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EFAS bulletins
Yearbook 2005

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The European Flood Alert System project – a European Commission initiative to increase preparedness for riverine floods across Europe

Following the disastrous floods in the Elbe and Danube river basins in August 2002, the European Commission announced in the communication (COM(2002)-481) the development of a European Flood Alert System (EFAS). EFAS will be capable of providing medium-range flood simulations across Europe with a lead-time between 3 to 10 days. The benefit of EFAS is two-fold. First, EFAS should provide the European Commission with useful information for the preparation and management of aid during a flood crisis. Second, National Water Authorities should benefit from additional and medium-range flood information that might contribute to increased preparedness in an upcoming flood event. EFAS is aimed at complementing national flood forecasting systems, not to replace them. The European Flood Alert System (EFAS) activity is at present in a development and testing phase at the European Commission Joint Research Centre.

NEW - The EFAS bulletin

The EFAS bulletins are distributed every 2 months to inform the project partners, data providers, and receiving Water Authorities about recent EFAS developments, achievements, and simulated flood events. This first bulletin is intended to summarise some background information about the EFAS activity, describe the actual status of the project, and EFAS products, and give an outlook on future developments.

EFAS background information

Since the beginning of 2003 the European Commission DG Joint Research Centre (JRC) is developing a prototype of EFAS in close collaboration with relevant institutions in the Member States. The JRC benefits from experience gained already during the European Flood Forecasting System (EFFS) project (Reggiani et al, 2004) financed by DG Research. A prototype of EFAS for the Elbe and Danube catchments is expected to be ready and tested by 2006. Once developed and thoroughly tested at the JRC, it will be the decision of the Member States to which organisation the EFAS should be transferred.

What can EFAS provide?

- Flood hazard maps indicating up to 10 days ahead if certain discharge thresholds are exceeded. The rainfall-runoff simulations use several medium-range weather forecasts from the Deutsche Wetterdienst (DWD) and the European Centre of Medium-Range Weather Forecasts (ECWMF) as input.
- Maps with simulated flood event probabilities up to 10 days ahead based on full sets of the Ensemble Prediction System (EPS) from ECMWF.
- Consistent and comparable discharge simulations for entire trans-national catchments and for the whole of Europe.

EFAS design and set-up

The hydrological model employed in EFAS is the physically based rainfall-runoff model LISFLOOD (de Roo, 2000) that has been developed at the JRC specifically for the simulation of floods in large river catchments. The EFAS prototype foresees, however, open architecture so that any other model capable of simulating rainfall-runoff processes for entire catchments can also be plugged into the system.

There are essentially three different types of input:

- Static data that describe the river basin including topography, land-use, soil type and depth, geology, and river geometry
- Observed data to calculate the initial conditions of the flood forecasts, e.g. meteorological data, discharge data, etc.
- Medium-range weather forecasts to drive the flood model – weather forecasts over time periods longer than 3 days.

The simulated discharge forecasts are compared against threshold values that have been derived beforehand from long-term waterbalance simulations – using the same model and the same parameter sets. If the simulated discharges are exceeding these thresholds EFAS indicates the concerned river stretches

EFAS is set-up for the whole of Europe on a 5 km grid for all river basins larger than 2000 km^2 and on a 1 km grid for the Elbe and Danube river basins. Most data to define the river basin such as topography, land-use, soil type and depth, and river drainage system are available at the JRC. High-resolution river data to define cross sections or structural measures are being collected for the 1 km set-ups but not included in the 5 km set-up. The temporal resolution of the model is 1h. At present the 5 km set-up has been coarsely calibrated using observed data, and detailed calibration and validation studies for the 1km river basins are ongoing.

EFAS actual status

At present the weather forecasts from the Deutsche Wetterdienst (DWD) and the European Centre of Medium-Range Weather Forecasts (ECMWF) are incorporated into EFAS.

Table 1: Specification of meteorological forecasts incorporated into EFAS

	Leadtime	Runs	Grid resolution
DWD	7 days	00:00 12:00	7km (<48 h), 40km (> 49h
ECMWF Deterministic	10 days	00:00 12:00	40 km
ECMWF EPS (51)	10 days	00:00 12:00	80 km

EFAS 5km: The 5 km EFAS is automatically scheduled as soon as the meteorological forecasts arrive. EFAS results are analysed on a daily basis, 7 days a week. In case an increased chance of flooding is simulated an in depth-analysis is performed which may involve comparison with other weather forecasts, plotting of hydrographs, discussion with experts, etc. If the chance of flooding persists over several consecutive forecasts, and if it is located in a river basin with a Water Authority that has agreed to collaborate with EFAS, the Water authority receives updated EFAS information until the end of the simulated flooding. In return, the NWA is asked to send feedback on the usefulness of the EFAS information. If no collaborating Water Authority has been identified, no EFAS information is send out and the situation is monitored via other means, e.g. via European Media Monitoring (EMM), a procedure that has also been developed at the JRC and which scans the internet daily for any information or reports on floods.

EFAS 1km: For the simulations of Elbe and Danube catchments on a 1 km scale high-resolution data are being collected. Before they can be used in EFAS they need to be pre-processed and harmonised. The fragmented organisation of Water Authorities across Europe and the lack of standards for data formats make data collection a very time consuming task. Not only input data but also the output data need to be post-

processed before it can be stored and used for further analysis. The development of a multi-functional data base used for storing in- and output data is a major task that is ongoing. The work on the 1 km catchments is mostly done by National Experts that are detached by their Countries (Austria, Czech Republic, Germany, Hungary and Slovakia) and who benefit from extensive background knowledge of these basins.

Research: An integral part of the EFAS activity is the evaluation of input and output data with regard to medium-range flood forecasting. For example it is important to know if the meteorological models have a tendency to over- or underestimate rainfalls in particular river basins and if this has consequences for the EFAS flood simulations. Another core element of EFAS research address probabilistic flood forecasts - how can useful information be extracted from them for local flood forecasters? This work is ongoing and first results are being incorporated into the EFAS.

EFAS products

Several types of EFAS products have been developed and tested. It depends largely on the feedback from the national forecasting centres if the products are retained or modified. At present EFAS proposes two different types of information:

Flood hazard maps: Three different types of flood hazard maps are produced. All of them are based on the principle of threshold exceedance.

1) Flood hazard maps based on the different deterministic input weather data. EFAS products are based on 4 threshold levels indicating low, medium, high, and extreme chance of a flood to take place. They are illustrated colour coded as green, orange, red and purple respectively. River pixels for which the simulated discharges exceed a threshold level but the upstream area is smaller than 4000 km^2 are only shown in grey. Fig. 1 gives an example of such a map for the 28th October 2004 based on ECMWF data of 12:00. The map shows the highest class simulated during the 10 day forecasting period. Detailed maps for each day are also produced.

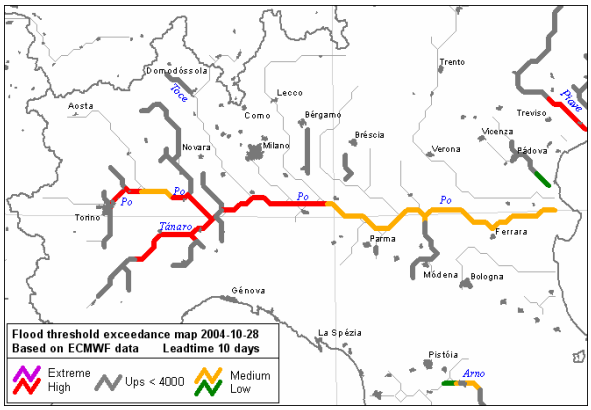

Fig. 1 Flood threshold exceedance map based on ECMWF data from 28th August 2004, 12:00. This map shows the highest class over the 10 day forecasting period.

2) Maps combining results obtained with input data from the different meteorological services. Fig. 2 gives an example of such a combined map for the 28th October 2004. Those river stretches for which the simulation exceeds the high flood threshold over the forecasting periods only with the DWD forecast is illustrated in green, those with only ECMWF forecasts are illustrated in blue and those river stretches where the high flood threshold discharge is simulated using both ECMWF and DWD forecasts, are shown in red.

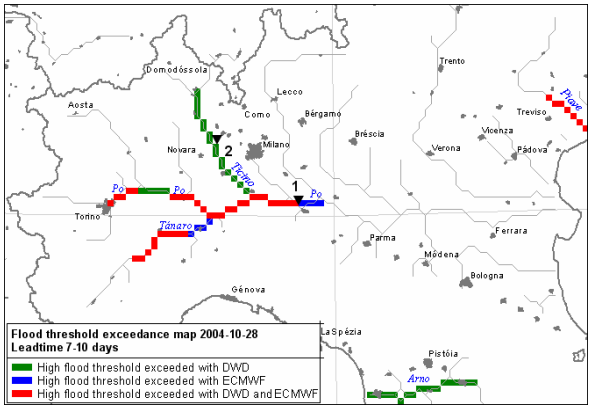

Fig. 2 Combined flood threshold exceedance map based on flood forecasts using DWD and ECMWF weather data from 28th October 2004, 12:00.

3) Ensemble flood event maps. The percentage of ensemble flood simulation members exceeding the high flood threshold is illustrated. This map is the outcome of the initial research performed on ensemble flood simulations. It is likely that this product is going to evolve with time.

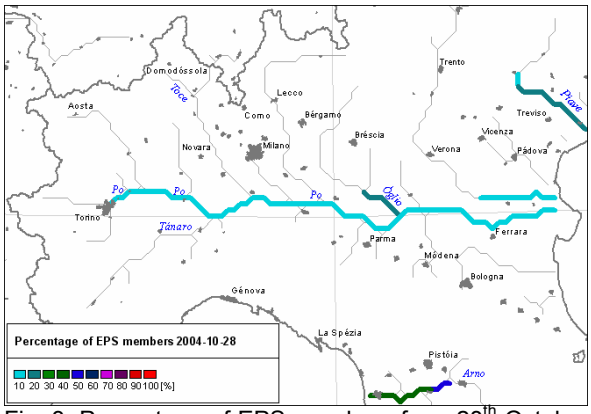

Fig. 3. Percentage of EPS members from 28th October 2004, 12:00 run exceeding high flood threshold during the 10 day forecasting period.

Block diagrams: The temporal evolution of the simulated flood event at a particular location is visualised by block diagrams as illustrated in Fig. 3. The Locations refer to Fig. 2 using the following colour code:
Extreme High Medium Low
Each block indicates the highest threshold class reached on the particular forecasting day. The first 2 days of the forecast are not considered in EFAS because the focus is on meso-scale forecasts.

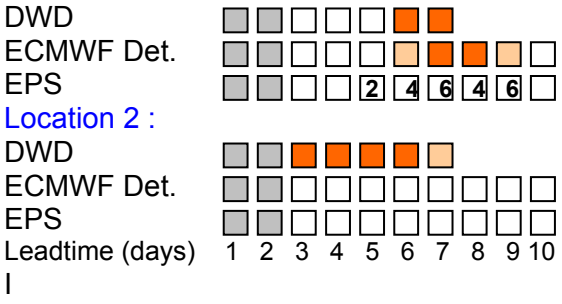

Fig 3. Example of block diagrams illustrating flood evolution at a given river pixel. The example is from the 12:00 forecasts of 26.10.2004 in the Po catchment. The first 2 days are not reported.

Summary and Conclusions

The development of the EFAS prototype has started at the Joint Research Centre in 2003. A suitable hardware infrastructure has been set-up allowing processing and storage of input and output data. At present EFAS simulates daily ion a 5km grid all deterministic DWD and ECMWF forecasts as well as one full set of EPS for all European catchments larger than 2000 km^2. All flood forecasts are analysed on a daily basis together with the input data. Different analysis procedures are being developed and tested and will be evaluated in close collaboration with the national forecasting Centres of the Member States. The exploitation of the probabilistic flood forecasts is a topic of extensive research.

Detailed set-up of higher resolution EFAS simulations for different pilot catchments are performed with support from the Member States through the work of Detached National Experts. Data collection of high-resolution data is a major task in this context, as well as extensive calibration and validation studies.

Over the next few months a refined calibration for the 5km model is intended, and as soon as the validation studies for Elbe and Danube are finished these catchments will be included in the daily EFAS routine.

The next bulletins

The next EFAS bulletin will cover the two-monthly period of Jan-Feb 2005. It will summarise the most recent EFAS developments, give an overview of the hydro-meteorological situation over the reporting period and illustrate particular EFAS results.

References

De Roo, A., Gouweleeuw, B., Thielen, J., Bates, P., Hollingsworth, A. et al. (2003) Development of a European Flood Forecasting System. International Journal of River Basin Management, Vol. 1, No. 1, 49-59

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EFAS bulletin

Issue 2005(2)

EFAS news

A crucial contribution to the future development of EFAS consists in the feedback from the end-users. For this purpose a Memorandum of Understanding (MoU) was set up and sent to selected National Water Authorities (NWA) from large trans-national catchments. Through the MoU the collaboration between the NWA and the JRC is formalized to ensure that NWA receiving EFAS alerts in real-time are aware that these alerts are a research product and sending them out is part of the testing and developing phase of EFAS. It also allows the NWAs to actively participate in the development of EFAS through their feedback. The draft MoU was sent out in the 2nd half of January 2005 to 29 agencies across Europe and 3 were agreed upon at the end of February (APAT, Bologna, Italy; BfG, Koblenz, Germany; Vilnius University, Lithuania).

Meteorological situation Jan/Feb 2005

Due to the cold temperatures across central and Eastern Europe much of the precipitation fell as snow resulting in high snow accumulations at places.

January : Particular attention should be drawn to Scotland and Northern England where flooding occurred from 8-10 Jan. From 6-9. Jan Scotland was hit by severe weather with rainfalls of up to 100mm/day. Elsewhere in Europe only little precipitation was observed. In the last third of the month high precipitation amounts were reported for the Balkan and peaks up to 150mm/d were measured in Greece (26.01). On the 28.01. and 29.01. parts of Central and South Italy received precipitation up to 60mm/d.

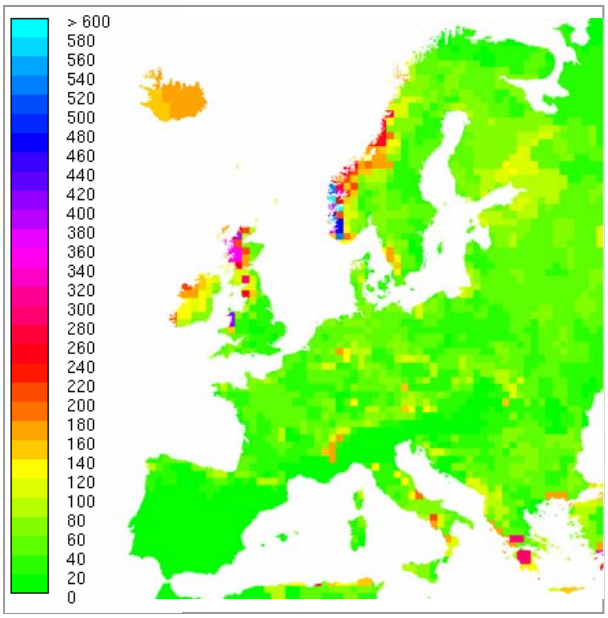

Figure 1 : accumulated Precipitation [mm] 01 2005

February : Only in the Balkan States precipitation was observed repeatedly with moderate intensities from mid-February onwards, much of it falling and accumulating as snow.

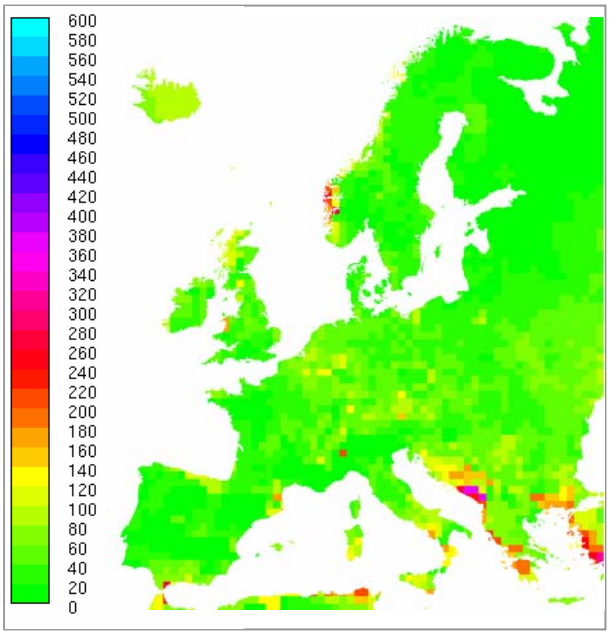

Figure 2 : accumulated Precipitation [mm] 02 2005

Simulated hydrological alerts by EFAS

EFAS simulates on a daily basis medium-range flood forecasts up to 7 and 10 days ahead based on weather forecasts from the Deutsche Wetterdient (DWD) and the European Centre for Medium-Range Weather Forecasts (ECWMF) respectively. Forecasts are run twice a day with both midnight and midday weather forecasts. At present the EFAS system runs with a resolution of 5x5 km^2. Analysis of input data has shown that for upstream areas less than 4000 km^2, which corresponds roughly to one grid box of the meteorological models, the uncertainty in the meteorological forecast data is very big. Therefore EFAS alerts in single catchments smaller than 4000 km^2 are normally not considered. Only if a large area is affected these catchments would be reported with a high chance of flooding.

First an overview of the EFAS simulations in January and February are given. Figs. 3 and 4 summarise the number of days for each month in which the EFAS simulations exceeded the highest alert level The figures show this information based on the forecasts with DWD data.

Figure 3 : number of days exceeding EFAS highest alert level for January 2005 (DWD)

Fig. 5 illustrates in which river stretches EFAS simulations based on ECMWF data agree or differ with the ones based on DWD for the Jan. 08/08 event in the UK. Fig. 5 shows in green where EFAS calculated a critical situation with DWD alone, in blue with ECMWF alone and in red where both

forecasts indicated extreme chance for flooding. Table 1 lists flood events that were simulated by EFAS and/or observed. Lead-times achieved are also indicated.

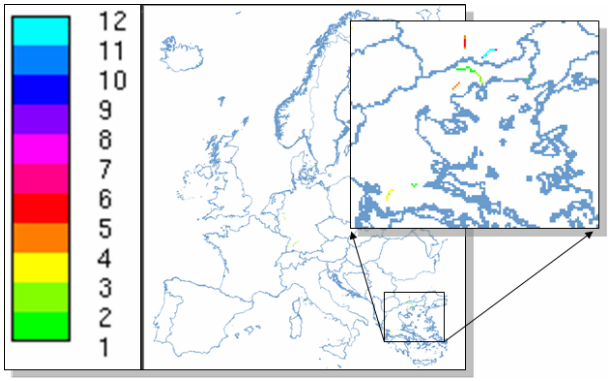

Figure 4 : number of days exceeding EFAS highest alert level for February 2005 (DWD)

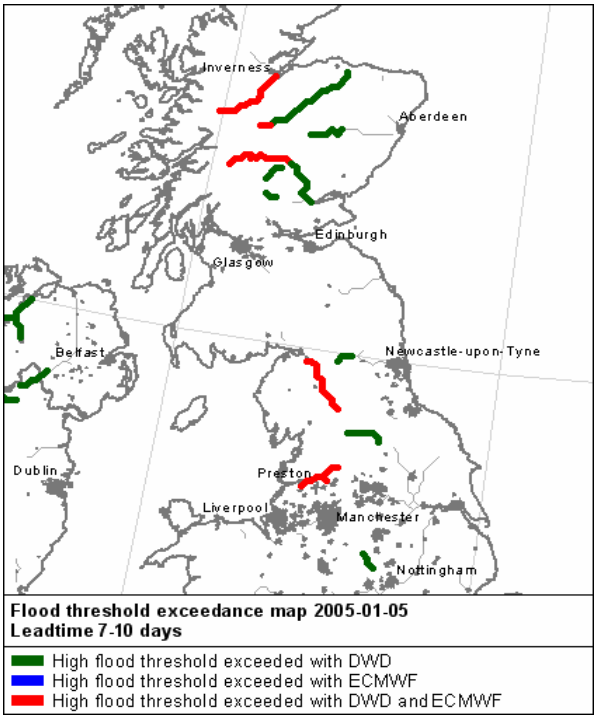

Figure 5 : Flood threshold exceedance map for the 05.01.2005. Green=DWD only, Blue=ECMWFd only, Red=combined

Table 1 : Hydrological extreme events in Jan. and Feb. 2005

Catchment name	Date of simulated critical situation	Leadtime of forecast	Confirmed y/n/?[1]
Eden, UK	08/01- 09/01 2005	6	y
Ribble, UK	08/01- 09/01 2005	6	y
Ouse, UK	08/01- 09/01 2005	4	y
Ness, UK	08/01- 09/01 2005	6	y
Tay, UK	08/01- 09/01 2005	6	y
Nagold, D	20/01-21/01 2005	3-4	?
Ruhr, D	20/01-21/01 2005	4	y
Rhine tributaries (Sieg, Mosel, Neckar)	11/02-14/02 2005	3-5	y
Strimonas, Greece	14/02-18/02 2005	3-4	y
Regi Lagni, Italy	23/02-24/02 2005	4	?
Neretva, Bosnia	23/02-24/02 2005	4	?
Evros, Bulgaria/Greece	24/02-28/02 2005	4	y
Arda, Bulgaria/Greece	24/02-28/02 2005	4	y

[1] ***y*** *if confirmed by media or other reliable source;* ***?*** *if no reliable info;* ***n*** *if definitively no flood/high levels were reported*

EFAS analysis UK floods in January 2005

The January summary picks up the UK flooding. This was a typical case where wide spread flooding affected a number of relatively small catchments in Northern England and Scotland on 08/01- 09/01 2005. EFAS simulated high chance of flooding in the Eden, Ribble, Ouse, Ness, and Tay rivers, which are all small river basins, but are spread over an area of >50.000 km^2. The achieved lead time of the event was 6 days, except for the Ouse river where only 4 days were achieved. The widespread flooding was confirmed by the Environment Agency for England and Wales and by the SEPA of Scotland. The results for the river Eden are reported in detail below.

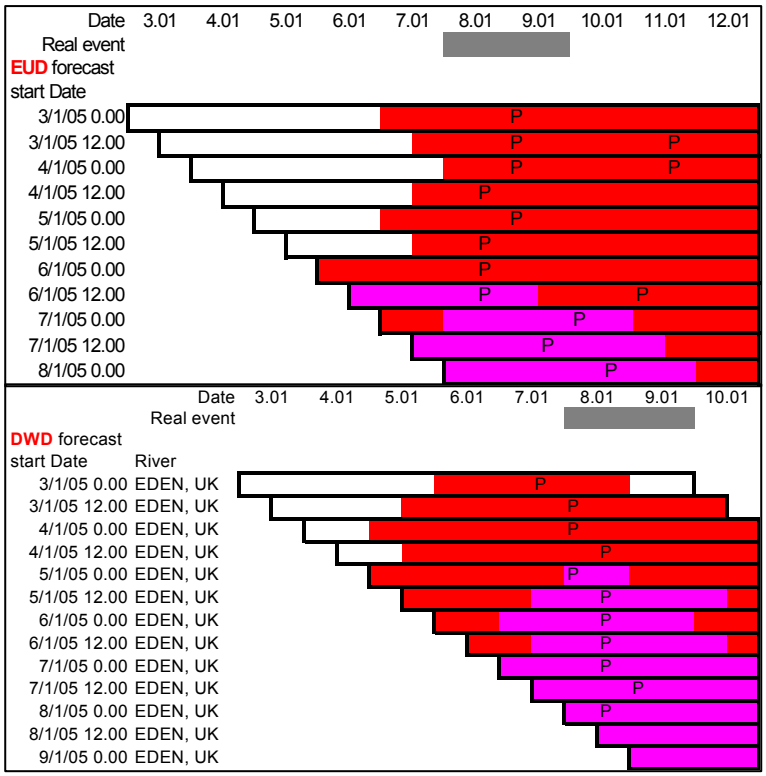

Figure 4 : EFAS EUD/DWD performance for the river Eden flooding event in January 2005

The diagrams show the results of the EFAS forecasts. Forecasts were done every 12 hours and the start date of the respective forecast is reported on the left of the diagrams and its timeline on top. The observed event took place around the 08.-09.01.2005 and is indicated in grey. Periods marked in red denote an EFAS high chance of flooding, in pink a very high chance of flooding (highest EFAS alert level) and the "P" marks the forecasted peak-flow-time. At time of writing of this report no hydrographs and no precise information on the observed peak discharge time were available.

All EFAS simulations showed a relatively stable peak for the 8th/10th of January, sometimes a second peak was predicted for the 11th.

There are ongoing efforts in the WDNH group of JRC to get access to more historical and real time discharge data in order to produce a statistically more valid EFAS performance analysis. This is a good example were close collaboration with the EFAS partners and their feedback can bring valuable improvements to the system and thus for the community as a whole.

Technical / Other

For the future statistic performance analysis and the improvement of the system, the collaboration with National Authorities is very important. The European Media Monitoring system (EMM), for instance, is a good general tool to monitor events that were reported by the press, but are biased because very often events are not in the press and "non-events" that are necessary to produce a realistic "hit/false alarm rate" are not reported. However, as long as measured discharge data for most rivers are unavailable, it remains the only way to check performance. Therefore feedback of local hydro/meteorological services is very welcome and necessary to draw up a more valid statistical assessment of the EFAS.

Acknowledgements
Meteorological forecast data are provided by ECMWF and DWD. The observed meteorological data are provided by the JRC MARS Unit. The European Media Monitoring (EMM) information is provided by JRC IPSC.

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EFAS bulletin

Issue 2005(3)

- ***EFAS news***
- ***Meteorological situation for March/April 2005***
- ***Simulated hydrological situation by the EFAS***
- ***Romania event : April 2005***
- ***Other***

EFAS news

A significant improvement of the EFAS has been achieved through the development of a new visual user interface and by automating the daily reporting of alerts. Now good overviews of the actual forecasting situation are produced automatically, and the additional in-depth analysis by the forecaster has been rendered easier and more efficient. Consequently the daily forecasting has become more objective and the possibilities of human errors are reduced to a minimum.

Considerable progress is achieved on the agreement of the hydrological Institutes to sign the Memorandum of Understanding with the JRC regarding EFAS. After a slow start due to administrative procedures on both sides, during March and April in total 9 MoU have been prepared for signature with hydrological Institutes in Poland, Bulgaria, Germany, Italy, Slovakia, Moldova and Lithuania.

Meteorological situation Mar/Apr 2005

In March above average precipitation amounts were registered in the Adriatic Balkan region, were the difference in accumulated measured precipitation was between 60 and 140mm/month higher (i.e. up to + 200%) than the 14-year average (from 1990 to 2004, observed MARS data). On the other hand the Alpine region received in up to 70 mm/month less precipitation (- 70%) than average.

In April precipitation was up to 100% higher than average mainly in S-E France (+120mm/month), and parts of Romania and Bulgaria (+120mm/month). Also regions in Central Germany had up to 110mm/month more precipitation than average. In contrast parts of the Alps received up to 120mm/month less precipitation than average and also Portugal and Spain had a drier month than normally (up to 70% less than average).

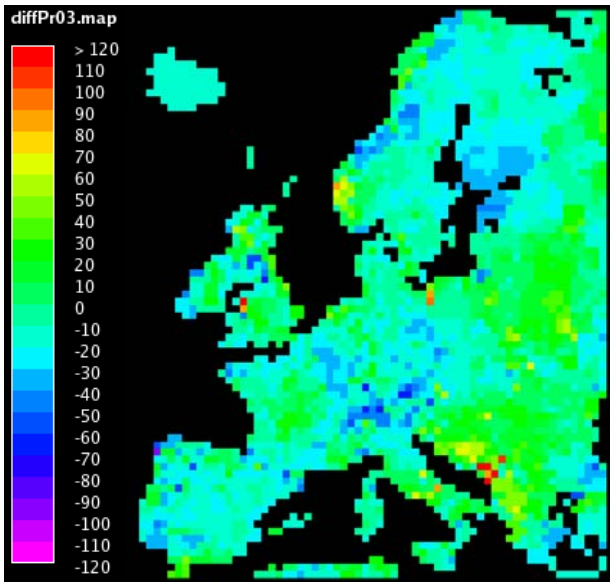


Figure 1 : Difference in precipitation [mm] 03 2005 in comparison to long term average (1990-2004)

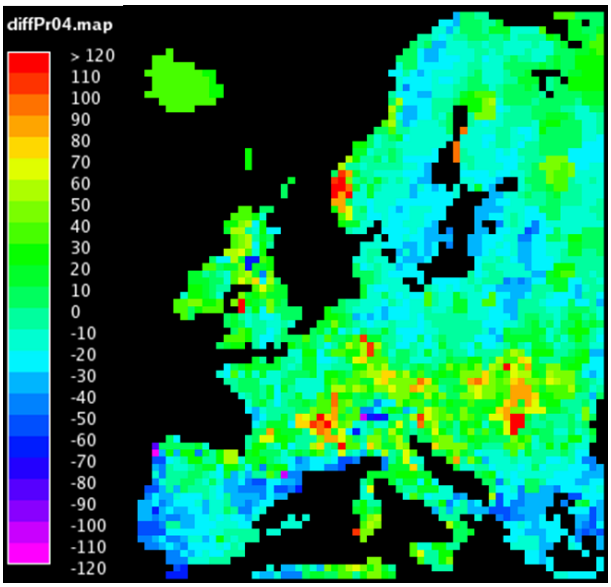


Figure 3 : Difference in precipitation [mm] 04 2005 in comparison to long term average (1990-2004)

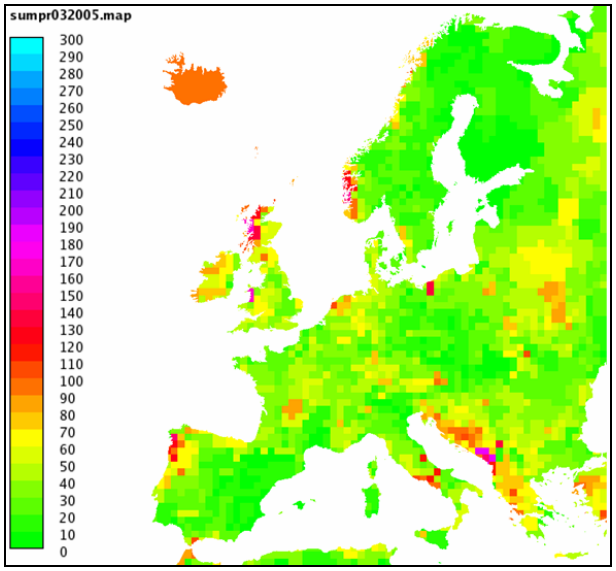


Figure 2 : Accumulated Precipitation [mm] 03 2005

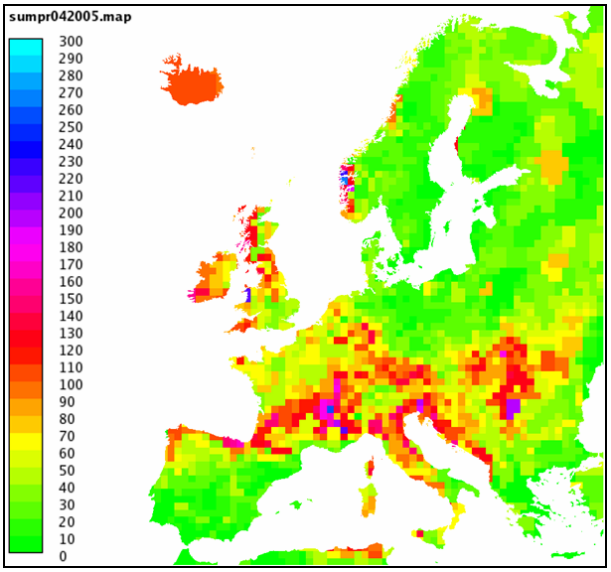


Figure 4 : Accumulated Precipitation [mm] 04 2005

Simulated hydrological alerts by EFAS

The overview of the EFAS simulations for March and April highlight problem areas in Italy (not confirmed) and the Balkans (confirmed). Figs. 5 and 6 summarise the number of days for each month in which the EFAS simulations exceeded its highest alert level (*see also legend Tab.2 for explanation of what alert levels actually mean*). Of particular interest for EFAS are the floods that took place in Romania and Bulgaria in April. It can be seen in Fig.6 and Tab.2, that although EFAS did predict *high flood alert* (red) the *very high alert* level (pink) was not reached. This is clearly illustrated in Fig.6 where the number of days exceeding *high* and *very high alert* levels are shown for April 2005. In contrast the current EFAS setup tends to overestimate floods probabilities for rivers like the Garigliano (central Italy, see Fig.5+6). There are two main reasons for the under- and overestimation of the flood hazard: First, in the present prototype setup, the calculations of the alert levels are based on a short time-series of 14 years only (1990-2004). Second, although providing on average good results, the EFAS for the whole of Europe is based on comparatively few discharge data – for a

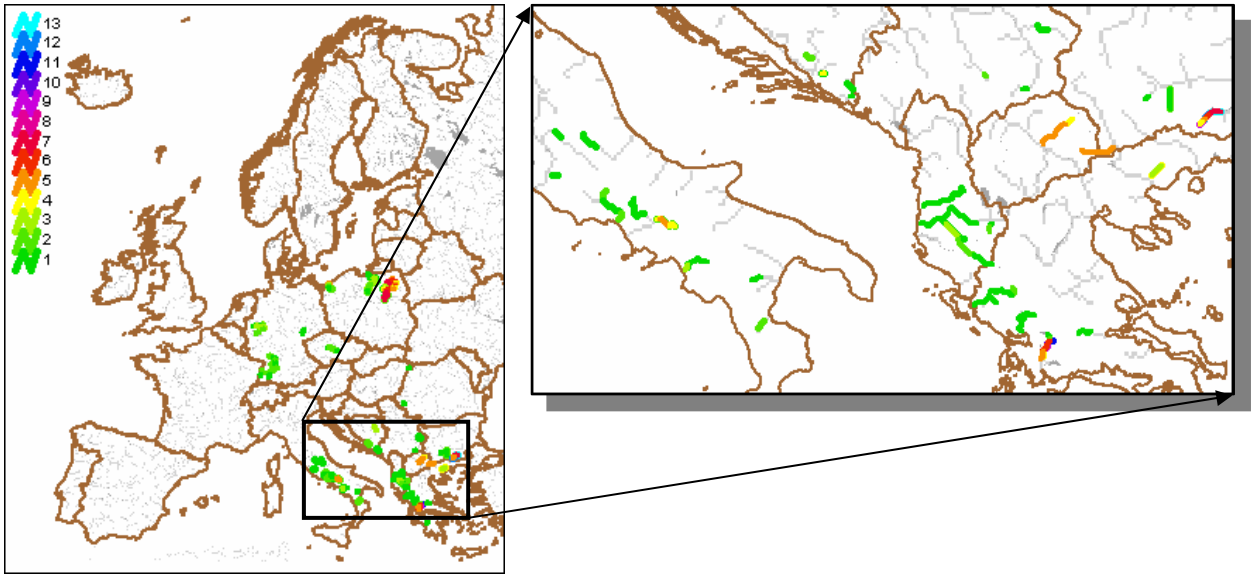


Figure 5 : Number of days exceeding EFAS (EUD) *very high alert* level for March 2005

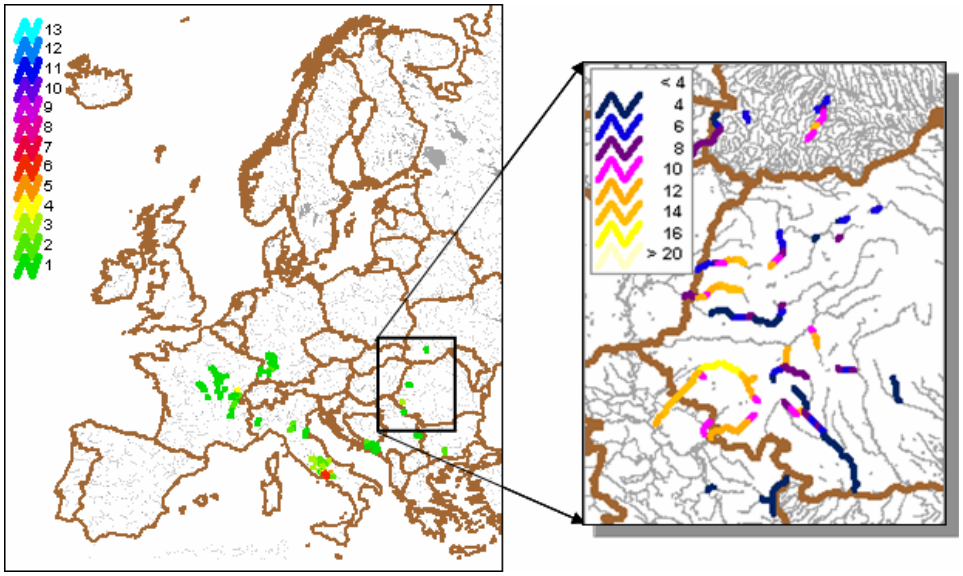


Figure 6 : Number of days exceeding EFAS (DWD) *very high alert* level for April 2005 (left) and EFAS *high alert* level (right) in detail for Romania for April 2005

Table 1 : River flood events in March and April 2005

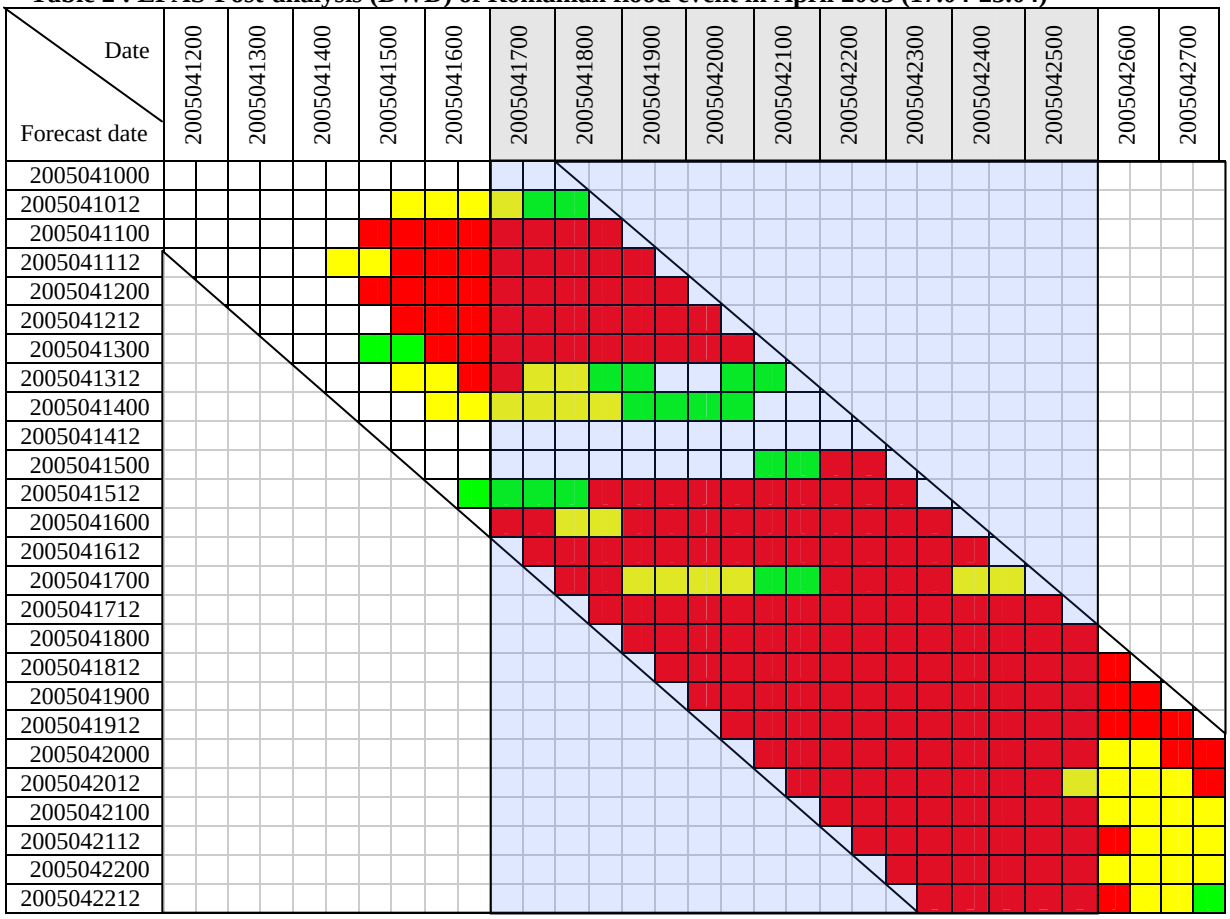
Catchment name	Date of simulated critical situation	Leadtime of forecast	Confirmed y/n/?[1]
Evros/Arda, Bulgaria	03/03- 07/03 2005	4	?
Seille, France	16/04- 18/04 2005	3	Y
Saone, France	16/04- 19/04 2005	4	Y
Doubs, France	16/04- 19/04 2005	5	Y
Tamis, Romania	17/04- 27/04 2005	2-4	Y
Mures, Romania	17/04-25/04 2005	4	Y
Körös, Romania	17/04- 25/04 2005	4	Y

[1] ***y*** *if confirmed by media or other reliable source;* ***?*** *if no reliable info;* ***n*** *if definitively no flood/high levels were reported*

considerable number of rivers no data are available at all. Obviously, the collection of more relevant data constitutes a major task over the coming years and will ultimately improve the overall quality of the system.

line" forecasts around the 14.04 where fewer precipitation was forecasted the signal remains stable and also the end of the event is forecasted well.

Table 2 : EFAS-Post-analysis (DWD) of Romanian flood event in April 2005 (17.04-25.04)



EFAS - alert levels *and what they mean*	low	medium	high	very high
	River discharges increased, no flood hazard expected.	*Significantly increased river discharges, no flood hazard expected.*	*Seriously increased river discharges with high possibility of reaching or exceeding bankful rivers.*	*Very high possibility of flooding.*

In the meantime, it is the role of the EFAS developers to identify areas of systematic over- and underpredictions of alert levels and to adapt the alert threshold levels accordingly. Feedback from the National Hydrological Institutes and gathering of more data for these regions will be important steps in this process. Tab.2 reports the performance of EFAS for the Romanian flood event in April (17.04-25.04). First indications for the event are given with a leadtime of 6 days and apart from some "out of the

Other

Responding to several inquiries: the name LISFLOOD evolved from LISEM (L*imburg* S*oil* E*rosion* Mod*el*) (A. de Roo, 1995) and the LIS prefix was kept also in the later LISFLOOD model.

Acknowledgements
Meteorological forecast data are provided by ECMWF and DWD. The observed meteorological data are provided by the JRC MARS Unit. The European Media Monitoring (EMM) information is provided by JRC IPSC.

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EFAS bulletin

Issue 2005(4)

- ***EFAS news***
- ***Meteorological situation for May/June 2005***
- ***Simulated hydrological situation by the EFAS***
- ***Bulgarian event : end of May 2005***

EFAS news

Further progress has been achieved on the agreement of the hydrological Institutes to sign the Memorandum of Understanding (MoU) with the JRC regarding EFAS. Now a total of 8 hydrological services (see Fig 1) have signed. These authorities receive EFAS real time alert information for the regions covered by the respective MoU if the affected basins correspond to certain criteria. Other 3 are still in the process of concluding their MoU's.

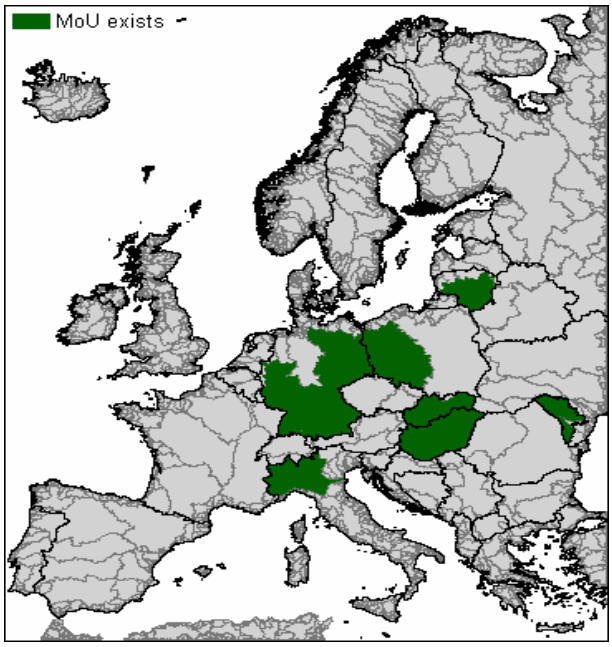


Figure 1 : Regions for which a MoU exists

Meteorological situation May/June 2005

In May great parts of Spain and Portugal received almost no precipitation at all, while the North and the East parts of Europe received far more than the 14-year average (from 1990 to 2004, observed MARS data, see Fig. 3). Parts of Bulgaria, Romania, Moldavia, Lithuania and Greece received up to 200 mm/month (≤ +350%). These differences are illustrated in Fig. 2.

June was comparably even dryer and saw great parts of Portugal, Spain, Italy and France with almost no precipitation (see Fig. 4 and 5). Only on the Northern rim of the Alps and in parts of East Europe precipitation over 100 mm/month (≤ +100%) was observed.

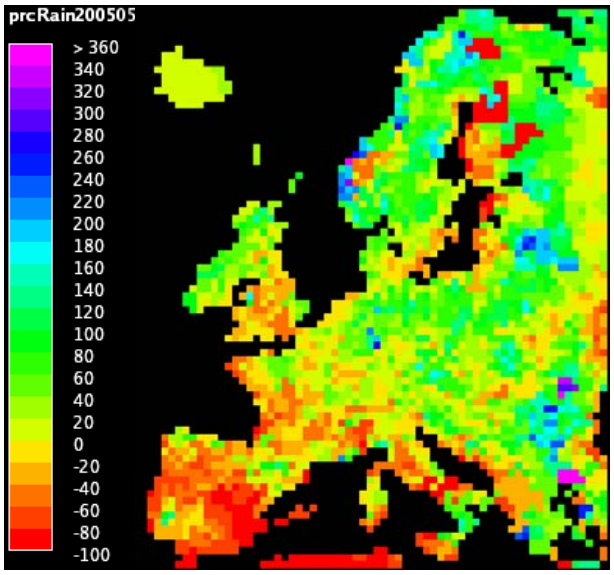


Figure 2 : Difference in precipitation [%] 05 2005 in comparison to long term average (1990-2004)

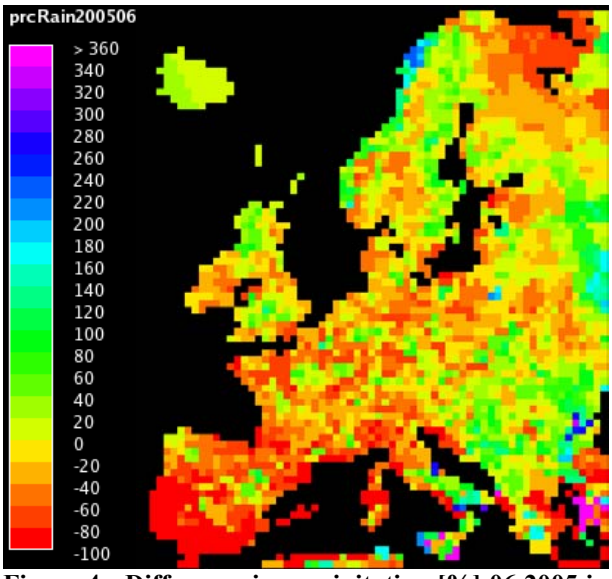


Figure 4 : Difference in precipitation [%] 06 2005 in comparison to long term average (1990-2004)

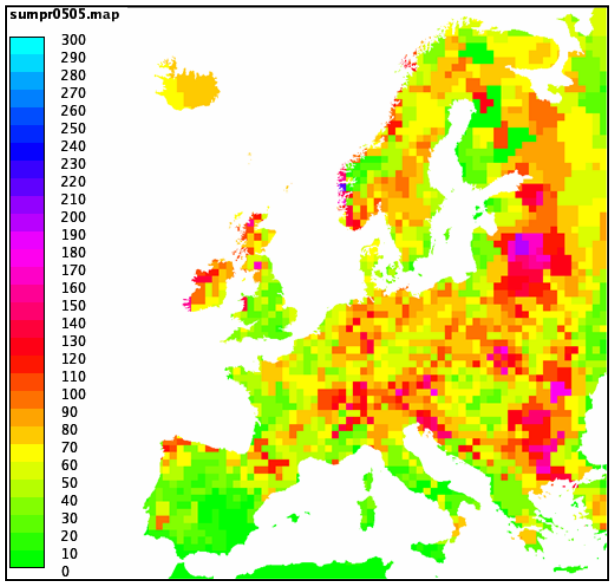


Figure 3 : Accumulated Precipitation [mm] 05 2005

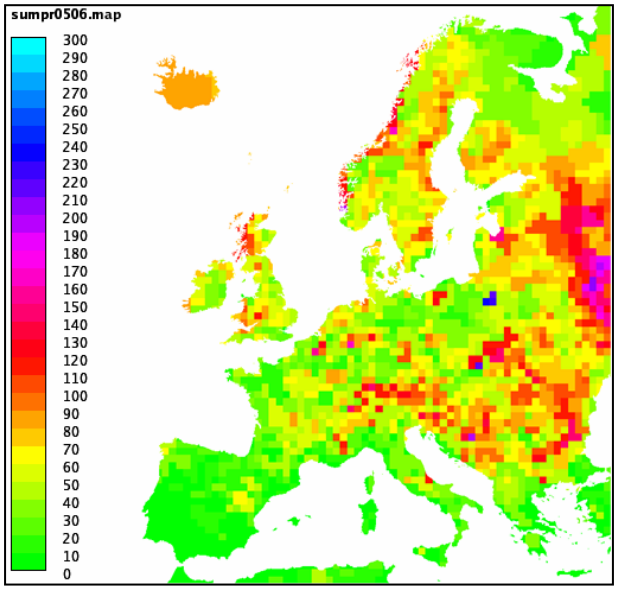


Figure 5 : Accumulated Precipitation [mm] 06 2005

Simulated hydrological alerts by EFAS

The overview of the EFAS simulations for May and June highlight problem areas manly in the Balkans (*confirmed by EMM, see Table 1*). Romania and Bulgaria were hit by several extreme rainfall events which resulted repeatedly in wide spread flooding. The EFAS forecast results are graphically summarized in Fig.6 and Fig.7 and show how many times EFAS predicted in 3 consecutive EFAS-forecasts an exceedance of the high threshold (*see also legend Tab.2 for explanation of what thresholds actually mean*) for both ECMWF and DWD meteo inputs.

The Bulgarian Danube tributaries Iskur, Vit, Osum and Yantra showed up to 14 times a persisting high threshold exceedance of EFAS forecasts during the month of May (and ≤ 8 times during June). Furthermore EFAS predicted several high threshold exceedances in Romania for both months. The EMM confirmed the flooding events in this area for the same periods. The Maritsa as well as Strimonas and Nestos (Bulgaria, Greece) are also showing a high number of threshold exceedances. However, EFAS-forecasts

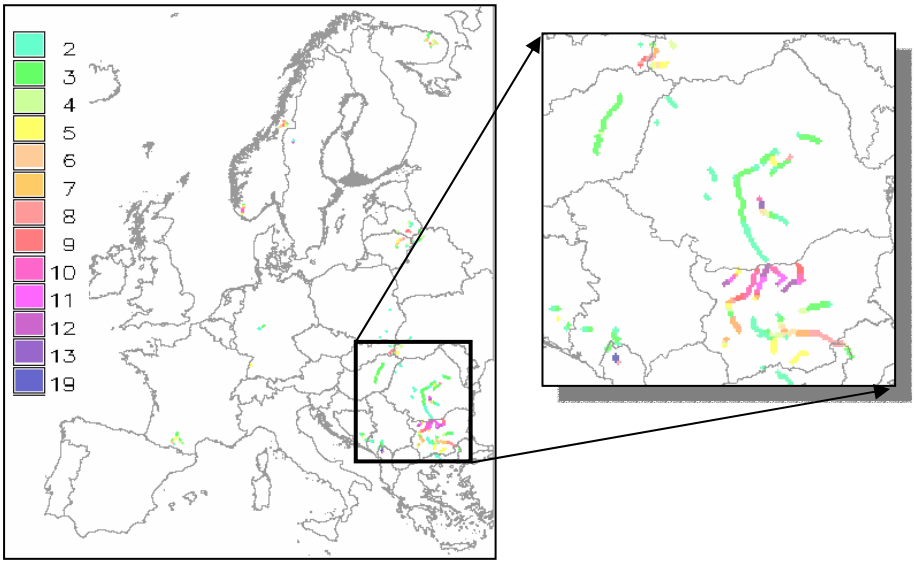


Figure 5 : Number of forecasts exceeding EFAS (EUD+DWD) *high threshold* level for May 2005 for 3 consecutive times

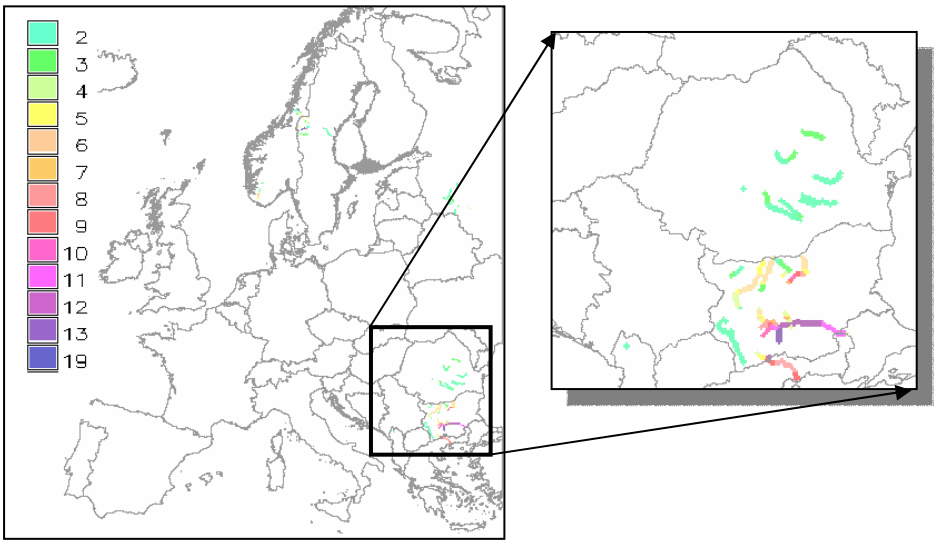
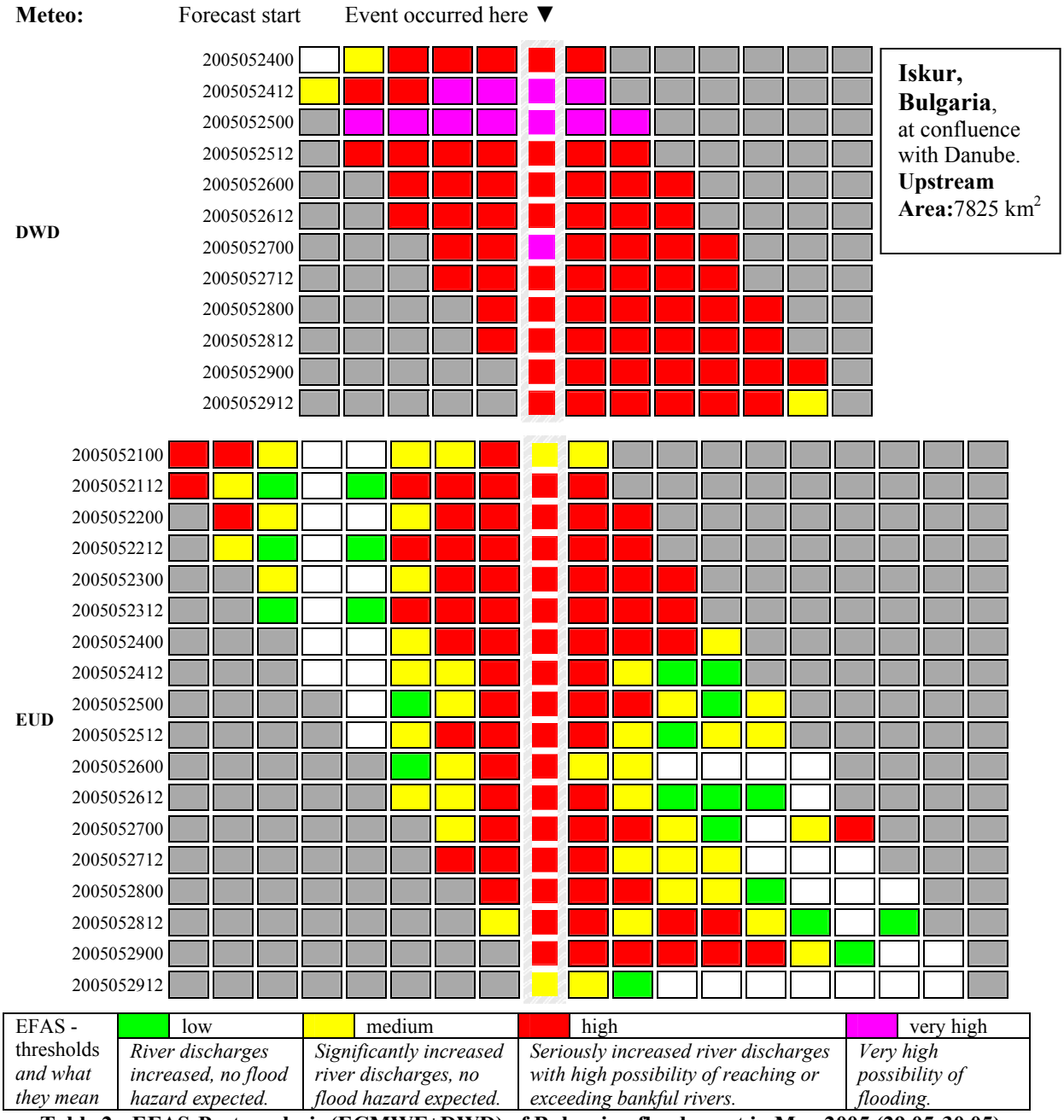


Figure 6 : Number of forecasts exceeding EFAS (EUD+DWD) *high threshold* level for June 2005 for 3 consecutive times

Table 1 : River flood events in May and June

Catchment name, Country	Date of EFAS-simulated critical situation	Date of observed critical situation [1]	Affected Basin size [km^2] [1]	Forecast leadtime
Olt, Romania	09/05- 011/05 2005	08/05- 010/05 2005	20.000	5
Nestos, Greece	20/05- 21/05 2005	20/05- 21/05 2005	5000	(4)[2]
Iskur, Bulgaria	29/05- 02/06 2005	29/05- 30/05 2005	8000	6
Romania, severe flash floods	No flooding forecasted	27/05- 29/05 2005	?	--
Iskur, Bulgaria	08/06-09/06 2005	07/06-08/06 2005	8000	4-5

[1] *if confirmed by media or other reliable source; **?** if no (reliable) info*
[2] *Too small basin, no steady forecast signal*



EFAS - thresholds *and what they mean*	low	medium	high	very high
	River discharges increased, no flood hazard expected.	*Significantly increased river discharges, no flood hazard expected.*	*Seriously increased river discharges with high possibility of reaching or exceeding bankful rivers.*	*Very high possibility of flooding.*

Table 2 : EFAS-Post-analysis (ECMWF+DWD) of Bulgarian flood event in May 2005 (29.05-30.05)

assuming unregulated rivers) for the Maritsa (heavily regulated) are not attendable (and also explicitly not requested by the corresponding hydrological authority).

One example for the EFAS performance regarding the flooding that took place in Bulgaria at the end of May is shown in Table 2. Despite the small Basin size (8000 km^2) EFAS forecasted this event with 6 days of leadtime, taking already into consideration that a forecast is just issued at the 3rd consecutive forecast.

Acknowledgements
Meteorological forecast data are provided by ECMWF and DWD. The observed meteorological data are provided by the JRC MARS Unit. The European Media Monitoring (EMM) information is provided by JRC IPSC.

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EFAS bulletin

Issue 2005(5)

- ***EFAS news***
- ***Meteorological situation for July/Aug 2005***
- ***Simulated hydrological situation by the EFAS***
- ***July event : 07.-14.07.2005***
- ***August event : 22.-26.08.2005***
- ***Some comments***

EFAS news

July and August were busy months for the EFAS team. Two large-scale flood events took place in the Danube catchment. In agreement with the signed MoU's EFAS external information reports were sent to the concerned EFAS MoU-partners in Germany, Slovakia, Hungary. In addition, the EFAS team asked ECMWF for permission to also send information reports the hydro-meteorological service in Austria for which no MoU is in place. The daily updated reports covered the whole period from the day for which a forecasted critical threshold exeedance was consistent since 2 consecutive forecasts until the day that EFAS did not simulate a critical threshold exeedance anymore.

Together with the respective last EFAS information report a questionnaire was sent out to get feedback from the authorities on the usefulness of the information reports. Feedback was positive and the content and presentation of EFAS forecast information was appreciated. EFAS reports were seen as a useful additional information source by operational forecasters.

Meteorological situation July/Aug 2005

In July most of Spain and Portugal as well as great parts of Italy did receive little or no rain at all. This extreme dryness contributed to increased forest fire risk in Portugal (see also http://inforest.jrc.it/ and for actual soil moisture http://natural-hazards.jrc.it/).

In Austria precipitation over 300 mm/month was measured (see Fig.1) which corresponds to more than twice the amount of the 14-year average (from 1990 to 2004, observed MARS data, see Fig. 2). Germany, Poland and most of the Balkan states also received well above average precipitation amounts with peaks in Romania and Bulgaria that received up to 5 times more precipitation than average.

In August again the South-West of Europe was comparably dry with large stretches were no precipitation was measured, whereas in the East of Europe fairly high amounts of precipitation were observed. Once more Romania, Bulgaria, were subject to precipitation up to 300mm/month (see Fig. 3). Together with Hungary, Serbia and Slovakia in this region precipitation of up to 5 times more than average (see Fig 4) was recorded.

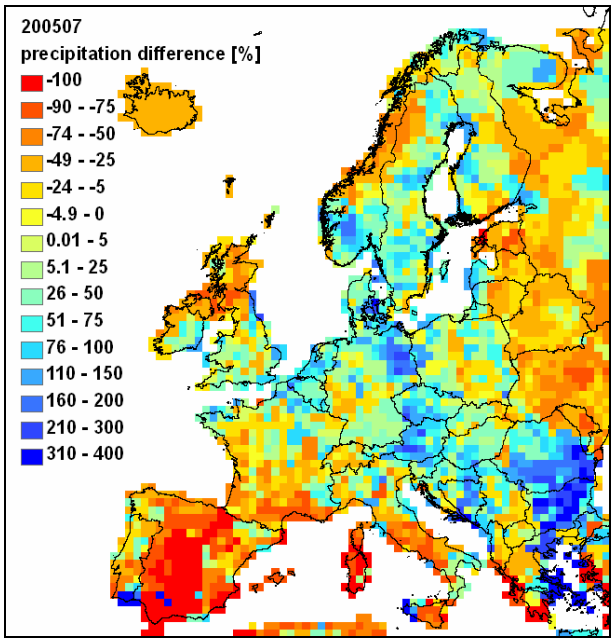

Figure 1 : Difference in precipitation [%] 07 2005 in comparison to long term average (1990-2004)

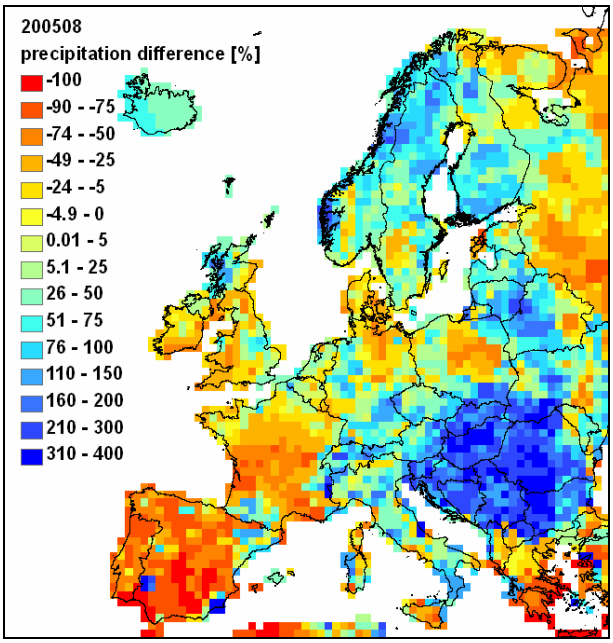

Figure 3 : Difference in precipitation [%] 08 2005 in comparison to long term average (1990-2004)

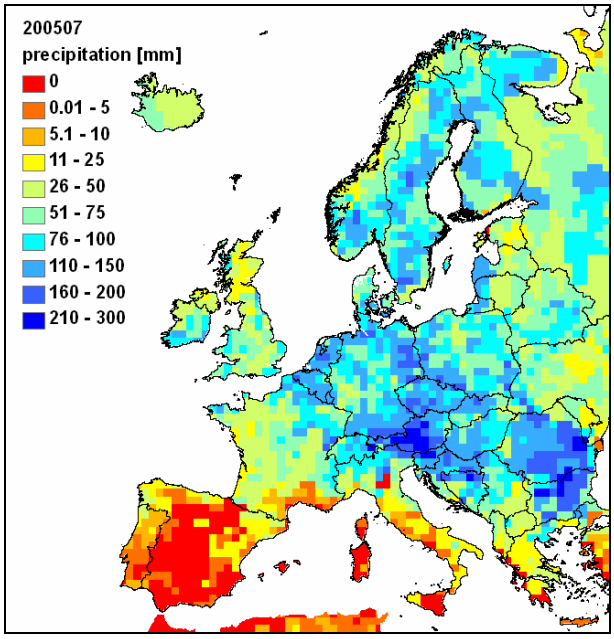

Figure 2 : Accumulated Precipitation [mm] 07 2005

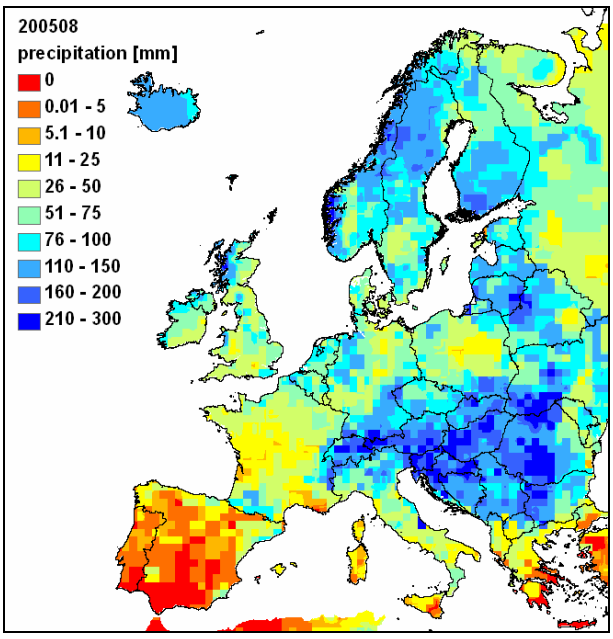

Figure 4 : Accumulated Precipitation [mm] 08 2005

Simulated hydrological situation by EFAS

EFAS thresholds are based on LISFLOOD runs with observed meteorological data of the past 14 years. The forecasted exceedances of these thresholds (if predicted in 2 consecutive EFAS-forecasts) of the last two months are compared to the threshold exceedances simulated by the LISFLOOD model when using observed meteo data (JRC-MARS) from the same period as input. Results of this comparison for the last two months are shown in figures 5, 6 (July 2005) and 7, 8 (August 2005). The results highlight that EFAS forecasted similar threshold exceedances in the same areas that were calculated by the MARS-LISFLOOD control simulation. Clearly, these results reflect the heavy flooding that took place in Bulgaria and Romania during this time. However, there is some spatial spread of the EFAS flood forecasts which is

due to meteorological forecast inherent shifts regarding the forecasted location of precipitation fields. In table 1 the EFAS forecasts that led to external alerts are listed with forecast lead time, forecasted and observed (reported) event period as well as upstream area at forecast location. A more detailed analysis of the EFAS performance is given in the next two sections.

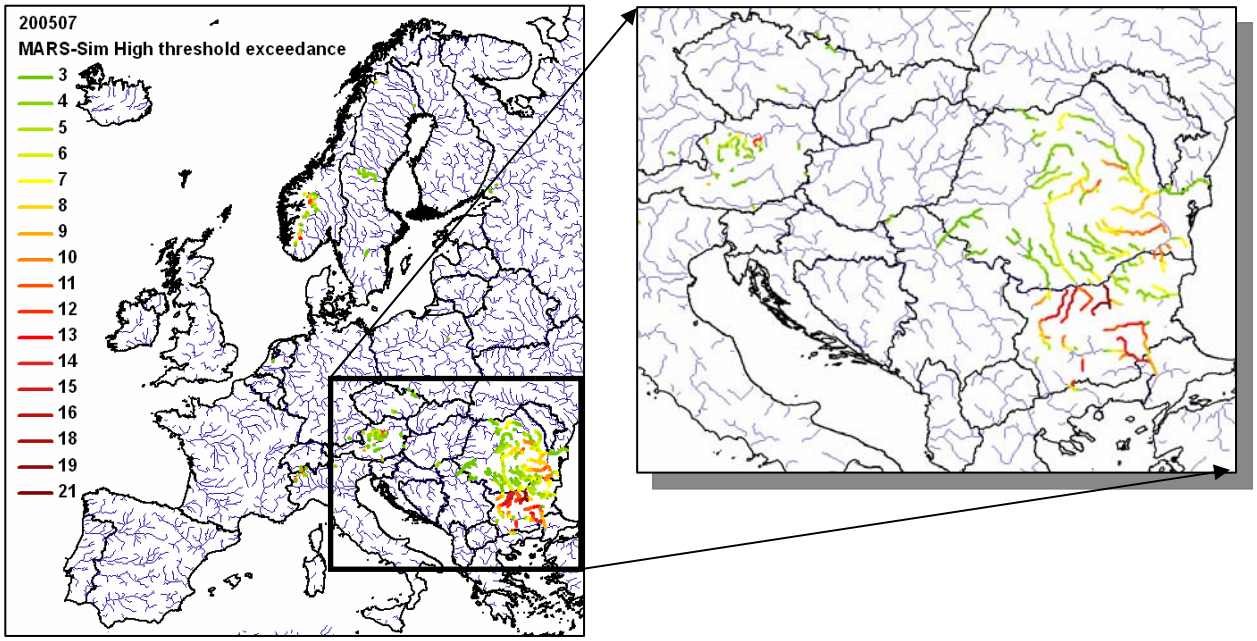

Figure 5 : EFAS high threshold exceedance (200507) for LISFLOOD simulations with observed meteorological data (JRC-MARS)

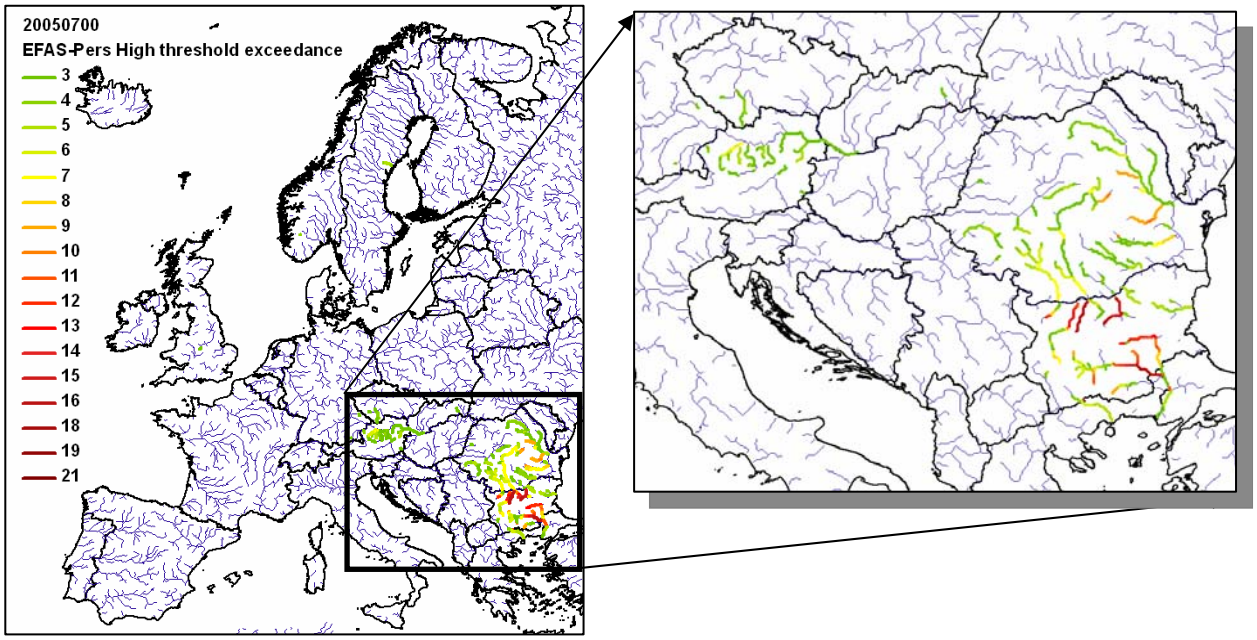

Figure 6 : EFAS persistent (2 consecutive forecasts) high threshold exceedance (200507) for LISFLOOD simulations with forecasted meteo data

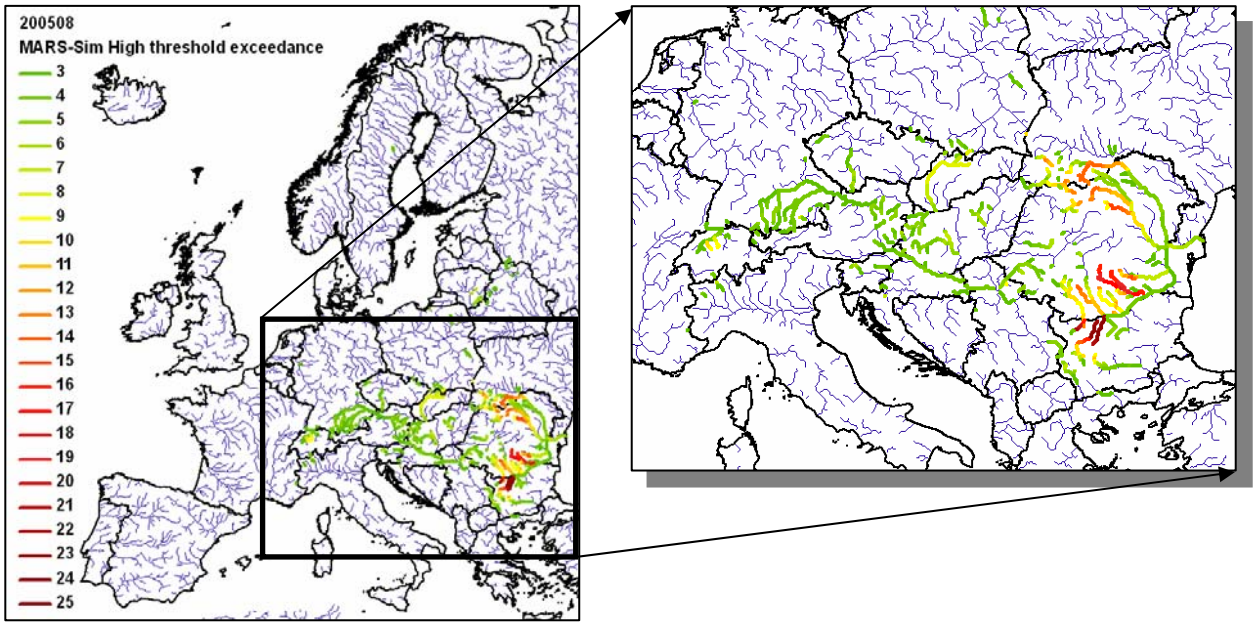

Figure 7 : EFAS high threshold exceedance (200508) for LISFLOOD simulations with observed meteorological data (JRC-MARS)

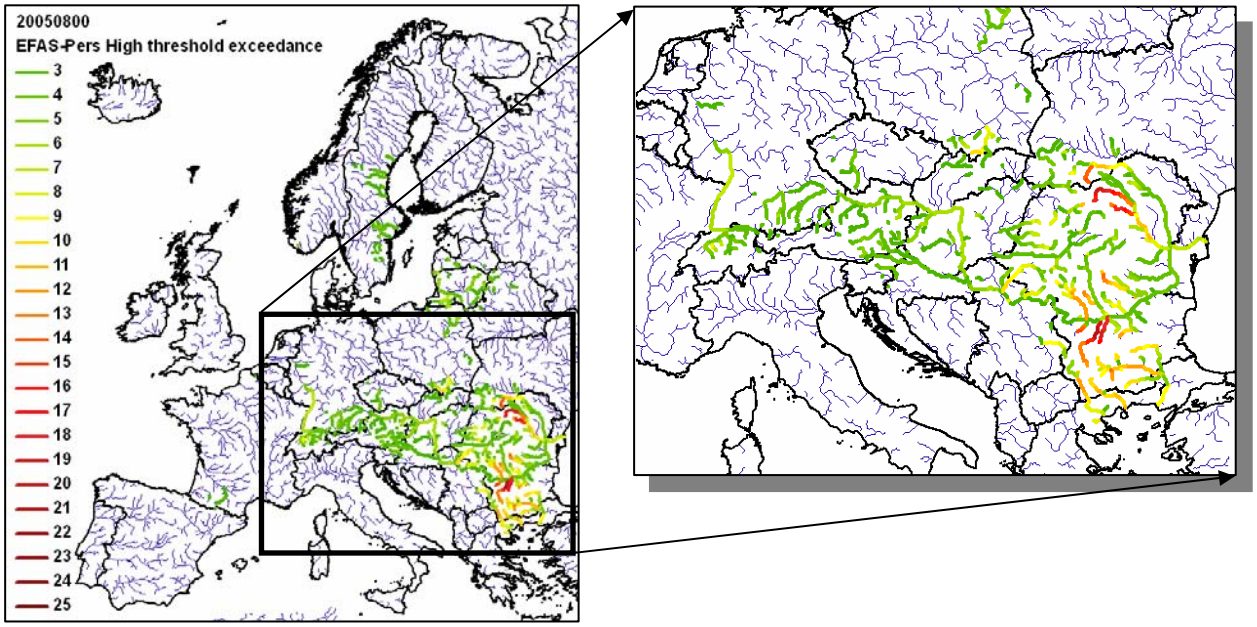

Figure 8 : EFAS persistent (2 consecutive forecasts) high threshold exceedance (200508) for LISFLOOD simulations with forecasted meteo data

Table 1 : EFAS flood forecasting information sent out in July and August

Catchment name, Country	Date of EFAS-simulated critical situation	Date of observed critical situation [1]	Affected Basin size [km^2] [1]	Forecast leadtime
Rabe, Hungary	12/07-14/07 2005	*No flooding*	15.000	--
Drava, Hungary	12/07-14/07 2005	*15/07 2005*	14.000	4
Danube, Hugary, Slovakia	14/07-15/07 2005	13/07 2005 *national alert: low*	170.000	5
Danube, Hugary	15/07-17/07 2005	*16/07-17/07 2005*	209.000	6
Koros, Hungary	03/08-05/08 2005	*No flooding*	28.000	--
Danube, Germany	23/08-27/08 2005	23/08-26/08 2005	75.000	3-4

Isar, Germany	22/08-27/08 2005	23/08-25/08 2005	10.000	2
Iller, Germany	22/08-27/08 2005	23/08-24/08 2005	7.500	2
Lech, Germany	22/08-27/08 2005	23/08-24/08 2005	5.000	2
Danube, Austria	25/08-26/08 2005	25/08-26/08 2005	100.000	3-4

July event : 07.-14.07.2005

On the 10./11.07.2005 heavy rainfall occurred in South Bavaria/ West Austria and precipitation amounts of up to 130 mm in 24h were observed. In many smaller Danube tributaries in the area this led to flooding with peak discharges measured between the 12. and 13.07.2005. In the main Danube levels rose as well and high levels were reached. For example Slovakian authorities were on alert level 1 (low). From the 08.07.2005 this event was predicted by EFAS (i.e. 4-5 days lead time). As illustrated for a location in the main Danube (upstream area 170.000 km^2; Fig. 9) for the EFAS-DWD forecasts the signal was persistent over the whole period whereas EFAS forecasts based on ECMWF meteorological forecast were intermittent. At lead times less than 3 days EFAS forecasted an event with less intensity, comparing well to later observations.

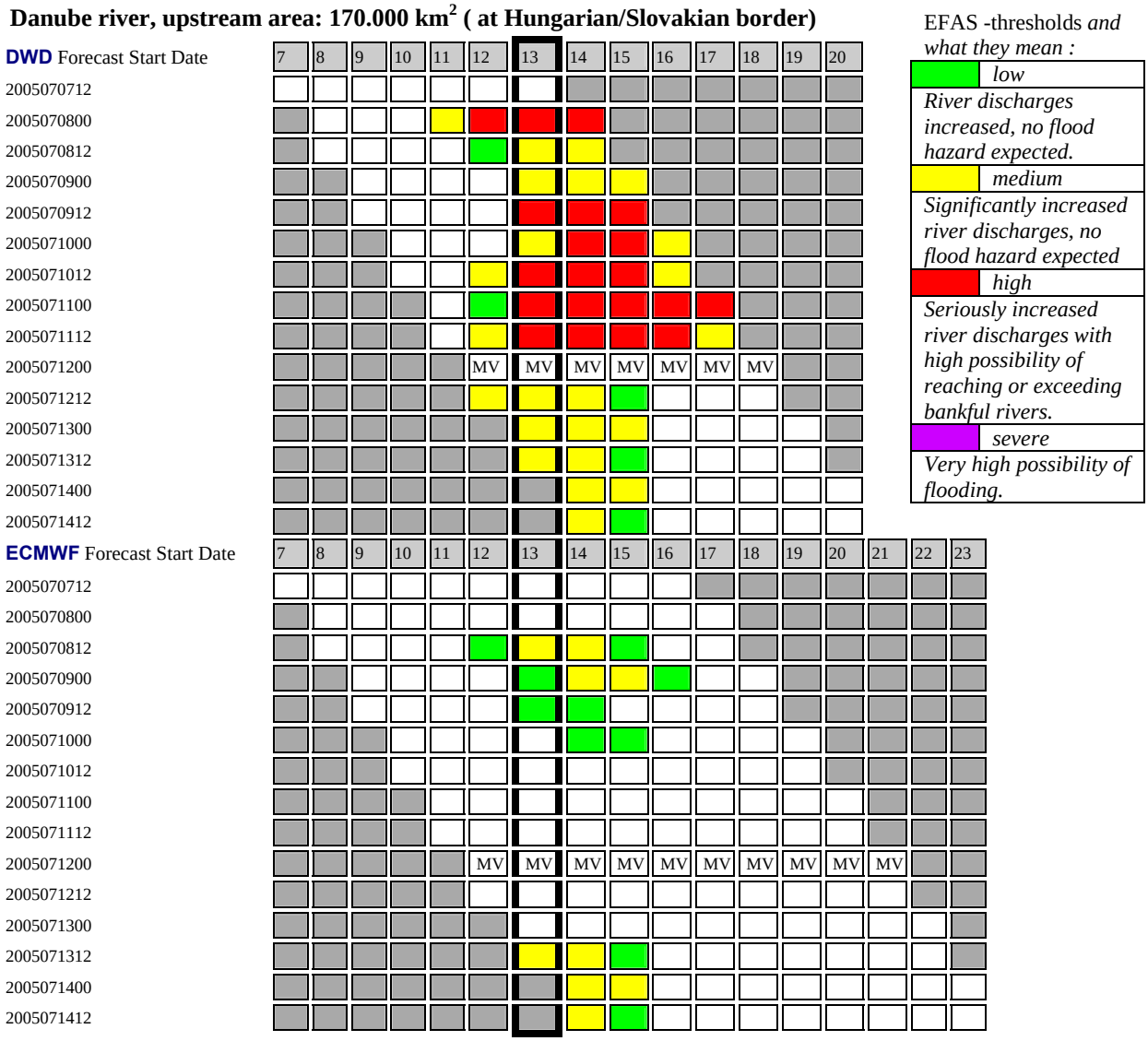

Figure 9 : Sequence of EFAS forecasts for the Danube (upstream area 170.000km^2) for 07.07 to 14.07.2005

August event : 22.-26.08.2005

Only 5 weeks after the July floods in the same region, Switzerland, Austria and South Germany reported precipitation amounts of up to 280 mm during the period from 19.08 to 24.08.2005. In some Danube tributaries like the Iller and the Isar this resulted in historical record discharges around the 23.08.2005. The EFAS deterministic forecasts picked up a signal on this event at the 16.08.2005 (see Fig. 10), but it was intermittent and was only persistent in the EFAS-DWD forecasts from the 20.08 onwards. For other rivers in the area the situation was the same, so that an external EFAS alerts were only sent out to the relevant MoU partners starting from the 21.08.2005. During this period there were technical problems with the EFAS EPS runs so that they were only calculated properly 2 weeks later. Astonishingly, these EFAS EPS reruns showed that for the forecast with start date 14.08.2005 already 18 % (for the example of the Isar river in Germany) of the probabilistic EFAS forecasts exceeded the high threshold on day 10 of the forecast (i.e. the 23.08.2005). This percentage oscillated for the following forecasts but steadily gave a signal for a possible flooding event around the 23.08.2005 and more than once some EFAS EPS members exceeded also the severe threshold in this period (see Fig. 11).

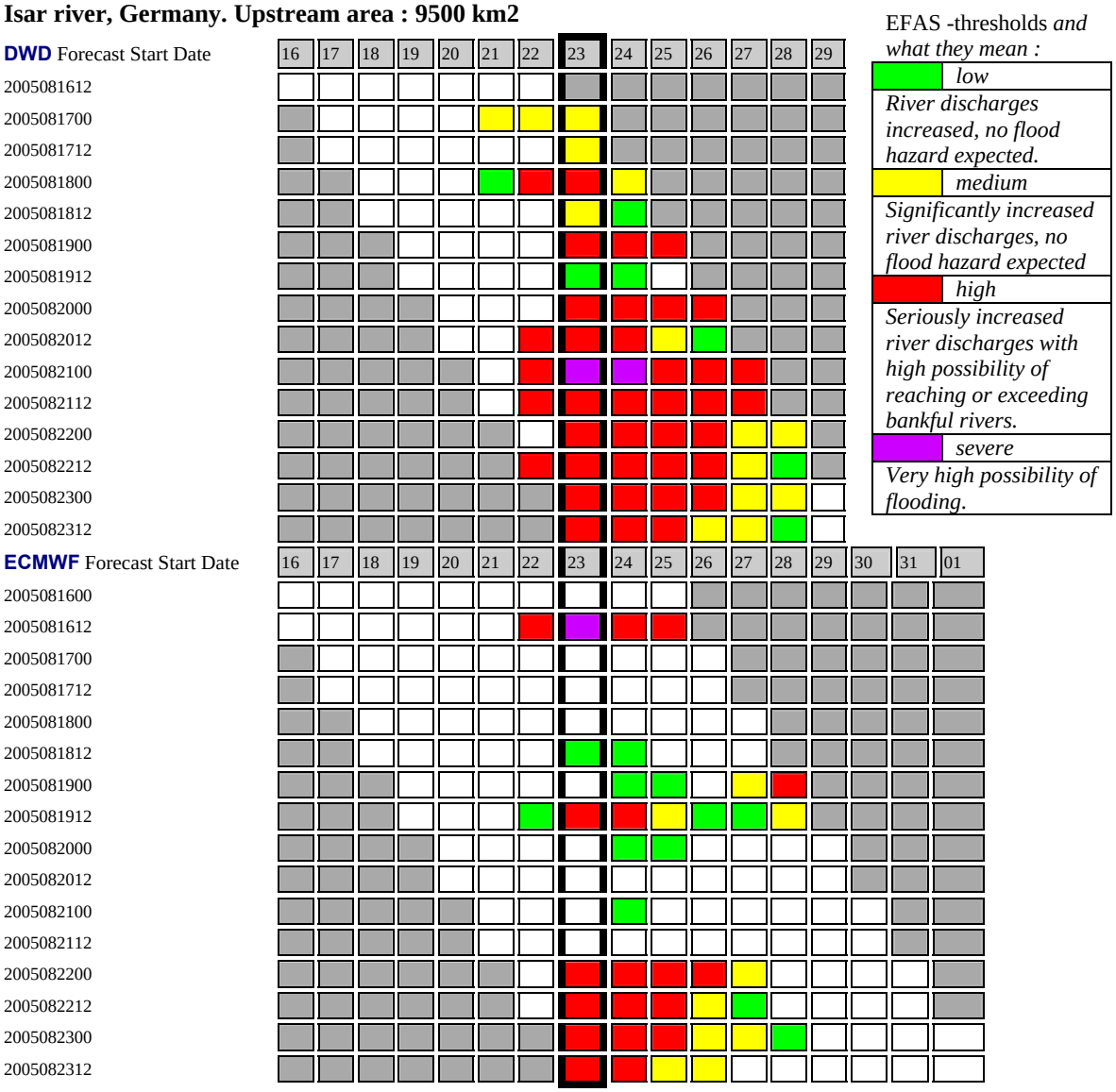

Figure 10 : Sequence of EFAS forecasts for the Isar (upstream area 9.500km^2) for 16.08 to 23.08.2005

Isar river, Germany. Upstream area : 8500 km2.

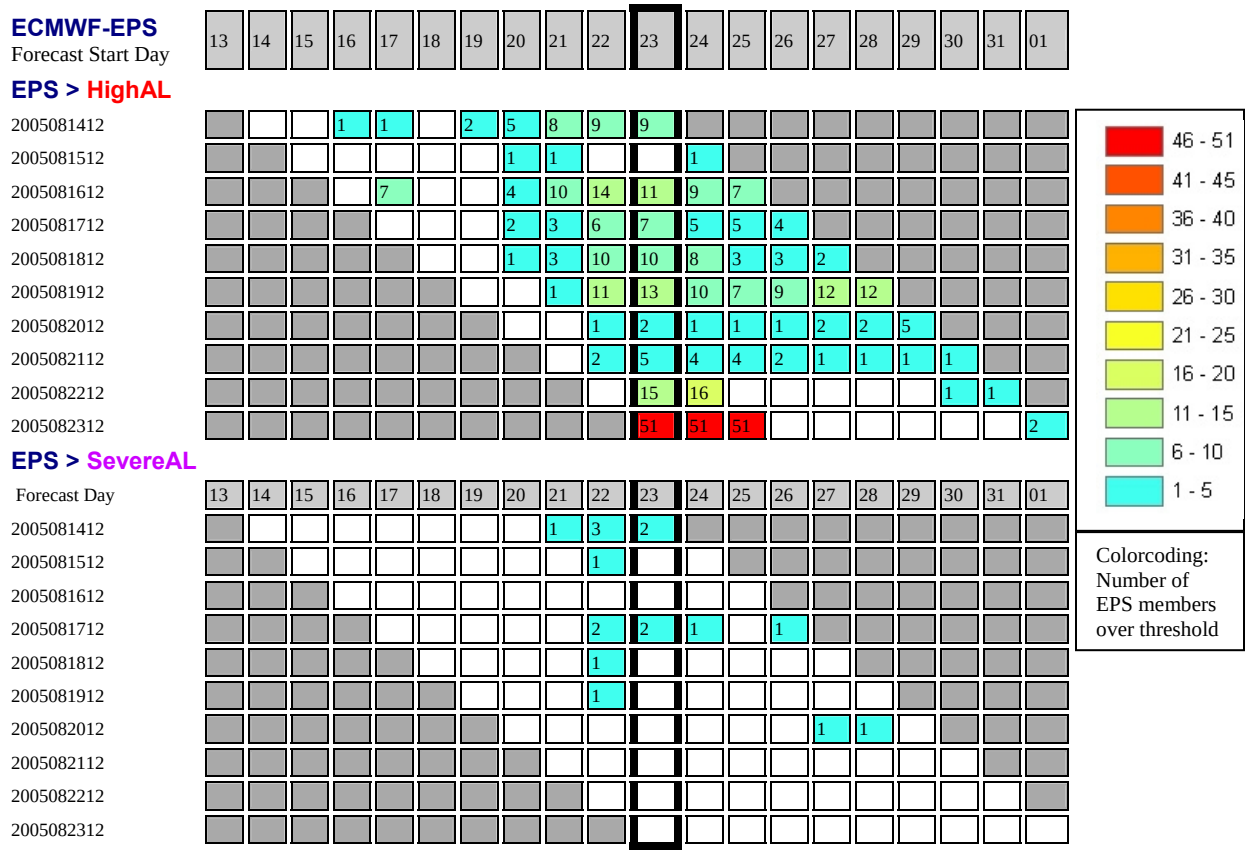

Figure 11 : Sequence of EFAS-EPS forecasts for the Isar (upstream area 8.500km^2) for 14.08 to 23.08.2005. Reported numbers are EPS members (max 51) that are over high alert level threshold (HighAL) or respectively over severe alert level threshold (SevereAL).

Some comments

EFAS is a research project in pre-operational phase and is still evolving and undergoing many changes. Nevertheless, the EFAS team succeeded to maintain the forecasting exercise 7 days a week even during summer holidays and during sickness induced heavy staff reductions.

Apart from some missing information regarding EFAS EPS forecasts (principal informatics support person reported sick for 2 weeks) EFAS information reports were sent in real time to respective MoU partners if the forecasts indicated the necessity to do so.

The EFAS information reports were revised according to feedback of MoU partners. An in depth discussion on possible improvements of the form in which EFAS forecast information is presented will take place during the technical EFAS meeting with MoU partners in January 2006. At the same meeting the forum will also discuss the issue of when to start sending out EFAS information reports and when to stop.

The performance of EFAS during the last months confirmed confidence in EFAS results and showed the additional benefit of using a combination of deterministic and probabilistic flood forecasts.

More and more parts of the EFAS forecasting exercise are automated and the EFAS Graphical User Interface (GUI) is now offering a large amount of additional data analysis options. In the near future the fusion of the EFAS- and FEWS-GUI will provide further improvements and user-friendliness.

Acknowledgements

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EFAS bulletin

Issue 2005(6) ***Sept/Oct 2005***

EFAS news

During the past 2 months the number of hydrological Institutes for which an EFAS-Memorandum of Understanding (MoU) already exists, or for which it is in an advanced preparation phase, has grown further. The actual status is shown in Fig.1.

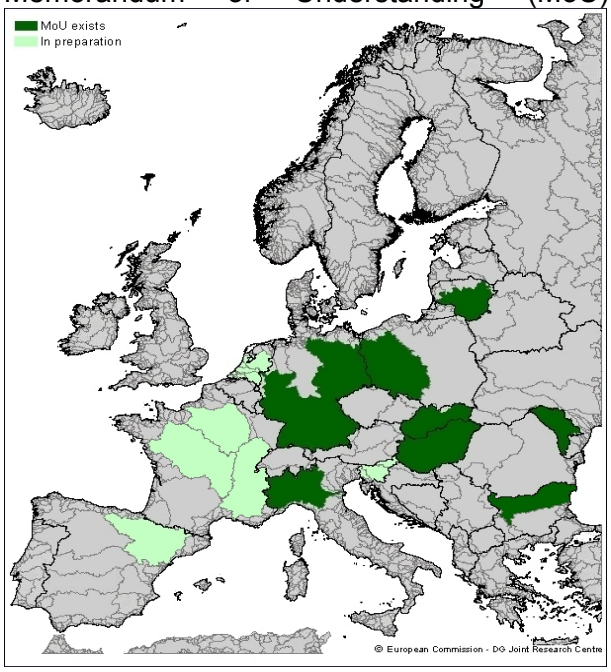

Figure 1 : Memorandum of Understanding (MoU) status 10/2005. Dark green MoU exists, light green MoU is in preparation.

Meteorological situation Sept/Oct 2005

In September most of Spain and Portugal as well as the North-West of France did receive little or no rain at all (for actual soil moisture see also http://natural-hazards.jrc.it/). On the contrary in the Mediterranean part of France, precipitation over 300 mm/month was measured (see Fig.3) which in places corresponds to more than three times the amount of the 14-year average for this month (from 1990 to 2004, observed MARS data, see Fig. 2). Parts of Romania and Bulgaria also received up to 5 times more precipitation than average.

In October great parts of Europe were comparably dry with large stretches in the East were almost no precipitation was measured. In contrast precipitation in the UK, Spain, Portugal and Italy was up to 300mm/month (see Fig. 5) which corresponds to ratios between 2 and 5 times more than average (see Fig. 4).

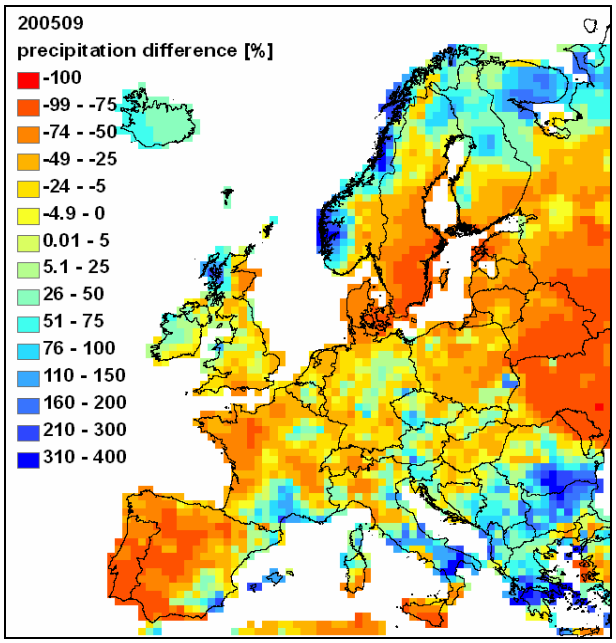

Figure 2 : Difference in precipitation [%] 09 2005 in comparison to long term average (1990-2004)

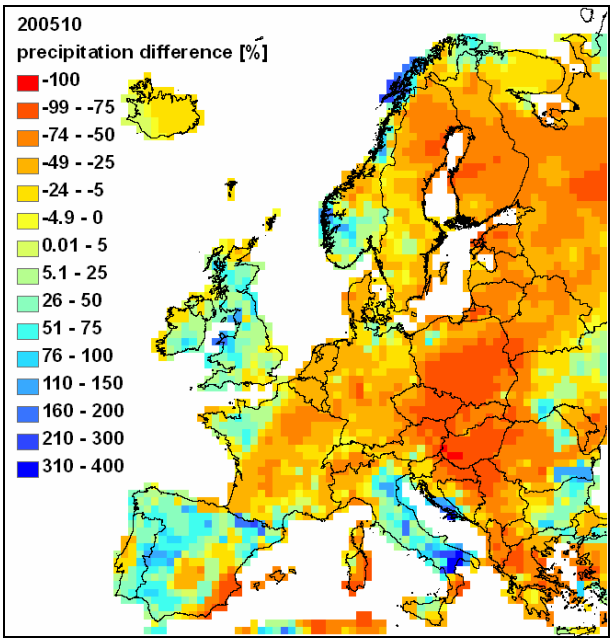

Figure 4 : Difference in precipitation [%] 10 2005 in comparison to long term average (1990-2004)

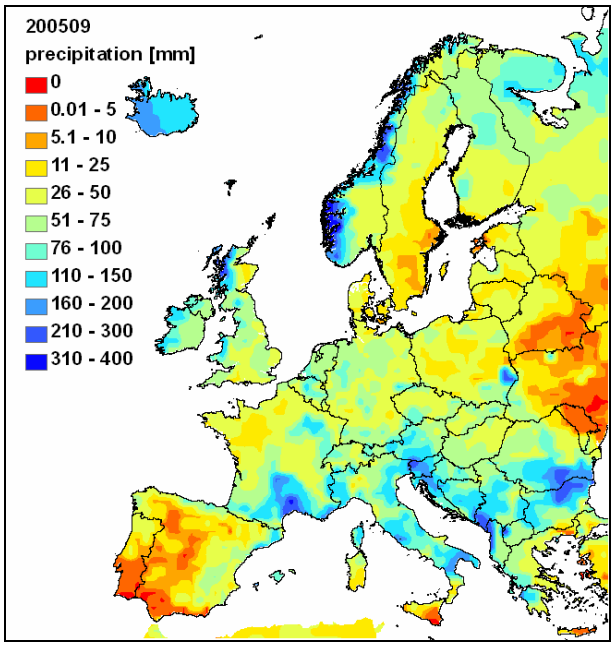

Figure 3 : Accumulated Precipitation [mm] 09 2005

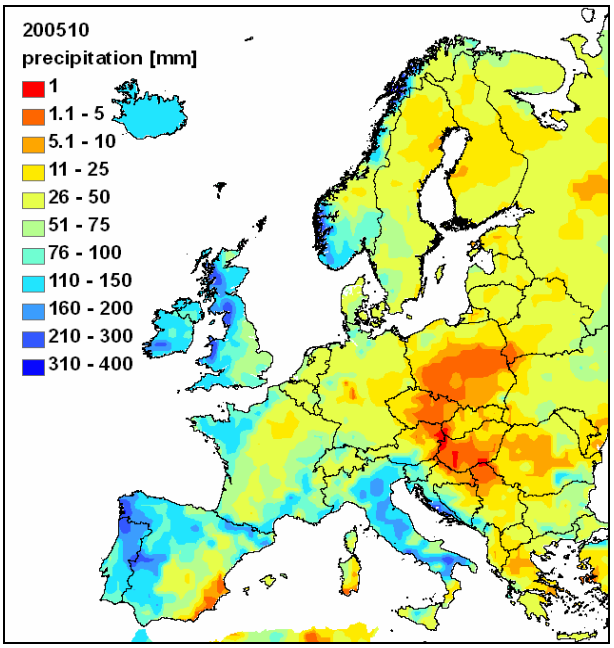

Figure 5 : Accumulated Precipitation [mm] 10 2005

Simulated hydrological situation by EFAS

An overview of the threshold exceedances resulting from LISFLOOD simulations using observed meteorological data (JRC-MARS) is shown in figures 6 and 7.

In the first third of September EFAS high threshold exceedance (>HAL) was simulated for the South of France, mainly for some small Garonne tributaries (see also Figure 6). This was confirmed by the media. Starting from the 20th of September again Romania and Bulgaria were subject to high amounts of precipitation, which together with the wet initial conditions of the ground let to a simulation of >HAL in many of the Danube tributaries in this region. Namely the rivers Arges, Iskur, Kamchiya, Lom, Olt and Yantra were consistently forecasted to be >HAL or even to exceed EFAS severe threshold. External information reports were sent to Bulgaria (19.-26.09.) and Romania (20.-24.09.).

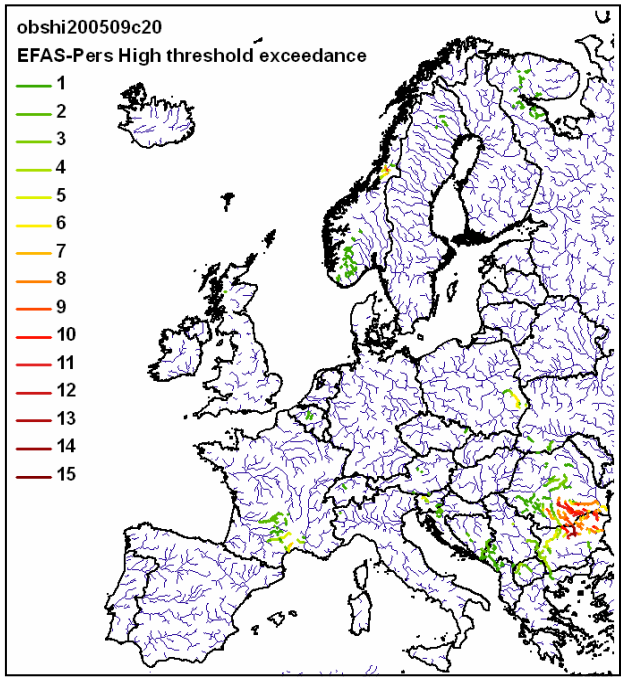

Figure 6 : EFAS high threshold exceedance (200509) for LISFLOOD simulations with observed meteorological data (JRC-MARS)

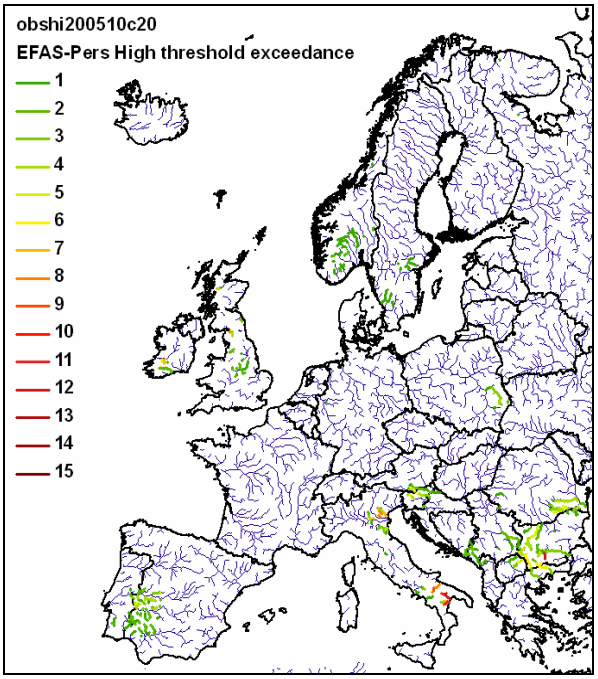

Figure 7 : EFAS high threshold exceedance (200510) for LISFLOOD simulations with observed meteorological data (JRC-MARS)

Later on, the Bulgaria hydrologic institute confirmed bankful conditions and correctly forecasted peak discharge timing for the rivers Yantra and Lom. Media confirmed the critical situation for the Romanian river Buzau.

At the beginning of October >HAL was forecasted for the Drava river (06.-09.10.2005) and external information reports were sent to the Hungarian hydrologic institute (02.10-04.10.2005). Coming closer to the event the forecasted discharge magnitude decreased and thus the reports were just sent as long as >HAL conditions were forecasted. Later on the Hungarian hydrologic institute confirmed high but not critical levels for this period and region. Small rivers < 4000km^2 in the South of Italy were simulated to be >HAL (around 10.10 and 20.10.2005) as well as in the UK (24./25.10.2005) which was confirmed by the national agencies. In Spain (26.-29.10.2005) few >HAL were simulated as well. Here, like in other cases, the problem is that no validation data is currently available which underlines again the need for real time discharge data and real local critical level discharge information with an Europe wide coverage.

Table 1 : EFAS flood forecasting information sent out in September and October

Catchment name, Country	Date of EFAS-simulated critical situation	Date of observed critical situation [1]	Affected Basin size [km^2]	Forecast leadtime
Po, Italy	10/09-12/09 2005	*Just high levels upstream*	16.000	--
Arges, Romania	24/09-26/09 2005	24/09-26/09 2005	12.000	5
Iskur, Bulgaria	22/09-24/09 2005 02/10-04/10 2005	22/09-23/09/2005 02/10-04/10 2005	7.500 7.500	4 5
Kamchiya, Bulgaria	25/09-26/09 2005	25/09-26/09 /2005	7.000	6
Vedea, Romania	22/09-24/09 2005	22/09-24/09/2005	5.500	4
Yantra, Bulgaria	23/09-26/09 2005 02/10-04/10 2005	23/09-26/09 /2005 ?	7.500 7.500	6 ?
Drava, Hungary	06/10-09/10 2005	06/10/2005 *high level*	16.000	5

[1] *if confirmed by media or other reliable source*

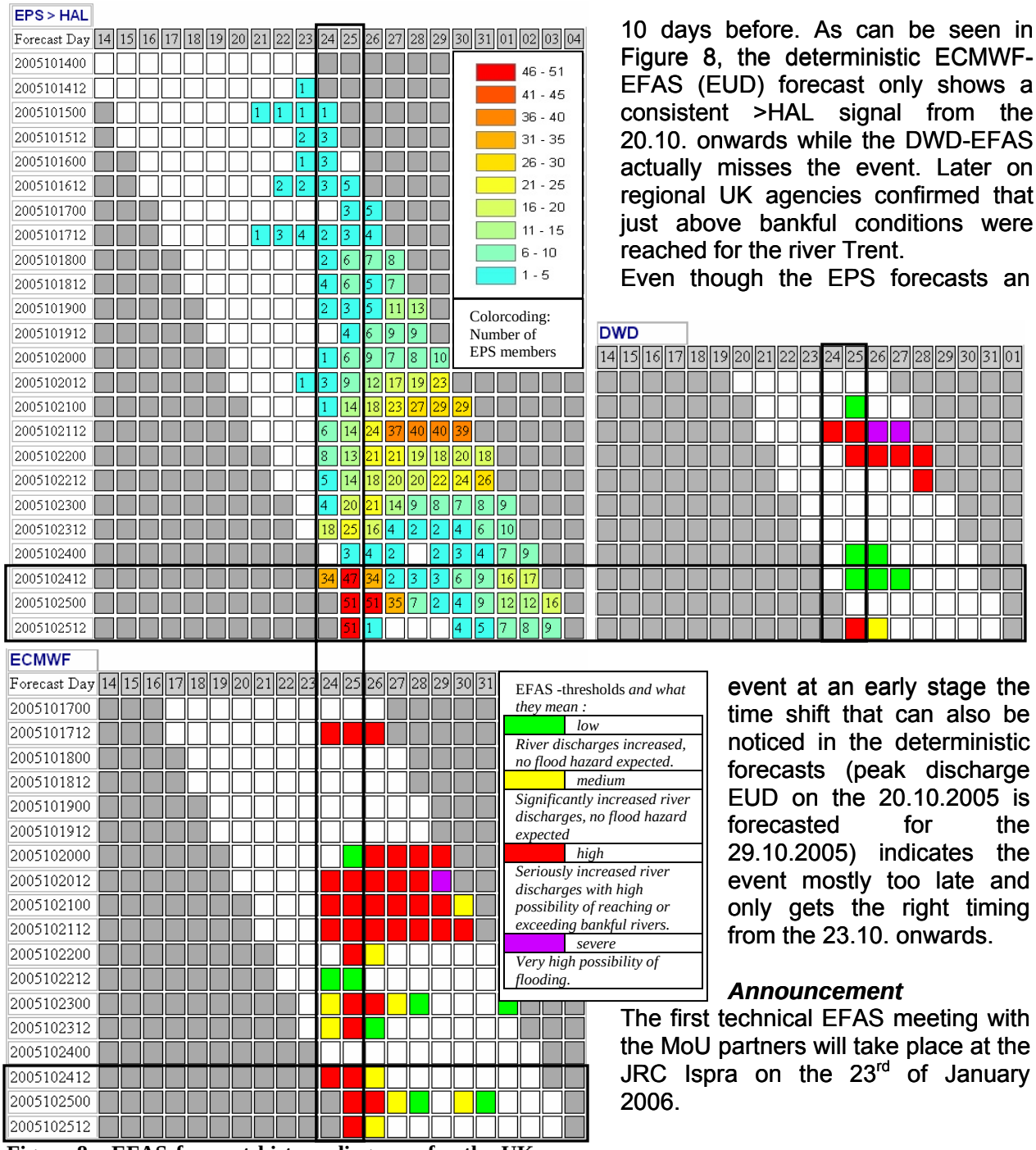

Figure 8 : EFAS forecast history diagrams for the UK case (24./25.10.2005). River Trent, upstream area 9200km^2

At the 23rd of October 2005 UK authorities issued warnings regarding upcoming bad weather and possibilities of flooding in the SW/centre of UK. Most of the concerned rivers were very small and not considered in EFAS but bigger rivers like the Trent (further to the East) were forecasted by EFAS to reach bankful conditions.

The interesting aspect of this event (24./25.10.2005) is the fact that it was picked up by the first EPS forecasts 10 days before. As can be seen in Figure 8, the deterministic ECMWF-EFAS (EUD) forecast only shows a consistent >HAL signal from the 20.10. onwards while the DWD-EFAS actually misses the event. Later on regional UK agencies confirmed that just above bankful conditions were reached for the river Trent.

Even though the EPS forecasts an event at an early stage the time shift that can also be noticed in the deterministic forecasts (peak discharge EUD on the 20.10.2005 is forecasted for the 29.10.2005) indicates the event mostly too late and only gets the right timing from the 23.10. onwards.

Announcement

The first technical EFAS meeting with the MoU partners will take place at the JRC Ispra on the 23rd of January 2006.

Acknowledgements
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EFAS bulletin

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EFAS news

The first EFAS-FEPS-workshop (Flood Ensemble Prediction System) took place at JRC-Ispra on the 21-22nd November 2005. 11 participants were invited from different 8 different hydrological services. The hydrological services were selected to cover a wide range of hydrological regimes ranging from dry-mediterranean to moist-continental. More specifically representatives from river basins in Spain (Ebro), Italy (Po), France (Loire, Rhone, Garonne, Seine), Germany (Rhine, Elbe, Oder, Danube), Netherlands (Rhine, Meuse), Slovakia (Danube), Hungary (Danube, Drava), and Poland (Oder) were invited.

The workshop's concept was to have a small group of flood forecasters from different river basins working through a number of case-studies, each one representing a potential flood situation as forecasted by EFAS. On the first day, the participants worked in groups on each case-study. The second day was targeted mostly to plenary discussions on the use of meteorological EPS for ensemble flood forecasting. Questionnaires and observer sheets were used to monitor the knowledge of EFAS and EPS products before and after the workshop.

The workshop was very successful in several respects. The participants expressed their interest in the subject and most of them found that the workshop brought their knowledge about ensemble prediction flood forecasting forward. The discussion about the case studies showed clearly that the use of EPS in flood forecasting has a great potential. Once introduced to the concept of probabilistic flood forecasting and being used to working with ensemble streamflows, the participants missed not having the EPS information during the case studies if they were not provided. The workshop revealed interesting patterns in the use of EPS, e.g. that they were considered positive when confirming the deterministic forecasts whereas they were considered rather disturbing when being contradictory.

An important part of the discussion revolved around the presentation of multiple forecasts and EPS in particular when dealing with medium-range flood forecasting. The form of presentation elaborated by the EFAS team

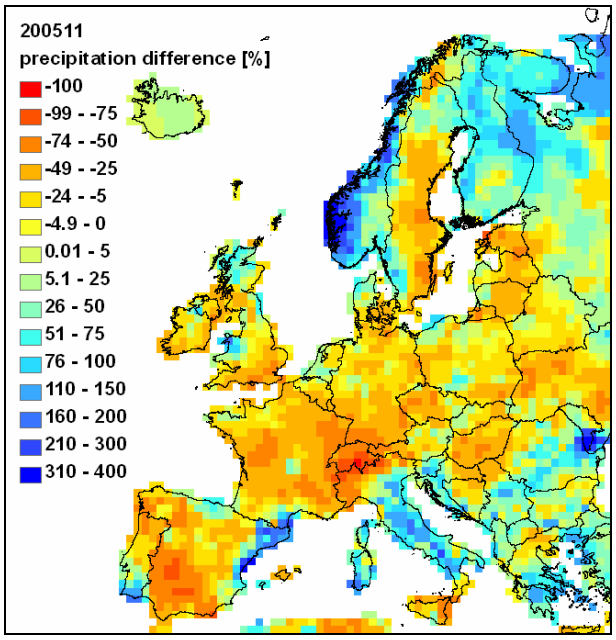

Figure 2 : Difference in precipitation [%] 11 2005 in comparison to long term average (1990-2004)

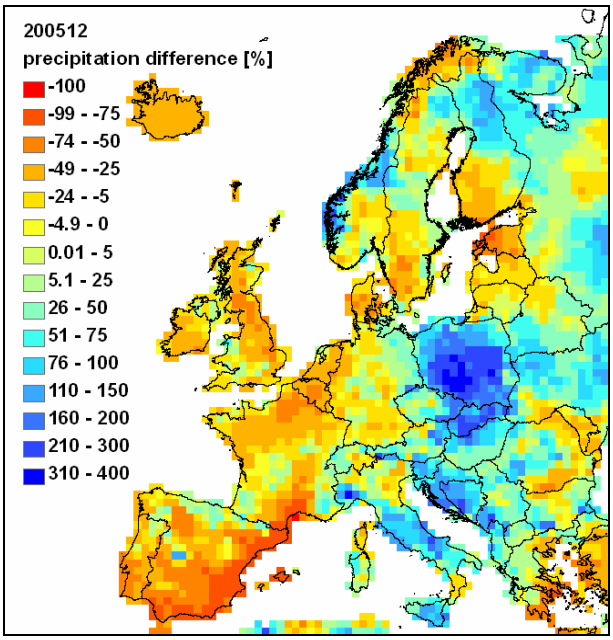

Figure 4 : Difference in precipitation [%] 12 2005 in comparison to long term average (1990-2004)

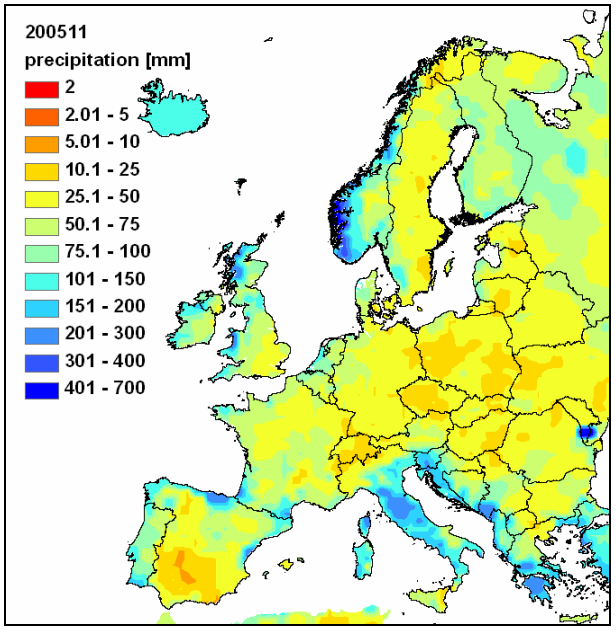

Figure 3 : Accumulated Precipitation [mm] 11 2005

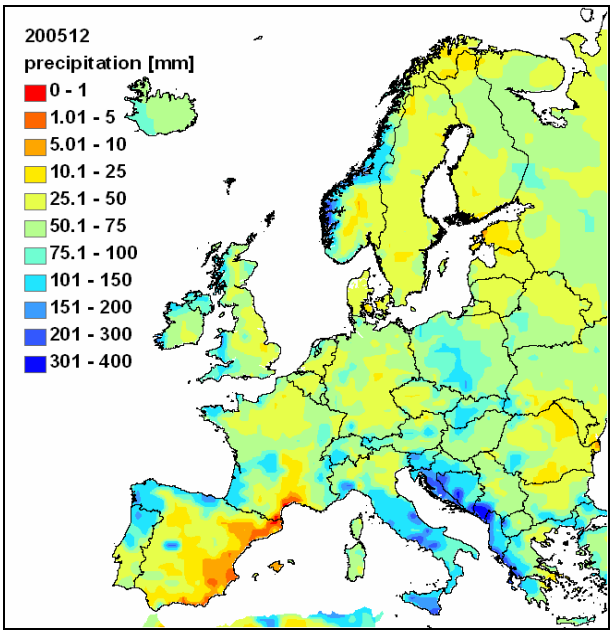

Figure 5 : Accumulated Precipitation [mm] 12 2005

found generally positive feedback and was considered very useful.

Overall the participants felt that training on specific case studies for their own river basins are necessary to properly understand the value of EPS. Providing training material or daily access to EFAS results was considered an important aspect for the successful use of EFAS results and guidelines were proposed.

Meteorological situation Nov/Dec 2005

In November most of Europe received less than average precipitation amounts(see Fig.2) except for Italy south of the river Po, North-West Spain, Greece and a region on the Romanian-Moldavian border received up to 4 times more precipitation than average. The Alpine region was extremely dry and with just +- 10mm/month (see Fig.3) received only 10% of the average precipitation for this

month (from 1990 to 2004, observed MARS data).
In December the western part of Europe received less and the Central/Eastern part more than average precipitation (see Fig. 4). Maximum precipitation amounts of up to 400 mm were measured in the region along the Adriatic west coast (see Fig. 5). In the Mediterranean coast regions of Spain and France almost no precipitation was measured (for actual soil moisture see also http://natural-hazards.jrc.it/).

Simulated hydrological situation by EFAS

An overview of the threshold exceedances resulting from LISFLOOD simulations using observed meteorological data (JRC-MARS) is shown in figures 6 and 7.

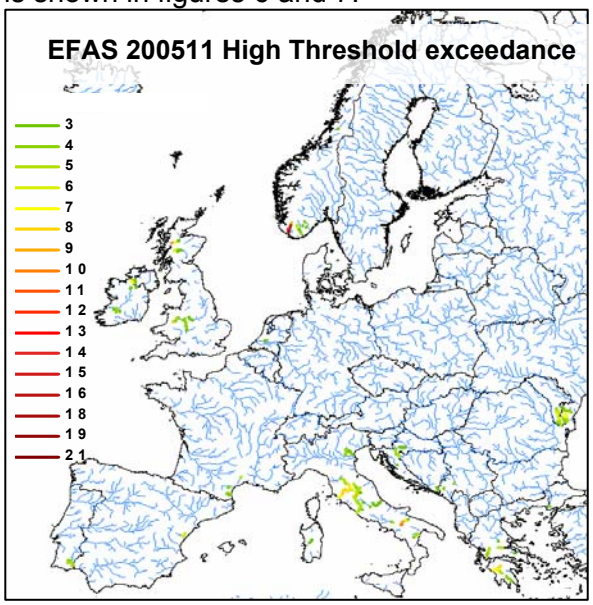

Figure 6 : EFAS high threshold exceedance (200511) for LISFLOOD simulations with observed meteorological data (JRC-MARS)

High river levels were simulated for UK between the 08.11. to the 11.11.2005. This was confirmed by the European Media Monitoring system (EMM). EFAS picked up the first signal with High alert level (HAL) on the 02.11.2006 and around the 06.11.2006 some stretches of the river Severn came up with Severe alert level (SAL).
On the 14-15.11.2005 the river Tet and the river Orb (SW France) showed >HAL and for this region (around Montpellier) flooding was confirmed by EMM. EFAS showed first SAL (deterministic and EPS) for the 14.11-17.11 2005 in this region on the 08.11.2005. The forecast was persistent up to the observed event.
In Greece LISFLOOD simulations showed high river levels on the 23.11-29.11.2005 and EFAS had forecasted this since the 18.11.2005. Greek hydrological authorities issued a flood warning on the 22.11.2005.
Since the end of November EFAS simulated/forecasted several HAL threshold exeedances in the west Adriatic Balkan region but no EMM information was available for this area.
From the 26.11.2005 the river Tevere (upstream area 16.500 km^2) in Italy carried high discharges (estimated 20 year return period) and inundations occurred in the region. This event was first forecasted with EPS>HAL on the 19.11.2005 and persisted until the first week of December 2005 (see also Fig.8). The ECMWF deterministic forecast first exceeds HAL on the 21.11.2005 00:00 and the DWD-EFAS forecast on the 22.11.2005. The deterministic forecasts indicated the start of the event on the 26/27.11.2005. On the contrary the majority of the EPS>HAL was for most of the leadtimes around the 30.11-02.12.2005. Only at the onset of the event this majority shifted to the 27.11.2005 due to the influence of initial conditions.

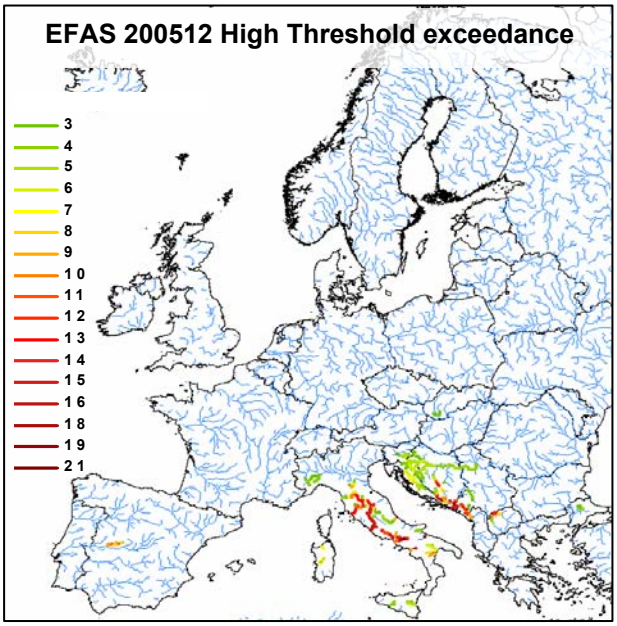

Figure 7 : EFAS high threshold exceedance (200512) for LISFLOOD simulations with observed meteorological data (JRC-MARS)

Table 1 : EFAS flood forecasting information sent out in November and December 2005 : NONE
The following reported forecasts were all for rivers for which NO MoU was in place.

Catchment name, Country	Date of EFAS-simulated critical situation	Date of observed critical situation [1]	Affected Basin size [km^2]	Forecast leadtime
Severn, UK	08/11-11/11 2005	08/11-11/11 2005	10.800	6
Tet, Orb, Herault, France	14/11-17/11 2005	14/11 -15/11 2005	800 to 3000	6
Alfeios, Greece	23/11-27/11 2005	23/11-26/11 2005	3000	2-5
Tevere, Italy	26/11-14/12 2005	26/11-05/12 2005 ??	16.500	5
Garigliano, Italy	26/11-14/12 2005	26/11-05/12 2005 ??	5.500	5

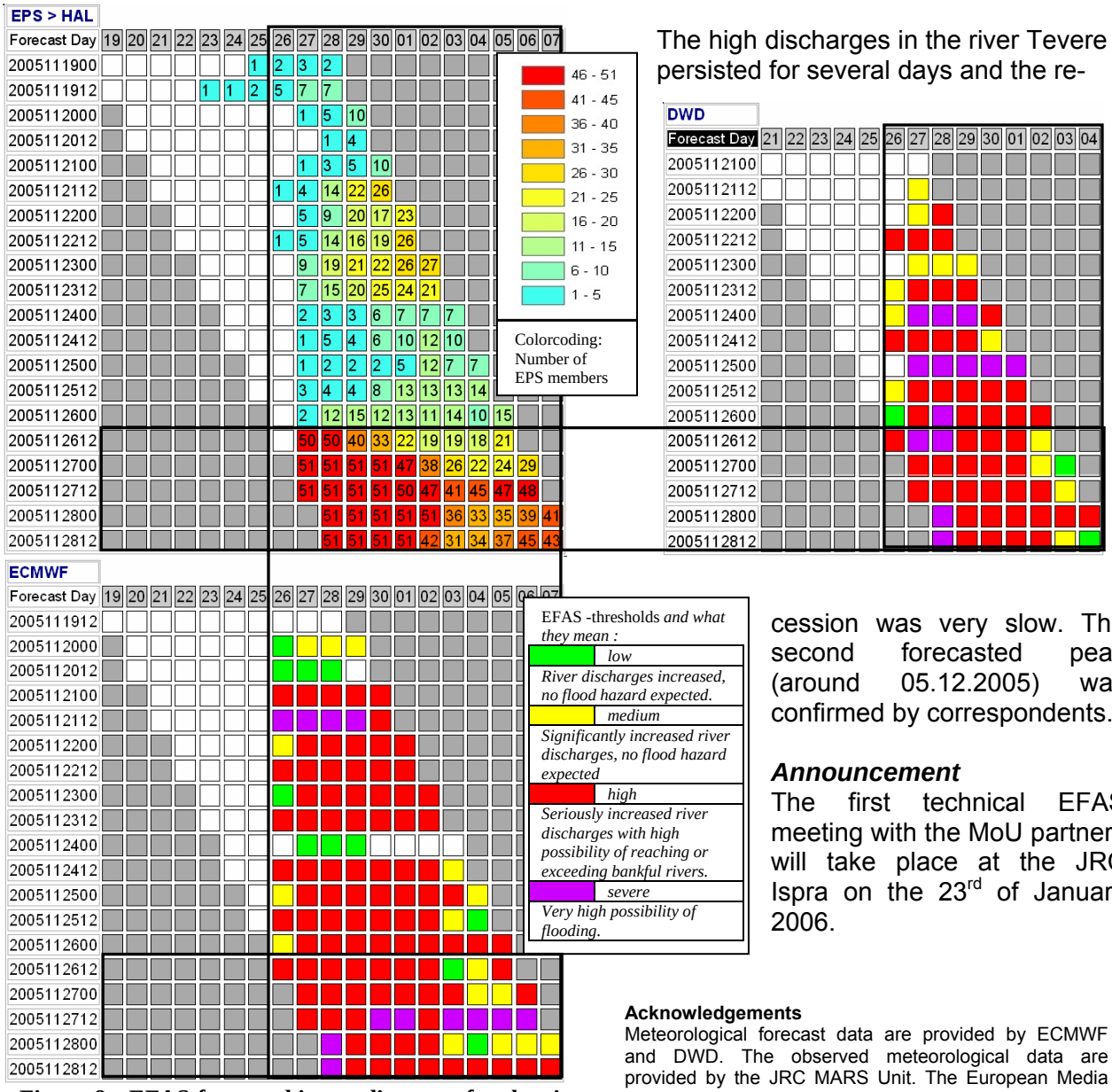

Figure 8 : EFAS forecast history diagrams for the river Tevere, Italy (event start 26.11.2005). Upstream area 16.500km^2

The high discharges in the river Tevere persisted for several days and the re-cession was very slow. The second forecasted peak (around 05.12.2005) was confirmed by correspondents.

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[1] *if confirmed by media or other reliable source*

European Commission

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Abstract

Bulletins containing news and information about the European Flood Forecasting System EFAS are being produced bi-monthly since the beginning of 2005. This year book is a collection of all EFAS Bulletins of the year 2005. It contains a comprehensive introduction to EFAS in the first EFAS Bulletin.

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