yesterday's forecast as today's forecast, which is slightly different than we used previously and very difficult to beat.

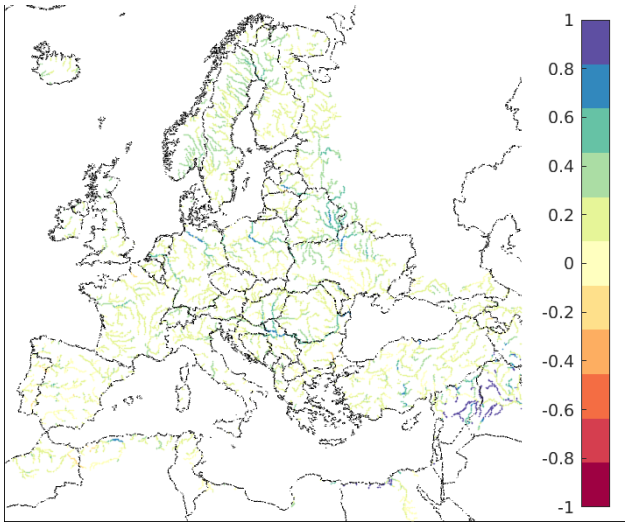

Figure 4. EFAS CRPSS at lead-time 5 days for August-September 2022 for catchments >2000km2. The reference score is persistence of using previous day's forecast.

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 5). 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.

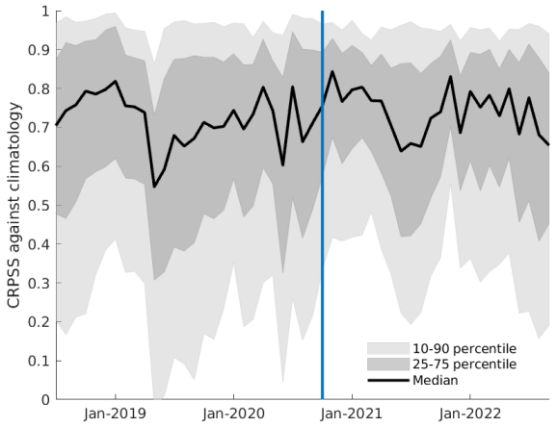

Figure 5. Monthly means of CRPSS the for lead-time 5 days for all the major river points in Europe with ECMWF ENS as forcing. Reference forecast was climatology. The skill is largest during the winter months, when there is less variation in the flow in large parts of Europe. The blue line indicates the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

ARTICLES

Flooding in northern Italy, August 2022

by Richard Davies, floodlist

Heavy rains wreaked havoc in the region of South Tyrol (Trentino-Alto Adige/Südtirol), northern Italy, from 05 August 2022.

Around 100 mm of rain fell within one hour in some areas, causing flash floods, debris flows and mudslides which damaged homes and hotels and left roads impassable. The region's volunteer fire service carried out more than 200 missions involving around 1,000 firefighters

Figure 6: Heavy rain triggered flood and landslides which cut roads in San Martino in Badia, Italy, 05 August 2022.

The government of Bolzano Province said areas around San Martin de Tor (Italian: San Martino in Badia; German: St. Martin in Thurn) were worst affected.
Almost 100 mm of rain fell in one hour from 17.20 on 05 August 2022. Over 50 tourists and staff were evacuated from a hotel in Val Badia in San Martin de Tor.

Figure 7:Flood and mudslide damage in South Tyrol region, Italy, 05 August 2022.

Elsewhere in the province, the a stream burst its banks in Pflersch damaging several buildings. Officials later reported 15,000 cubic meters of debris fell in the St. Anton area in Pflersch.

Two tourists managed to escape unharmed from their vehicle after it was buried by a mudslide in the municipality of Olang (Italian: Valdaora). No injuries were reported. A landslide also damaged several parked vehicles in Sorafurcia.
In the Province of Trento, local authorities said the municipalities of Campitello di Fassa, San Giovanni di Fassa and Mazzin were worst affected. Over 200 people were evacuated from homes and hotels. Many of those evacuated spent the night in emergency accommodation managed by the Red Cross. The severe weather caused major issues on the road system in the province, in particular on the SS 48 motorway and the SP 238 road in Moncion, which were closed to traffic for a few hours.

On 12 August the Trento provincial government declared a state of calamity for the territories of the Alta Val di Fassa affected by the severe weather.

Figure 8: Flood and mudslide damage in South Tyrol region, Italy, 05 August 2022.

According to Trento provincial government, between 17.15 and 19.45 on 05 August 2022, more than 123 mm of rain fell in Monzon, of which more than 100 mm fell between 18.30 and 19.30.

Credit for all images is to: *Landesverband der Freiwilligen Feuerwehren Südtirols / Unione Provinciale dei Corpi dei Vigili del Fuoco Volontari dell'Alto Adige.*

Floods in Portugal, Spain, Italy, and Croatia - September 2022

by Richard Davies, floodlist

Areas of Portugal, Spain, Italy and Croatia saw severe flooding as bouts of stormy weather moved across parts of Europe from mid-September 2022. As much as 420 mm of rain fell in just 3 hours in Italy's Marche Region where 11 people lost their lives in the ensuing floods.

Guarda District, Portugal 3 September 2022

The Portuguese Institute of Sea and Atmosphere (IPMA) issued warnings for severe weather from 11 September 2022 as Extratropical Cyclone Danielle made its way across the Iberian Peninsula.

Portugal Civil Protection recorded more than 350 incidents related to the bad weather from 12 to 13 September, mostly for wind damage and minor flooding in the districts of Lisbon and Setúbal.

The worst of the flooding however occurred in Manteigas municipality, Guarda District, where heavy rain fell on burn scar areas of the Serra da Estrela mountain range. The area had seen intense forest fires during the summer prompting the government to declare a state of calamity.

From late 12 September 2022 flood water, mud, downed trees and debris raced down hillsides around the village of Sameiro in Manteigas municipality, damaging buildings, infrastructure and dragging vehicles into the Zêzere river. The Mayor of Manteigas, Flávio Massano said the damage was enormous.

The Portuguese Institute of Sea and Atmosphere (IPMA) reported the city of Guarda recorded 83.7 mm of rain in 24 hours on 13 September.

Figure 9: Floods and debris flows in Sameiro, Manteigas municipality, Guarda District, Portugal, 13 September 2022. Credit: Presidente da Câmara Municipal de Manteigas

Catalonia and Valencia, Spain 16 to 18 September

Stormy weather and heavy rain affected the regions of Catalonia and Valencia in Spain from 16 September 2022.

According to the Meteorological Service of Catalonia, 90 mm of rain fell in the Port of Mataró area in 60 minutes on 16 September. One person was injured when a vehicle was submerged in a flooded underpass in Mataró in the province of Barcelona on 16 September. Emergency services responded to over 150 incidents during the storm, mostly in Maresme and Selva comarques.

Flooding was also reported in Castellón and Alicante Provinces in Valencia Region from 17 September. In 12 hours, Oropesa del Mar recorded 144.4 mm of rain; Benissa 139.0 mm; Torreblanca 138.8 mm; and Callosa d'en Sarrià 132.0 mm.

Firefighters in Castellón Province rescued people from several vehicles trapped in flood waters. Dozens of

people were evacuated from flooded campsites in Cabanes. A police officer died in tragic circumstance trying to rescue a driver swept away in flood waters in Benissa.

In a statement, Ximo Puig, President of the Valencian Government, said "I want to convey my condolences to the family and friends of the policeman, who tried to save a man in an act of great generosity."

Marche Region, Italy 15 to 16 September 2022

At least 11 people lost their lives after torrential rain overnight 15 to 16 September 2022 triggered catastrophic flooding in the Marche Region of Italy.

President of the Marche Region, Francesco Acquaroli, said in a statement that 420 mm of rain fell in about 3 hours.

The regional government reported severe flooding in Cantiano, Cagli, Frontone, Pergola, Serra Sant'Abbondio in the province of Pesaro Urbino; and in Sassoferrato, Arcevia, Ostra, Serra de Conti, Ostra Vetere, Barbara, Trecastelli, Corinaldo in the province of Ancona.

Rivers including the Misa, Cesano and Esino, along with several small watercourses, broke their banks. The regional government said flooding caused bridges to collapse, blocked roads, damaged homes, interrupted power supply and swept away vehicles. Some areas were left without telecommunications and water supply. Emergency Services received more than 2,600 calls for assistance.

Italy's fire service Vigili del Fuoco said teams involving 300 personnel rescued dozens of people. Many had taken refuge on the roofs of houses and in trees to escape the flooding. By 16 September more than 400 interventions had been carried out, including helicopter rescues. Vigili del Fuoco reported 7 people had died and 3 were missing. Some of those rescued were taken to hospital with injuries or for treatment for hypothermia. As of 18 September, news agencies reported 11 fatalities and 2 missing.

Francesco Acquaroli, President of the Marche Region declared 2 days of mourning. He said "the pain for what happened is deep, but the Marchega community is strong and will know how to react. My thoughts are with the missing people and their families, to whom I express my sympathy and closeness."

The Copernicus Emergency Management Service Rapid Mapping team was activated by the Italian Civil Protection.

Figure 10: Flood damage in Cantiano , Italy, September 2022. Credit: Mayor of Cantiano Alessandro Piccini

Figure 11: Image acquired by one of the Copernicus Sentinel-3 satellites on 18 September shows the plume of sediment that poured into the Adriatic Sea as a result of the floods. The sediments, carried into the sea by the rivers were transported by wind and marine

Murcia Region, Spain 25 to 26 September

Heavy rain caused destructive floods in the Murcia region of Spain from 25 to 26 September 2022. Firefighters reported one person died after floods destroyed a home, while emergency services responded to dozens of call-outs including flood rescues.

Spain's State Meteorological Agency AEMET reported more than 29 mm of rain was recorded in just 10 minutes at the Cabo de Palos weather station in the municipality of Cartagena, and more than 86 mm in 60 minutes.

The rain triggered flooding and landslides in 19 municipalities of the region, damaging homes, streets and vehicles. Several road traffic accidents were blamed on the severe weather. Emergency services received a total of 293 calls for assistance, including 77 in Cartegena aand 72 in Murcia.

Murcia Fire Service reported one person died and several were rescued from their homes after a torrent of water destroyed one house and damaged others in Javalí Viejo district near Murcia city.

Figure 12: Flood damage in Murcia, Spain, 25 to 26 September 2022. Credit: Bomberos Murcia

Croatia, 28 September

Police in Croatia reported one person died in flash floods in the port city of Rijeka after torrential rain on 28 September 2022.

Croatian Meteorological and Hydrological Service (DHMZ) said 287.5 mm of rain fell in 24 hours in Rijeka. Local media said unofficial figures showed the city recorded 140 mm of rain in just 2 hours.
Streets of the city and areas of Istria County were swamped and traffic brought to a standstill. Homes and public buildings including a school and a police headquarters were damaged. Emergency services received around 200 calls for assistance.

In a statement early 29 September Mayor of Rijeka Marko Filipović offered his condolences to the family of the victim.

EFAS Partner Survey

By Vera Theimig

The **EFAS partner survey** regarding the general satisfaction with the EFAS service, products and performance during the year 2021 was sent out to all partners in January 2022. A total of 54 responses were received, compared to 54 responses received in 2020, 36 in 2019, and 43 in 2018. The survey was, as in previous years, anonymous.

The survey responses are summarized according to the following categories:

- Demographics
- Overall Satisfaction
- Skill, model performance and trust
- EFAS Services
- EFAS Products and added value
- Future Developments

Demographics

The distribution of country origin for the survey respondents was similar in 2020 and 2021, but there was a higher percentage of respondents from the "others" category in 2021.

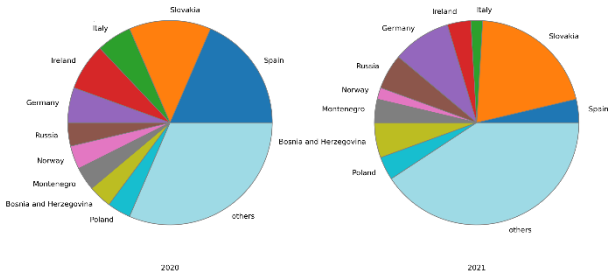

Figure 13: Pie-chart showing the country origin of the EFAS partners that answered the survey.

Most of the survey participants were both a data provider and an EFAS partner.

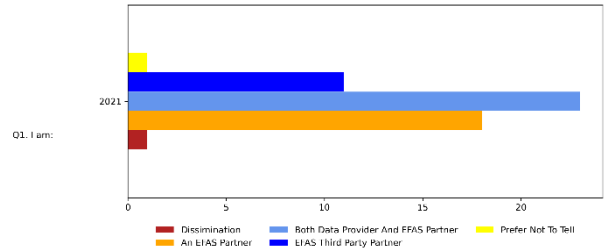

Figure 14: Roles of survey respondents.

Overall Satisfaction

No major changes in the overall satisfaction were reported in comparison to the previous four years. However, it is worth noting that there was an increase in satisfaction in overall performance during the past 12 months in comparison to the 2020 survey, in which 7% of the participants rated the performance as "low".

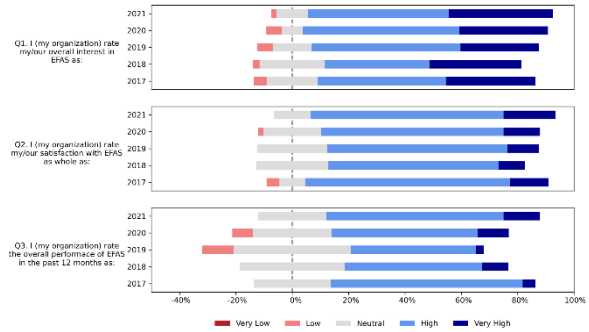

Figure 15: Average user response on overall satisfaction with the EFAS.

Skill, model performance and trust

Most of the participants (67%) rated the information about the EFAS model performance and forecast skill as high. However, 4% of participants indicated that they did not know this information was available.

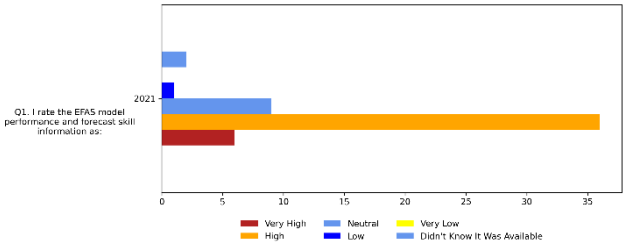

Figure 16: User response about the model performance and forecast skill.

EFAS services

The EFAS bulletin and the annual hydrological report are the most read, with 94% and 85% of participants respectively reading them at least sometimes. The detailed assessment report was read the least; 20% of participants did not read the report, and 11% of participants did not know it existed.

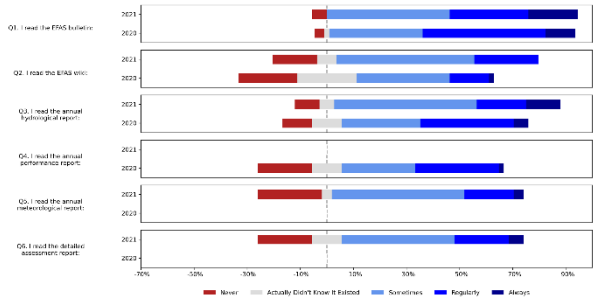

Figure 17: Average user response to EFAS informative resources.

Survey participants provided similar responses in 2021 as in 2020 when asked to identify their main benefits of being an EFAS partner. Overall, the main benefits were the forecast, followed by the notifications, learning practices during annual meetings, and observed and forecasted precipitation. In 2020, the least voted benefit was "Training by DISS", and this option was not provided in the 2021 survey. New options for the 2021 survey were: (1) Europe-wide overview on ongoing and forecasted events, and (2) To be able to see/monitor the situation/forecast of neighboring basins. For both of these new options, 52% of the participants indicated that these were among their main benefits of being an EFAS partner.

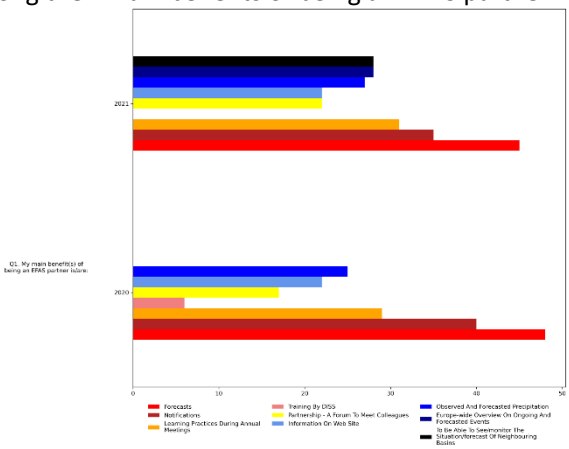

Figure 18: User responses on the main benefits of being an EFAS partner.

Participants were asked to comment on if they have noticed an improvement/worsening from the upgrade of the flash flood product in 2021. Their responses are included below. Overall, the responses indicate that the updates generally improved the flash flood product. However, survey participants identified several limitations of the current model and methodology and indicated that the flash flood

notifications may be issued too often in some locations. It is also worth noting that many survey participants joined EFAS in 2021 and therefore did not have experience with the previous flash flood product.

Positive Feedback:

- I have noticed the improvement - a smaller amount of false notifications
- Yes, I have noticed an improvement of flash flood forecast product in 2021.
- A little improvement
- Yes
- We have noticed improvement
- Number of flash flood forecasts is more realistic since the upgrade
- The number of Flash FNs decreased - it is excellent the handling with triangles is very comfortable
- It appears to have improved slightly. The improvement appears to be better in predicting the locations of flash flooding.
- The forecast of a flash flood is very useful for us. Our warnings are based on our forecast and on EFAS products and notifications. Thanks to EFAS!
- Improvement for Croatia, especially mountain region and southern region (inner parts of Dalmatia near Cetina river). Also improvements for southern parts of Bosnia and Herzegovina (rivers Neretva and Trebižet).
- It has become better, more convenient.
- There is an improvement in that fewer notifications are issued now reducing the probability of false alarm.
- Better overview between the current Flash Flood reporting points on the basis of which notifications are issued.

Neutral Feedback:

- The performance is generally good, however we had an extreme event on 25th December in the South East of Ireland - up to 90mm of rain in less than 8 hours. On review, this was predicted by the AROME model but not by others (ECWMF, Harmonie etc.).
- No special feedback. I however notice a steady reliable availability of the EFAS-product which is important. Forecast quality is relatively poor but for us the notification is more important than the exact measurement vs forecasted discharges.
- The number of false alarms has been reduced, but work still needs to be done to reduce the number of overestimated flash flood announcements.
- Any improvement. I think there were several Mediterranean events not included
- In general, not a clear change for our country area (Romania), we consider that flash flood forecast product have a similar performance as before.

Negative Feedback:

- The flash flood notifications are issued too often. The information in the e-mail is confusing / doesn't correspond to the expectation of many users (area susceptible to landslides isn't something often a relevant criteria / information for the user)
- Users of flash flood products should be aware of the methodology of the ERIC points and its limitations, e.g. ERIC calculates also 24h precipitation, which is much longer than usual perception of flash floods.
- I consider that the number of flash flood notifications issued for my country is extremely high. In some cases, there is an overlapping regarding the locations concerned. Moreover, I find the upgraded feedback as more complicated, it requires more time to be filled than the previous one.
- From my point of view, you have to introduce another layer into the EFAS portal, on which, within the framework of the forum, any issues related to the independent installation of the LISFLOOD model and its modernization can be discussed. Time is going very quickly. Without such action LISFLOOD will not be seriously improved in near future.

Other Feedback:

- We are new at EFAS in 2021. So the experience is not very big yet.
- I, personally, started to serve in 2021, thus, I can not compare the progress of 2021 with 2020.
- Actually, I don't have the experience yet, as we are partner only for a very short amount of time
- N/A, my organization is EFAS partner since Sept. 2021. In result no real experience is available at this time.
- We are not able to comment this since we are partners from 2021.
- Flash floods are not part of our work/agenda

- The flash floods are not characteristic feature of our rivers
- N/A
- Not sure.

For the question, I (my organisation) compare EFAS forecast with those from other provides, 39% answered no, 44% answered yes, and the remaining percent did not answer the question. Participants who answered yes were asked to specify which systems they use and how they compare with EFAS. Many different systems were used:

- National System (3 participants)
- Sava Flood Forecasting and Warning System (2 participants)
- We compare EFAS forecasts with the products of the Hungarian Hydrological Service for the Danube and the Tisza, as well as the products of the DELTARES FEWS platforms for the Sava, Velika, Zapadna and Južna Morava basins.
- All EFAS forecasts are compared with forecasts been worked out in regional national forecast centers.
- AEMet and other meteorogical services
- Italian CP hydrological models
- ICONPANDARHEI
- 16 competent flood services of the federal states of Germany (using different systems), usually they do compare well with EFAS
- Forecasts of DWD in Germany and governmental forecasts for Rivers.
- FFGS, SEE-MHEWS
- National system hydrological warning in Slovakia providing by SHMU
- Forecast precipitation is compared with Met Éireann's HARMONIE forecast and the AROME Forecast

Partners were asked to rank their preference on different forms of training with a value of 1 indicating their first choice and a value of 4 indicating their last choice. Overall, the partners prefer to receive training in the form of short online tutorials (average rank = 2.18), followed by regular webinars (average rank = 2.20). Online documentation and workshops during the annual meeting were the least preferred with average ranks of 2.79 and 2.82, respectively. These responses were similar to those received during the 2020 survey.

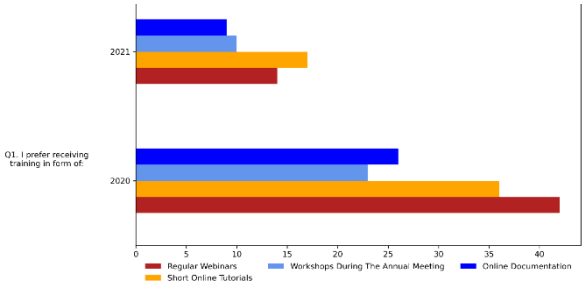

Figure 19: User responses about the preferences for receiving training. Note that in the 2020 survey partners were asked to check all that apply, but in the 2021 survey they had to rank them.

The participants were asked in which topic(s) they would like to receive training, which resulted in the following responses:

- LISFLOOD (6 responses):
  - Installation of LISFLOOD model and main problems of this action
  - New achievements in the problem of modernization LISFLOOD model
  - Training in LISFLOOD also in native language, not only in English
- The Climate Data Store and downloading/using EFAS hydrological data (6 responses):
  - How can I download EFAS hydrological data?
  - Downloading real time EFAS simulations, both for discharge and models state parameters, in gridded format, and recommendations / best practice on how to read and process these raw data, in order to integrate / compare with the national system data and to generate new specific products for our country.
  - How to access and download EFAS hydrological data (simulations and forecasts 30 days after real-time) from the CDS (Climate Data Store)
  - Training in the Climate Data Store in native language, not only in English
  - Interaction and use of the EFAS data with other forecasting systems i.e. Sava Flood Forecasting and Warning System.
  - How to use EFAS Hydrological data from the CDS
- Jupyter notebooks (3 responses):

  - Training in Jupyter notebooks in native language, not only in English
- Use of the EFAS products (2 responses):
  - Handling /user guide of EFAS products for personnel (non-hydrologists) in our 24/7 situation centre of the federal civil protction authority - note that such a guide should have to focus on application and interpretation of EFAS by non-hydrologists / non-meteorologists, who quickly need to take decisions.
- Evaluation of forecasts and model skills (2 responses):
  - Detailed information about forecasts skill (the methodology, examples, how this skill can be interpreted from the user's point of view) and planning developments in this area
- Seasonal and subseasonal forecasts
- EMS Mapping for satellite imagery support.
- Deactivation and reissue of notifications if the peak time is shifted
- Overall capabilities of the EFAS system for newly organized group of the employees in our organization and detailed one for the advanced ones.
- Training for beginners
- EFAS training for my institution in our offices.

EFAS products and added value

The ratings of the added value of the different EFAS notifications were similar in 2021 to those of the previous survey years. In general, most survey participants rate the added value of the different notifications as either high or very high, and there have not been major changes in the responses between survey years.

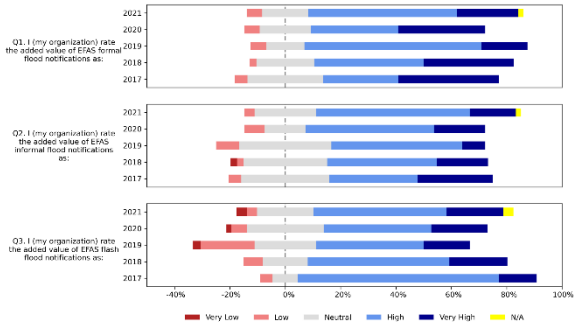

Figure 20:Average user response to the added value of notifications.

Satisfaction with each of the EFAS centres in 2021 was predominantly positive and similar to that of 2020. For the 2021 survey, the participants were not asked to rate the ease of providing feedback using the in-built form.

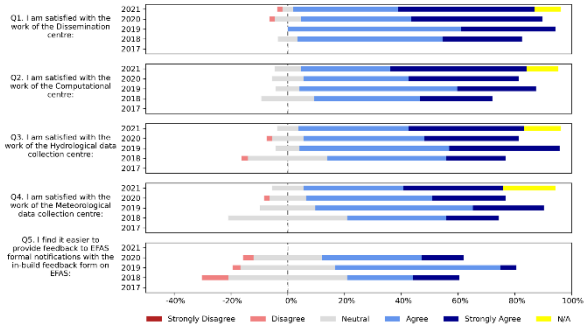

Figure 21: Average user response about the satisfaction of the work of the different EFAS centers and the easiness/difficulties to give feedback.

In general, participants rated the usability or added value of the EFAS products higher in 2021 than in 2020. Participants were especially positive about the added value of the 6-hourly flood forecast information. The added value of the rapid risk assessment layer and of the sub-seasonal forecast were the least popular.

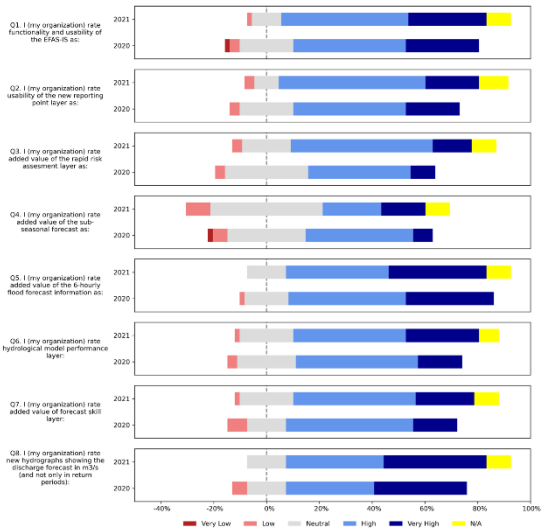

Figure 22: Average user response to the functionality/added value for some of the EFAS products/features.

Overall, awareness of the different EFAS products and features was similar in 2020 and 2021. For both years, the highest awareness was for the possibility to activate EMS (Emergency Management Service) Mapping for satellite imagery, that the LISFLOOD model is now open source, and about the training material on the EFAS-IS. It is also worth noting that from 2020 to 2021 there were large increases in

awareness about: (1) the possibility to request training of the EFAS Dissemination Centre, and (2) the EFAS wiki pages. However, awareness about the Jupyter notebooks and what can be done with them remained lowest among the products/features.

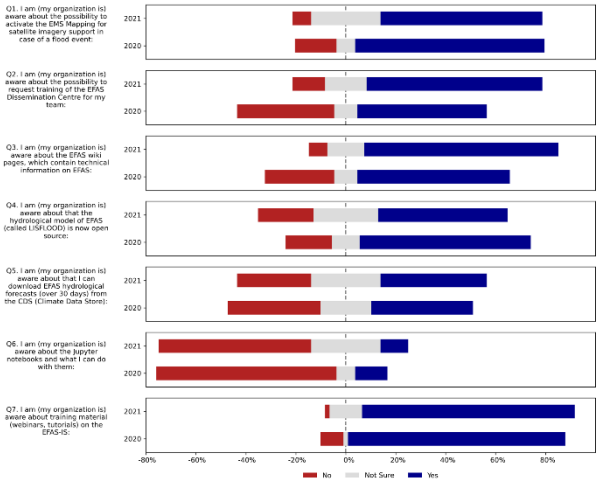

Figure 23: Average user response to awareness about some EFAS products/features.

From 2020 to 2021, there was an increase in usage of the simulated runoff, snow, and soil moisture data provided by the Sensor Observation Service (SOS) and the Climate Data Store (CDS). In addition, there were increases in the percentage of respondents who indicated that they think their organization will use the data in the future.

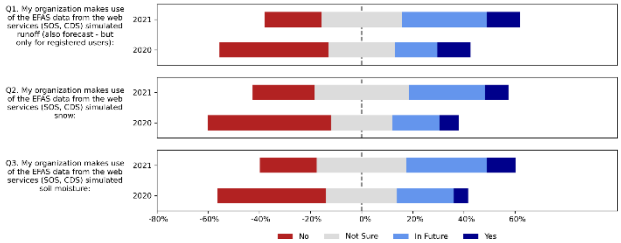

Figure 24: Average user response to the use of some EFAS products.

The survey participants were then asked to comment on: (1) what prevents them from using this data, and (2) what EFAS data they would like to have access to. These responses are summarized below:

- Did not know about these services. Lack of time and know how to download and integrate in information tools and decision support systems.
- I would like to have access to the following EFAS data: simulated river discharge (also forecast), simulated snow and simulated soil moisture.
- I think I have not yet reached the full potential of Copernicus CDS
- The main problem that up to now regional forecast centers have no any real support from official power organizations. First of all from Roshydromet.
- Technical equipment. Trained staff.
- Data of accumulated precipitation
- How to webinar
- We are in a process of establishing data downloads from EFAS to our national system
- I have access to data and I am satisfied with it. I have only one question concerning soil moisture. Is it any plan in future to add real time measurements, e.g. from some providers or from the satellite?
- We produce or get such data ourselves in finer spatial resolution
- 1. Systems to use data still at conceptual stage. 2. Recorded precipitation (24-hour accumulation from radar)

Overall, participants were less willing to provide feedback or analysis/articles for EFAS in 2021 than in 2020. However, 52% of the participants were willing to provide feedback for flash flood notifications, and 39% were willing to provide feedback for informal notifications. In contrast, only 13% of participants were willing to write a short article, and 9% were willing to conduct a short verification analysis.

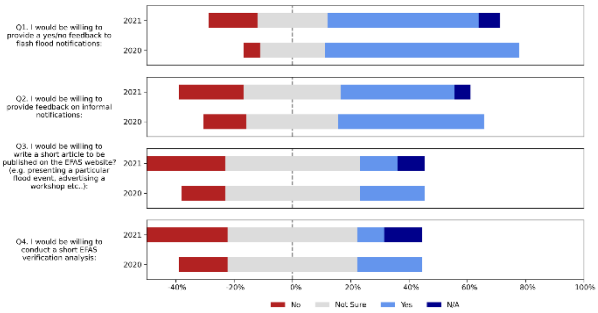

Figure 25: Average user response about the willingness to provide feedback or analysis/articles for EFAS.

Future Developments

Survey respondents provided the following responses when asked what they are missing in EFAS:

- Special layer in EFAS portal where any EFAS partner can discuss the problems connected with LISFLOOD installation
- More detailed sub-seasonal and seasonal outlook products

- Accumulations of forecasted precipitation for more intervals, not just for the entire forecast period (e.g. 24, 48, 72 hours, 5 days)
- Maps with accumulated recorded precipitations in the last: 1, 3, 5, 10 days.
- During the period with snow cover, maps with accumulated simulated snowmelting contribution, both for the last 1, 2 and 3 days period, and forecasted for the next 24, 48, 72 hours, 5 days.
- Physical meetings

Between 2020 and 2021, there was a decrease in the percentage of survey participants who would like to receive both quality flags for hydrological/meteorological data and data in a standard format (harmonized time step and unit, quality controlled), which might also be due to the fact that a higher percentage of participants were no EFAS data providers. However, over 50% of the participants replied either "Yes" or "Maybe" to both questions.

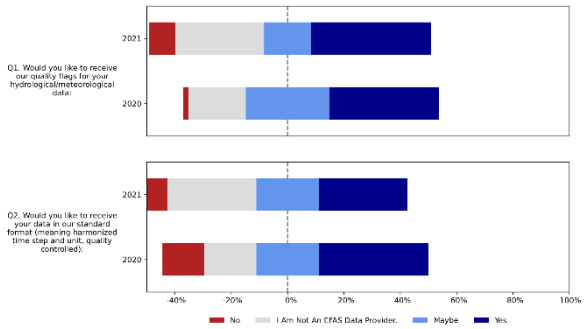

Figure 26: Average user response about obtaining specific EFAS product/data.

The survey participants were also asked to indicate their thoughts on EFAS and open data. Responses were generally neutral, but more participants were in favor of making EFAS public without the flood notifications than of making the entire system publicly available.

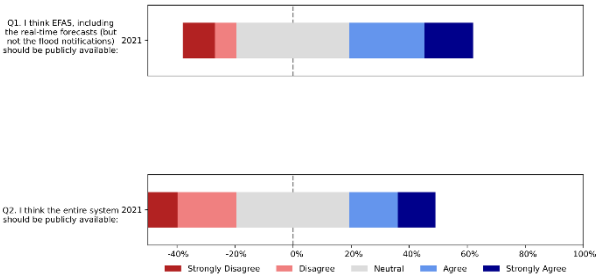

Figure 27: Average user response about making publicly available the EFAS products/forecasts and the entire system.

Lastly, partners were also asked on any other comment they might have. These responses are included below:

- I wrote a lot. If 75% of written suggestions will be done it will be a very good result.
- Nice to work with all of you!!!!!
- On the EFAS and open data issue, I think that selected existing EFAS products but also new more specific and useful products dedicated for the public could be made publicly available.
- Thank you for hard work on improving the EFAS functionalities
- Thank you for organising the annual meetings and providing different webinars.
- About EFAS public availability: it would be nice to have some info available for everyone, but in some simple form, taking care not to turn general audience into self-proclaimed "scientist" and "forecasters" because real alerts should come from local authorities
- To make the data or system open, first run a pilot, then consider results carefully.
- N/A, my organization is EFAS partner since Sept. 2021. In result no real experience is available at this time.

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: Italy captured by Copernicus Sentinel-3 satellites on 18 September 2022, showing the plume of sediment that poured into the Adriatic Sea as a result of the floods.

Appendix – figures

As of February 2022, reporting of the meteorological situation by the Meteorological Data Collection Centre (MDCC) will **no longer** be published in the EFAS bulletin. Instead, the state of recent meteorology will be conducted by the Copernicus Climate Change Service (C3S) and published as monthly Climate Bulletins.

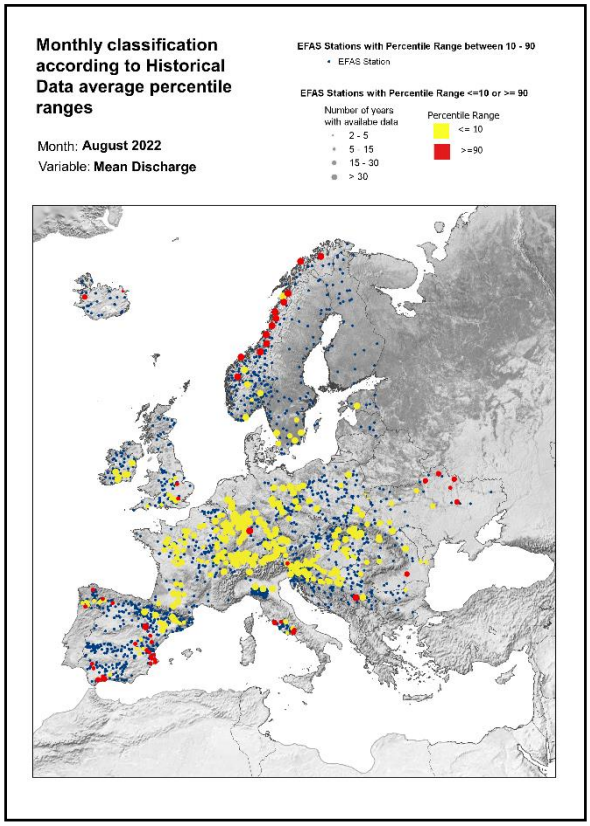

Figure 28: Monthly discharge anomalies August 2022.

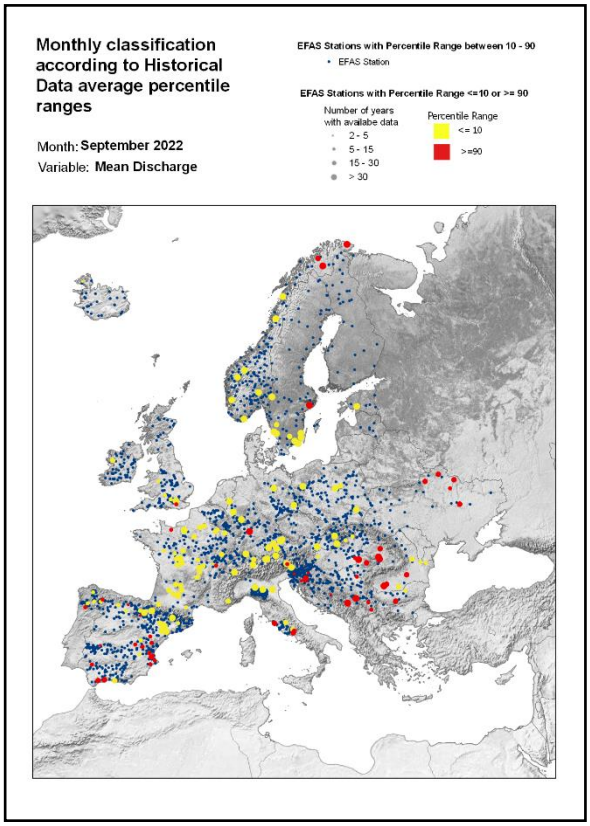

Figure 30: Monthly discharge anomalies September 2022.

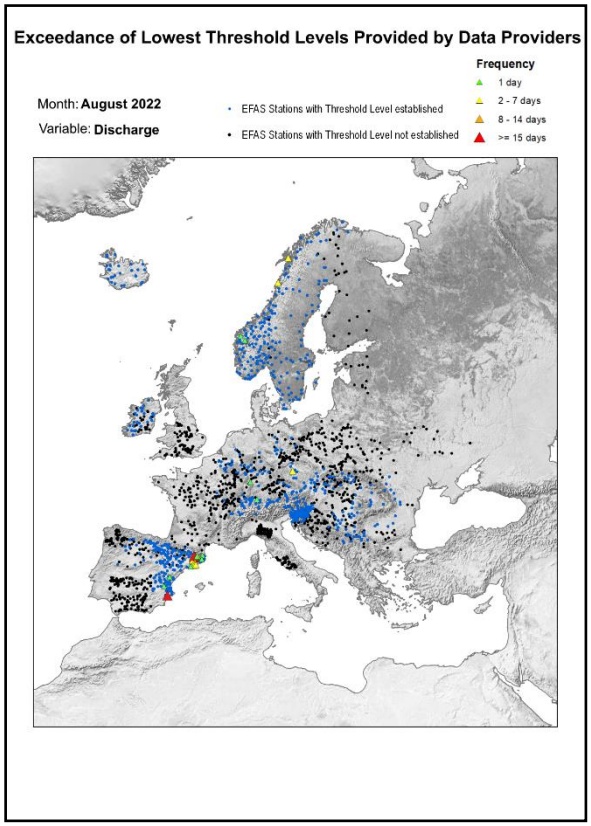

Figure 29: Lowest alert level exceedance for August 2022.

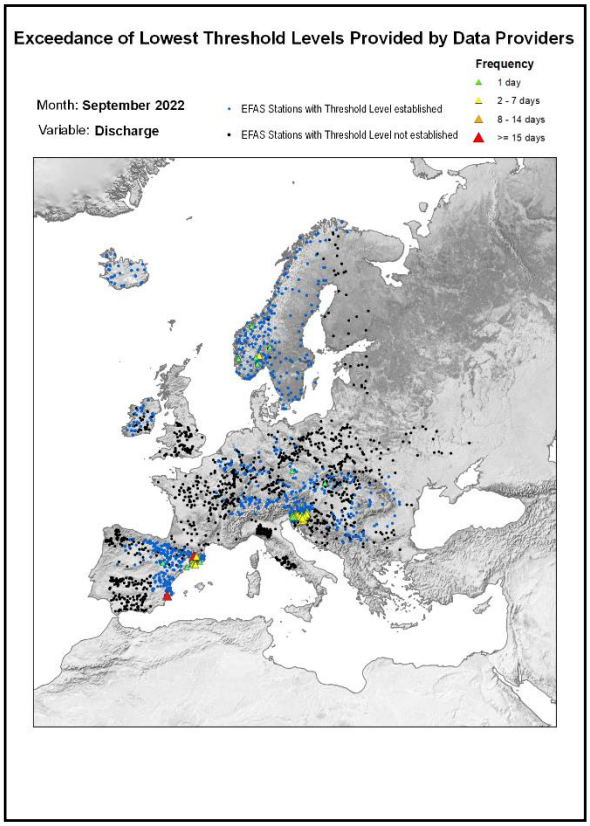

Figure 31: Lowest alert level exceedance for September 2022.

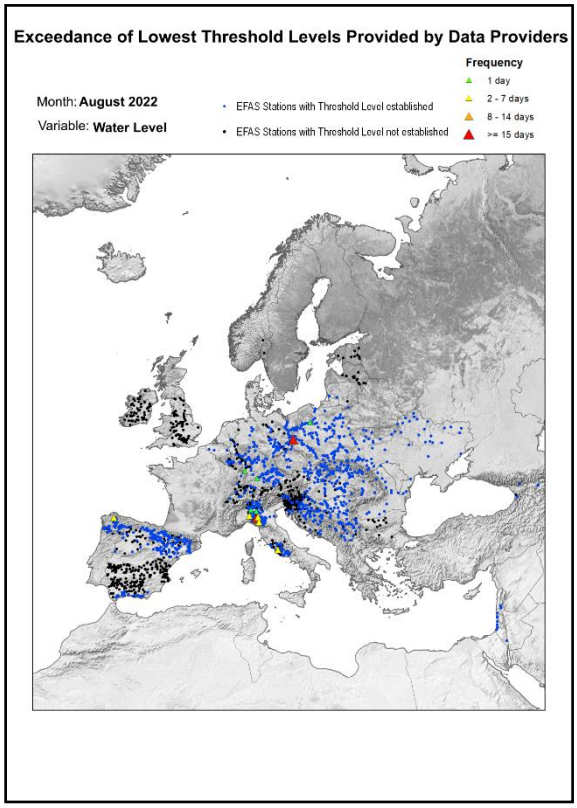

Figure 32: Lowest threshold exceedance for August 2022.

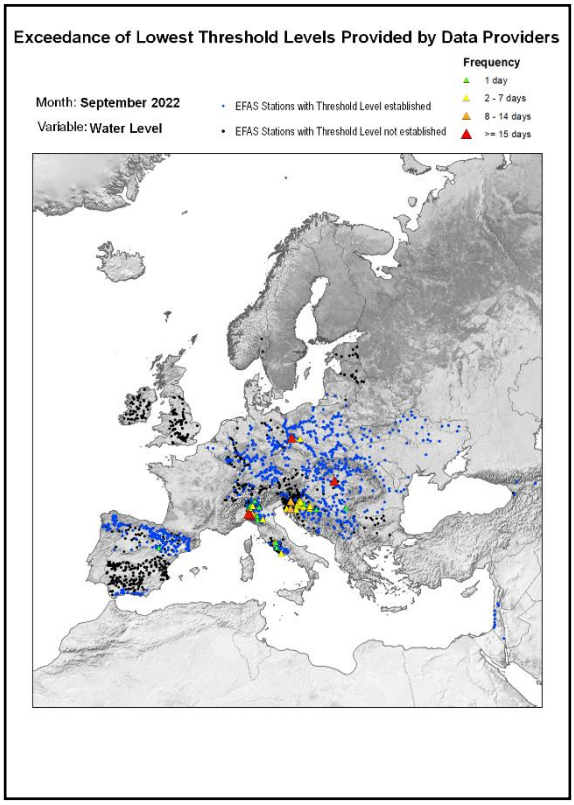

Figure 33: Lowest threshold exceedance for September 2022.

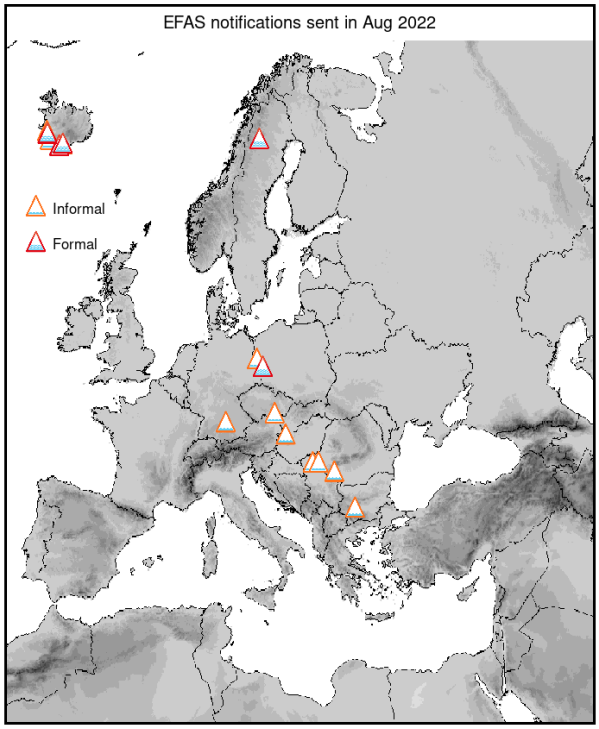

Figure 34: EFAS flood notifications sent for August 2022.

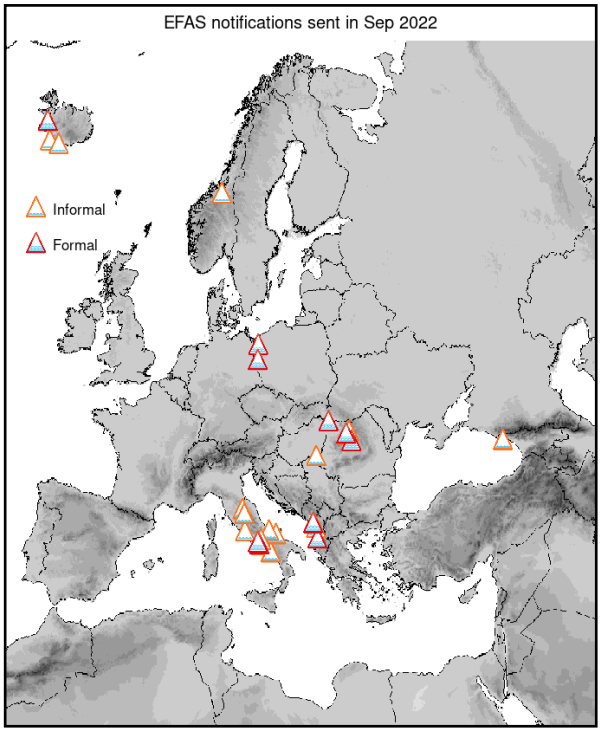

Figure 36: EFAS flood notifications sent for September 2022.

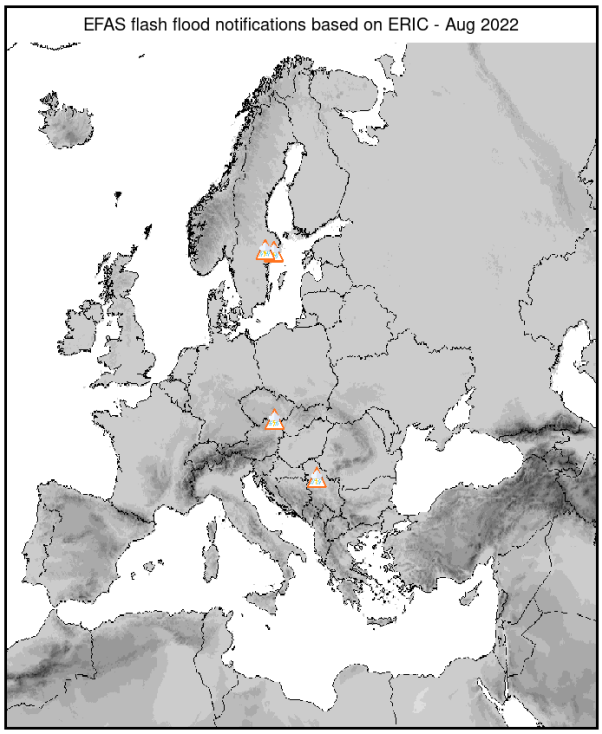

Figure 35: Flash flood notifications sent for August 2022.

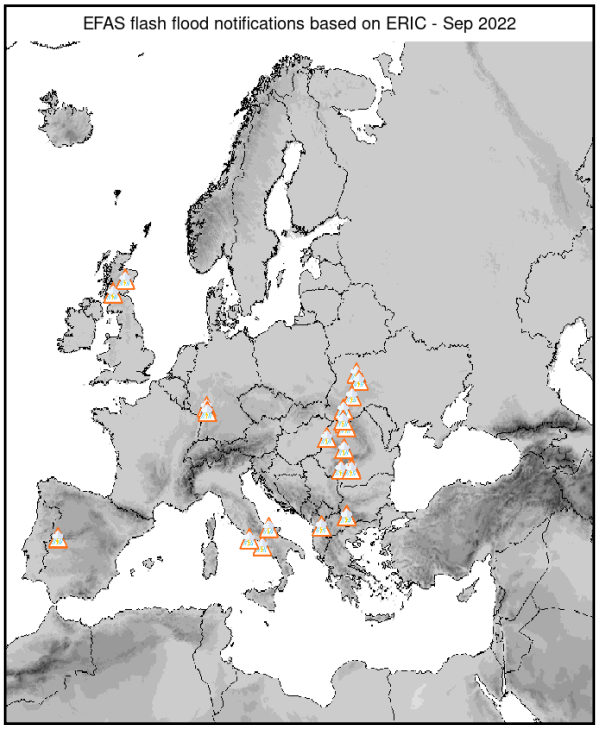

Figure 37: Flash flood notifications sent for September 2022.

Appendix - tables

Table 1: EFAS flood notifications sent in August – September 2022

Type	Forecast Date	Issue Date	Lead Time	River	Country
Informal	05/08/2022 00 UTC	05/08/2022	66	Coastal zone	Iceland
Informal	05/08/2022 00 UTC	05/08/2022	66	OELFUSA	Iceland
Formal	05/08/2022 00 UTC	05/08/2022	84	Pjorsa	Iceland
Informal	14/08/2022 12 UTC	15/08/2022	78	Coastal zone	Iceland
Formal	14/08/2022 12 UTC	15/08/2022	78	Coastal zone	Iceland
Formal	14/08/2022 12 UTC	15/08/2022	78	Coastal zone	Iceland
Formal	16/08/2022 00 UTC	16/08/2022	36	Skellefteälven	Sweden
Informal	20/08/2022 00 UTC	20/08/2022	30	Tisza, section Mures - Tamis	Serbia
Informal	20/08/2022 00 UTC	20/08/2022	24	Begej	Romania
Informal	20/08/2022 00 UTC	20/08/2022	12	Donau	Germany
Informal	21/08/2022 00 UTC	21/08/2022	6	Cerna	Romania
Informal	21/08/2022 00 UTC	21/08/2022	18	Jihlava	Czechia
Informal	20/08/2022 12 UTC	21/08/2022	30	Raab, Raba	Hungary
Informal	20/08/2022 12 UTC	21/08/2022	12	Maritsa (Evros), above Tundzha	Bulgaria
Formal	23/08/2022 00 UTC	23/08/2022	54	Oder	Poland
Informal	24/08/2022 12 UTC	25/08/2022	54	Oder	Poland
Formal	27/08/2022 12 UTC	28/08/2022	72	Leira	Iceland
Formal	28/08/2022 12 UTC	29/08/2022	72	Pjorsa	Iceland
Informal	01/09/2022 00 UTC	01/09/2022	30	Mures	Romania
Informal	01/09/2022 12 UTC	02/09/2022	72	Mures	Hungary
Formal	09/09/2022 12 UTC	10/09/2022	0	INA	Poland
Formal	09/09/2022 12 UTC	10/09/2022	0	Warta	Poland
Informal	09/09/2022 12 UTC	10/09/2022	6	Leira	Iceland
Informal	13/09/2022 00 UTC	13/09/2022	54	Tevere	Italy
Informal	12/09/2022 12 UTC	13/09/2022	90	Tiber	Italy
Informal	12/09/2022 12 UTC	13/09/2022	66	Topino	Italy
Informal	14/09/2022 00 UTC	14/09/2022	48	Sieu	Romania
Informal	14/09/2022 00 UTC	14/09/2022	60	Valea Mare	Romania
Formal	14/09/2022 00 UTC	14/09/2022	60	Bojana	Albania
Informal	14/09/2022 00 UTC	14/09/2022	72	Mati	Albania
Formal	13/09/2022 12 UTC	14/09/2022	60	Somesul Mare	Romania
Formal	15/09/2022 00 UTC	15/09/2022	48	Shkumbin	Albania
Informal	14/09/2022 12 UTC	15/09/2022	48	Gaula (Melhus)	Norway
Formal	14/09/2022 12 UTC	15/09/2022	66	Mures	Romania
Informal	21/09/2022 00 UTC	21/09/2022	0	BZIPI	Georgia
Informal	20/09/2022 12 UTC	21/09/2022	102	Coastal zone	Iceland
Formal	20/09/2022 12 UTC	21/09/2022	102	Hvita	Iceland
Informal	22/09/2022 00 UTC	22/09/2022	78	Volturno	Italy
Formal	23/09/2022 00 UTC	23/09/2022	60	Volturno	Italy
Formal	23/09/2022 00 UTC	23/09/2022	60	Coastal zone	Italy
Informal	24/09/2022 00 UTC	24/09/2022	36	Biferno	Italy
Informal	25/09/2022 00 UTC	25/09/2022	30	Sele	Italy
Informal	25/09/2022 00 UTC	25/09/2022	6	Regi Lagni	Italy
Informal	25/09/2022 00 UTC	25/09/2022	30	Sele	Italy

Formal	24/09/2022 12 UTC	25/09/2022	48	Bojana	Albania
Informal	24/09/2022 12 UTC	25/09/2022	24	Candelaro	Italy
Formal	28/09/2022 00 UTC	28/09/2022	84	Tisza, section Kraszna - Bodrog	Hungary

* 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 2022

Type	Forecast Date	Issue Date	Lead Time	Region	Country
Flash Flood	20/08/2022 00 UTC	20/08/2022	30	Danube	Serbia
Flash Flood	21/08/2022 00 UTC	21/08/2022	30	Danube	Czechia
Flash Flood	28/08/2022 00 UTC	28/08/2022	30	Norrstrom	Sweden
Flash Flood	27/08/2022 12 UTC	28/08/2022	30	Norrstrom	Sweden
Flash Flood	01/09/2022 00 UTC	01/09/2022	48	Danube	Romania
Flash Flood	02/09/2022 00 UTC	02/09/2022	24	Danube	Romania
Flash Flood	01/09/2022 12 UTC	02/09/2022	36	Danube	Romania
Flash Flood	12/09/2022 00 UTC	12/09/2022	42	Tajo	Spain
Flash Flood	13/09/2022 00 UTC	13/09/2022	48	Rhine	Germany
Flash Flood	13/09/2022 12 UTC	14/09/2022	48	Rhine	Germany
Flash Flood	16/09/2022 00 UTC	16/09/2022	42	Strimonas(GR)/Struma(BG)	Bulgaria
Flash Flood	16/09/2022 00 UTC	16/09/2022	42	Crni Drim / Drin,Drini i Zi	Albania
Flash Flood	17/09/2022 00 UTC	17/09/2022	36	Dnepr	Ukraine
Flash Flood	17/09/2022 00 UTC	17/09/2022	42	Dnepr	Ukraine
Flash Flood	17/09/2022 00 UTC	17/09/2022	36	Dnister / Nistru	Ukraine
Flash Flood	17/09/2022 00 UTC	17/09/2022	42	Danube	Romania
Flash Flood	17/09/2022 00 UTC	17/09/2022	42	Danube	Romania
Flash Flood	17/09/2022 00 UTC	17/09/2022	24	Danube	Romania
Flash Flood	16/09/2022 12 UTC	17/09/2022	42	Dnister / Nistru	Ukraine
Flash Flood	16/09/2022 12 UTC	17/09/2022	48	Danube	Romania
Flash Flood	16/09/2022 12 UTC	17/09/2022	42	Danube	Romania
Flash Flood	25/09/2022 00 UTC	25/09/2022	30	Biferno	Italy
Flash Flood	25/09/2022 00 UTC	25/09/2022	48	Danube	Romania
Flash Flood	24/09/2022 12 UTC	25/09/2022	42	Italy (Ligurian Sea/Tyrrhenian Sea)	Italy
Flash Flood	26/09/2022 00 UTC	26/09/2022	48	Strimonas(GR)/Struma(BG)	Bulgaria
Flash Flood	25/09/2022 12 UTC	26/09/2022	24	Italy (Ligurian Sea/Tyrrhenian Sea)	Italy
Flash Flood	29/09/2022 00 UTC	29/09/2022	36	Dee	United Kingdom
Flash Flood	28/09/2022 12 UTC	29/09/2022	48	Scotland	United Kingdom

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

Contact details:

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