ISSN 1831-9424

European Commission

Drought in Europe August 2022

GDO Analytical Report

2022

EUR 31192 EN

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JRC130493

EUR 31192 EN

PDF ISBN 978-92-76- 55855-2 ISSN 1831-9424 doi:10.2760/264241 KJ-NA-31-192-EN-N

Luxembourg: Publications Office of the European Union, 2022

How to cite this report: Toreti, A., Bavera, D., Acosta Navarro, J., Cammalleri, C., de Jager, A., Di Ciollo, C., Hrast Essenfelder, A., Maetens, W., Magni, D., Masante, D., Mazzeschi, M., Niemeyer, S., Spinoni, J., *Drought in Europe August 2022*, Publications Office of the European Union, Luxembourg, 2022, doi:10.2760/264241, JRC130493.

Joint Research Centre

GDO Analytical Report

Drought in Europe - August 2022

JRC Global Drought Observatory (GDO) of the Copernicus Emergency Management Service (CEMS) - 22/08/2022

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Executive summary

- The severe drought affecting many regions of Europe since the beginning of the year has been further expanding and worsening as of early August. Dry conditions are related to a wide and persistent lack of precipitation combined with a sequence of heatwaves from May onwards.
- The severe precipitation deficit has affected river discharges widely across Europe.
- Reduced stored water volume has had severe impacts on the energy sector for both hydropower generation and cooling systems of other power plants.
- Water and heat stresses have substantially reduced summer crops' yields. The most affected crops are grain maize, soybeans, and sunflowers.
- Recent precipitation (mid-August) may have alleviated drought conditions in some regions of Europe. However, in some areas, associated thunderstorms caused damages, losses, and may have limited the beneficial effects of precipitation.
- Warmer and drier than usual conditions are likely to occur in the western Euro-Mediterranean region in the coming months till November 2022. In some areas of the Iberian Peninsula, warning drier than usual conditions are forecasted for the next three months.

Combined Drought Indicator (CDI)

The latest update of the CDI, including the first ten days of August 2022, points to 47% of Europe being in *warning* conditions and 17% in *alert* conditions (Fig. 1). Soil moisture and vegetation stress are both severely affected. Drought hazard has been increasing, especially in: Italy, Spain, Portugal, France, Germany, the Netherlands, Belgium, Luxembourg, Romania, Hungary, northern Serbia, Ukraine, Moldova, Ireland and United Kingdom. The rest of Europe, already affected by drought, maintains stable severely dry conditions. Local recovery is observed in southern Czech Republic, northern Austria, and limited areas of central France. Regions already affected by drought in spring 2022 (e.g., northern Italy, south-eastern France, some areas in Hungary and Romania), are the ones with the most worsening conditions.

Drought in Europe - August 2022

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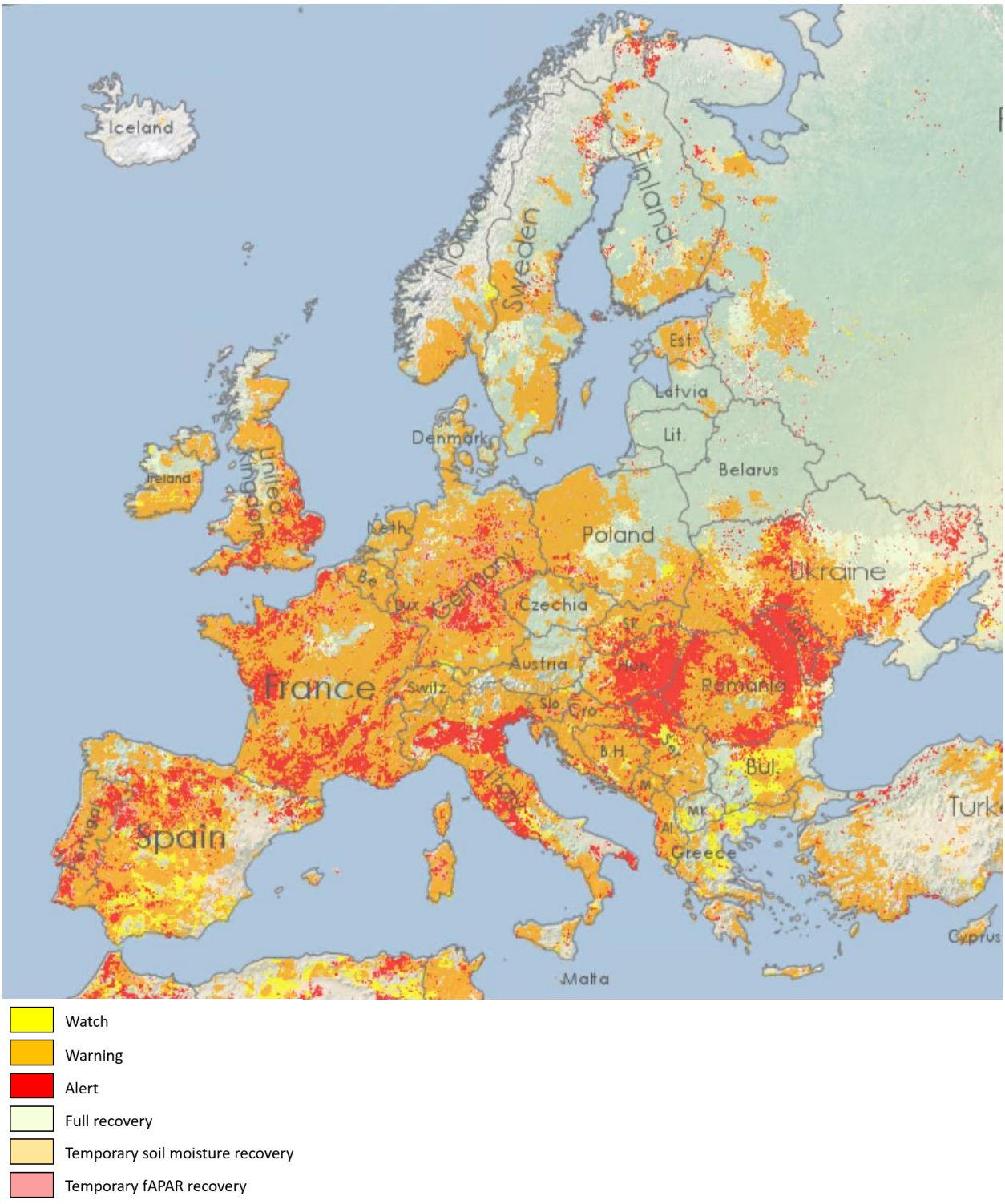

Figure 1: *Combined Drought Indicator (CDI v.2.1) – beginning of August 2022.*

Standardized Precipitation Index (SPI)

The regions most affected by the negative precipitation anomalies in the three months ending on the 10th of August 2022 are: central and southern Portugal; Spain; southern France; central Italy; Switzerland; southern Germany; a wide area across Ukraine, Slovakia, Hungary, Romania, Moldova; large areas in the western Balkans (SPI-3, Fig. 2)

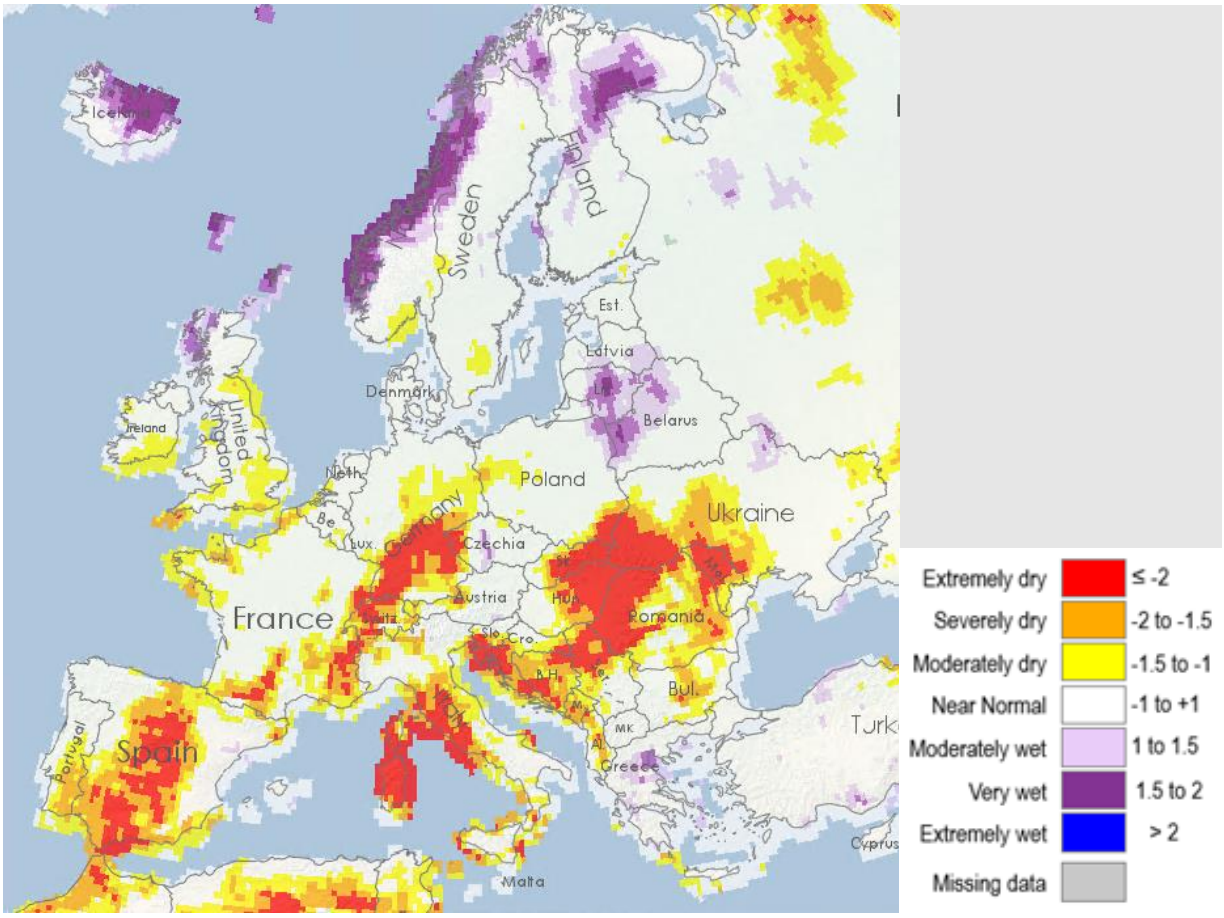

Figure 2: *Standardized Precipitation Index SPI-3, three months ending 10th of August 2022.*

By extending the analysis to the previous six months (February-July 2022), a severe-to-extreme broad meteorological drought emerges in: Italy, south-eastern and north-western France, eastern Germany, eastern Europe, southern Norway, and large part of the Balkans (SPI-6, Fig. 3). The yearly accumulated deficit (SPI-12, not shown) resembles quite closely the pattern identified by the SPI-6.

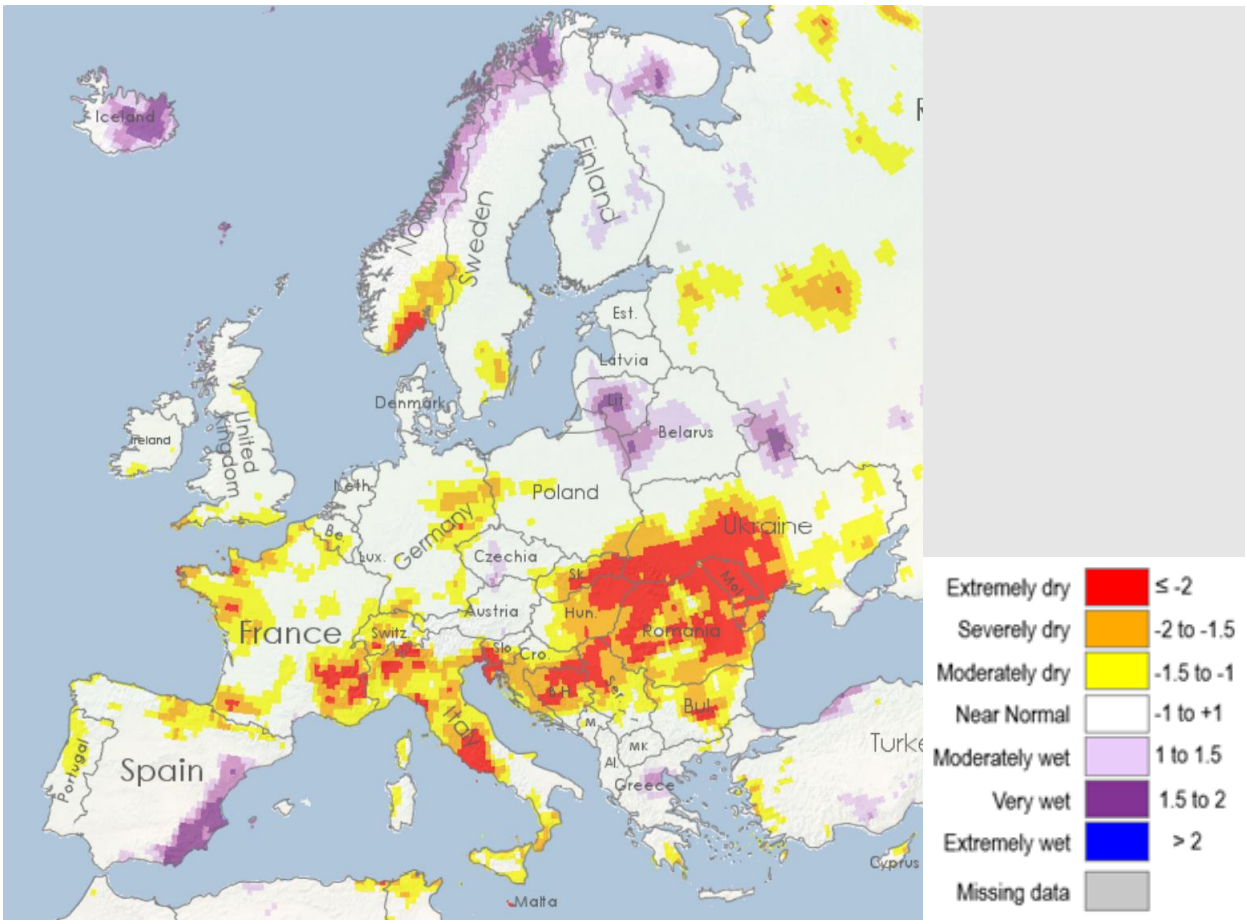

Figure 3: *Standardized Precipitation Index SPI-6, February-July 2022.*

Soil Moisture Anomaly

Soil moisture anomalies remain markedly negative in most of Europe (Fig. 4) due to the lack of precipitation and the heatwaves that occurred in the last months. Compared to June 2022, worsening conditions are estimated in France. Other relevant changes include the extension and intensification of negative anomalies over all the European countries. The southern part of Sweden is the only exception with some slight reduction of the negative anomaly.

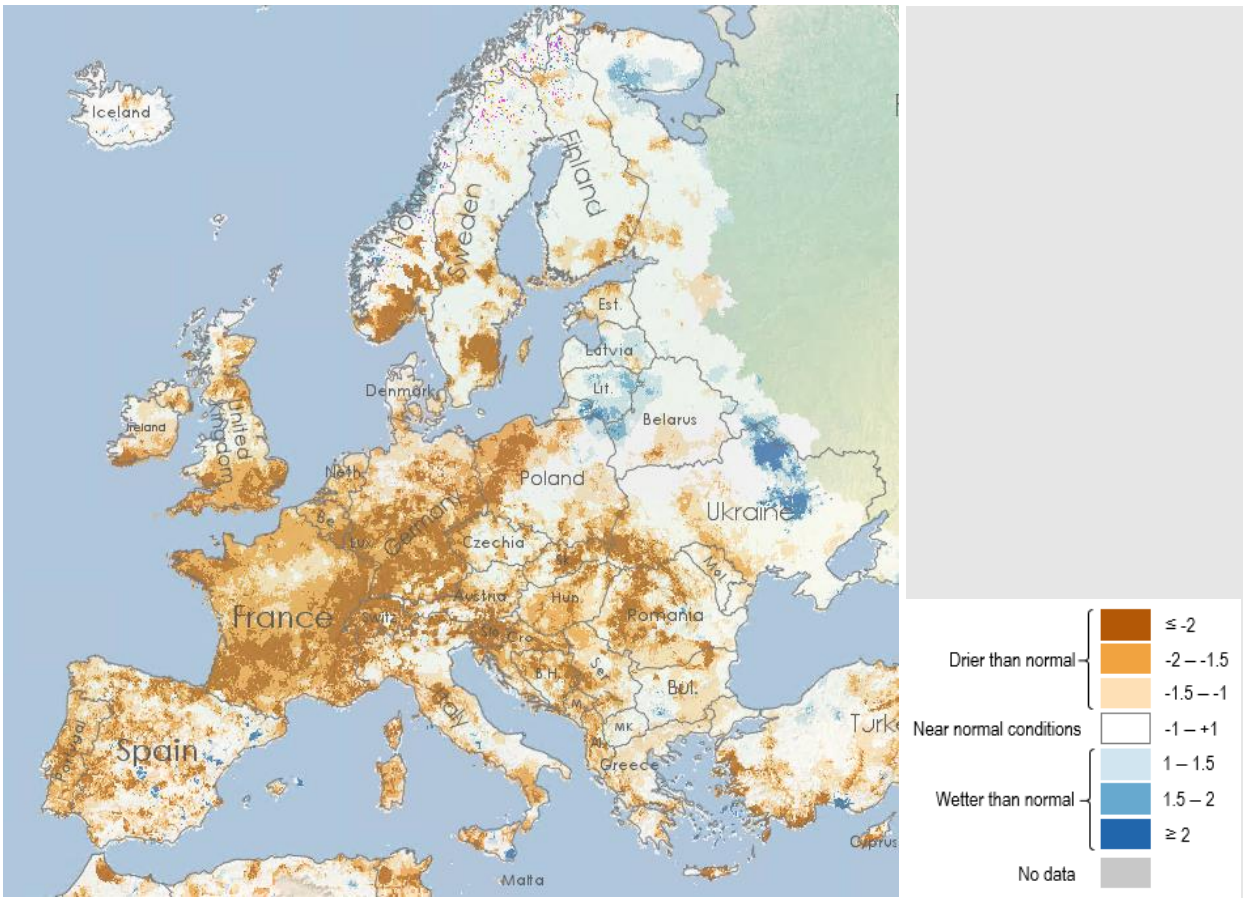

Figure 4: *Soil Moisture Anomaly – beginning of August 2022.*

FAPAR anomaly

One of the most relevant worsening effects, reflected also by the CDI, is the lowering of the FAPAR anomaly values compared to the long-term average. Some areas show more pronounced negative anomalies, highlighting a widespread stress on vegetation: Italian lowlands, Hungary, northern Serbia, and western and eastern Romania (Fig. 5). Elsewhere, conditions remain mostly stable.

Along the Alps, the June positive anomaly has been drastically reduced but it is still positive. As already discussed, this signal may be caused by an early start of the growing season and by an accelerated snow-melting due to early heatwaves.

Overall, comparing the current situation with the one at the end of June, July has shown a generalized decrease in photosynthetic activity compared to the seasonal norm. The most

affected regions in terms of worsening of vegetation conditions are: central-southern UK, eastern Ireland, Germany, northern and central Italy, Hungary, Romania, Moldova, Ukraine, Finland, and north-western Russia. Slight improvements are visible only in north-eastern France, Switzerland, and a few spots in the Iberian Peninsula.

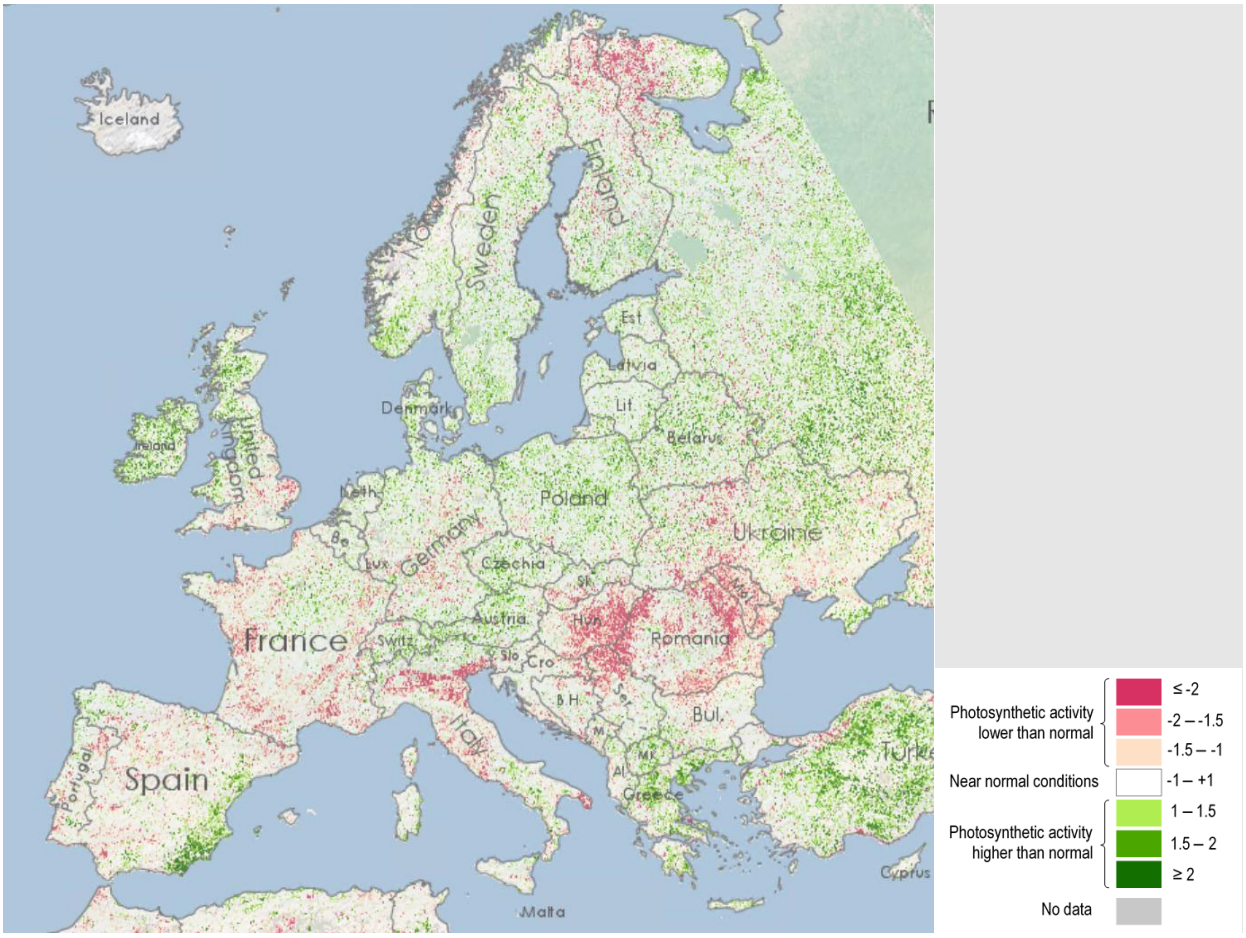

Figure 5: *fAPAR anomaly - beginning of August 2022.*

Low-Flow Index

At the beginning of August 2022, the Low-Flow Index (LFI; Fig. 6) shows lower values mainly in eastern Europe, northern Italy, southern and Eastern France, and Germany. However, rivers across all the other countries have been also experiencing low flows in some sections.

The Rhine river, as shown by both the LFI and the measured data, is affected by moderate to severe low flow levels (Fig. 6). Measured data are provided by the International Commission for

the Protection of the Rhine (ICPR)[1] and in the northern part of the river denote very rare to extremely rare low flow levels. The Rhine basin has been affected by a severely dry winter in the Alps with scarce snow accumulation[2], followed by a dry spring and summer with below average precipitation and above average temperature. Consequently, the Rhine river discharge has been shrinking, causing multi-sectorial impacts and concerns for the incoming months over central Europe. Critical conditions and warnings have been reported for the Netherlands, with impacts on water distribution systems, dike stability and commercial navigation.[3]

[1] Ihttps://www.iksr.org/en/

[2] See also https://edo.jrc.ec.europa.eu/documents/news/GDO-EDODroughtNews202203_Northern_Italy.pdf

[3] See also https://edo.jrc.ec.europa.eu/documents/news/GDO-EDODroughtNews202208_Netherlands.pdf

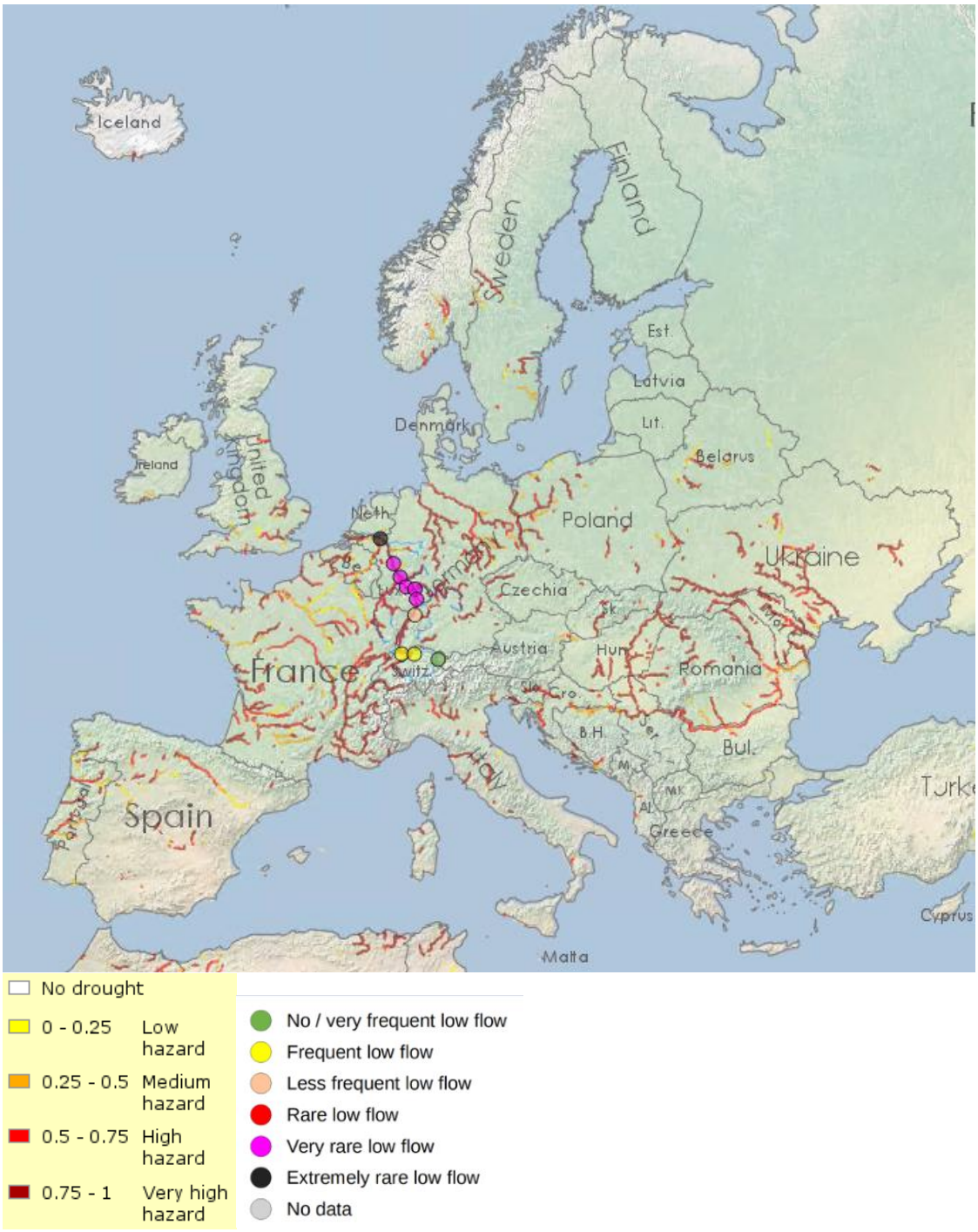

Figure 6: *Low-Flow Index (LFI) at the beginning of August 2022. A Low-Flow Index of 0 corresponds to no drought and a value of 1 to the highest drought hazard.*

Heatwaves

Hot temperatures increase evapotranspiration and trigger higher water demand, thus contribute substantially to enhance drought severity.

The Iberian Peninsula experienced a prolonged heatwave in the first half of July 2022 (Fig. 7, top-left), dragging temperatures above the long-term average for the same month. Later on, the heatwave shifted to south-eastern France and north-western and central-western Italy (Fig. 7, top-right). At the beginning of August a wide area crossing France, Germany, Switzerland, northern Italy and western Poland has been also affected by a short period of very hot days (Fig. 7, bottom-left).

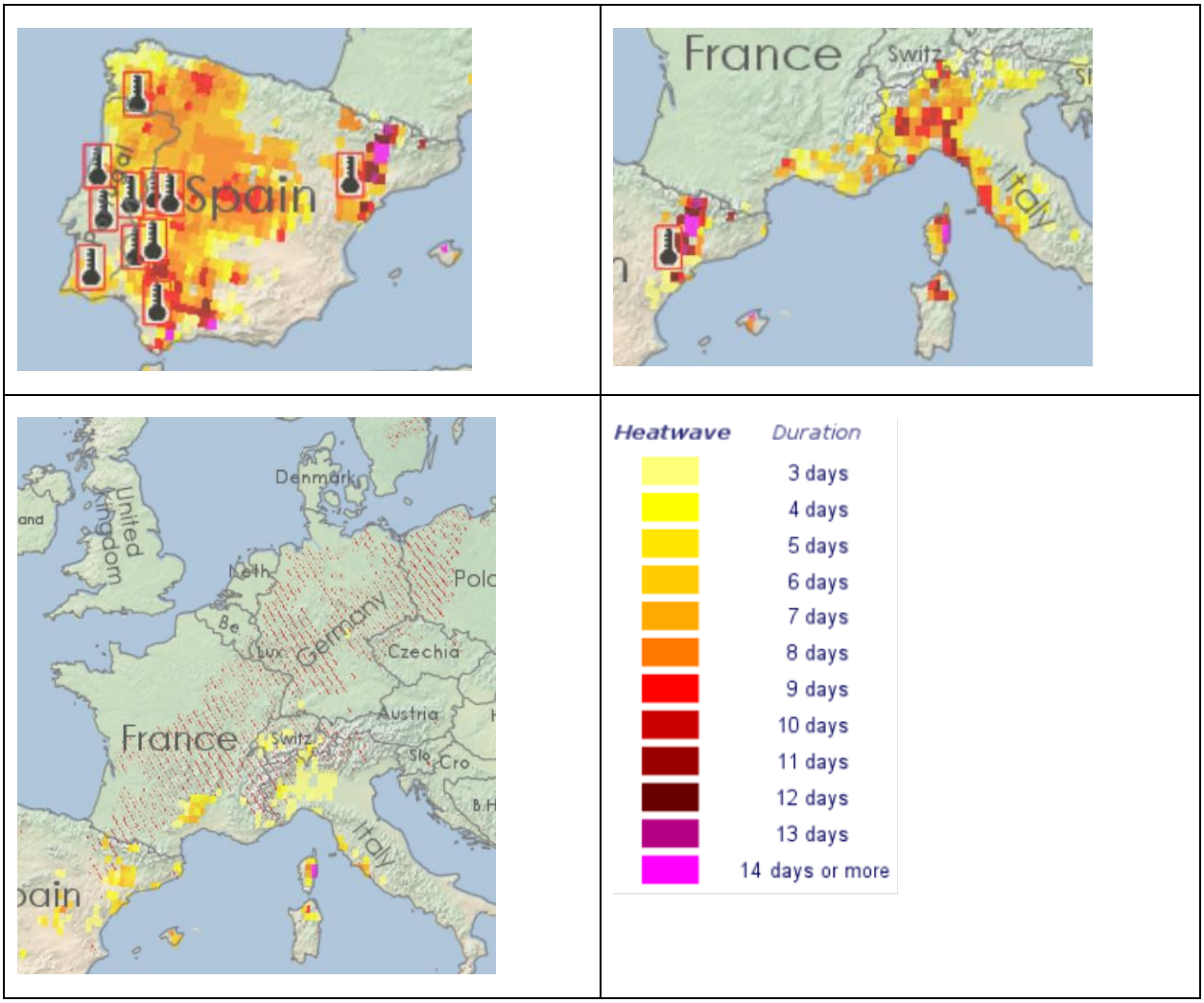

Figure 7: *Duration (days) of the identified heatwaves. Yellow to purple colours represent increasing duration (days), dashed lines show hot days (less than 3). Top-left panel: July 14th. Top-right panel: July 22nd. Bottom-left panel: August 4th.*

Large-scale atmospheric conditions

The general atmospheric circulation pattern in the late spring/early summer[4] has persisted further into the summer. High mid-tropospheric pressure anomalies over most of the European continent have been observed during the period May-July (Fig. 8). These circulation patterns are typically associated to both heat waves and drought during the summer months in Europe, as they tend to steer away from the continent weather systems that bring moist and cool air.[5] In fact, positive geopotential height anomalies in May, June and July 2022 (Fig. 8) in Europe rank highest or among the highest for those months since 1950 in large portions of the continent, particularly in western, southern and central Europe. The persistent series of heat waves recorded in several parts of Europe since May are likely driven by these exceptional atmospheric circulation conditions which persist into the beginning of August 2022 (not shown), additionally enhanced by the pre-existing drought and feeding back on it. The May-July mean pattern (Fig. 8), reveals that geopotential heights had the highest values since 1950 in most of Europe (except Fennoscandia and parts of East Europe).

[4] See also: https://edo.jrc.ec.europa.eu/documents/news/GDO-EDODroughtNews202207_Europe.pdf

[5] References: Yiou, Pascal, et al. "Analyses of the Northern European summer heatwave of 2018." *Bulletin of the American Meteorological Society* 101.1 (2020): S35-S40. Stefanon, Marc, Fabio D'Andrea, and Philippe Drobinski. "Heatwave classification over Europe and the Mediterranean region." *Environmental Research Letters* 7.1 (2012): 014023.

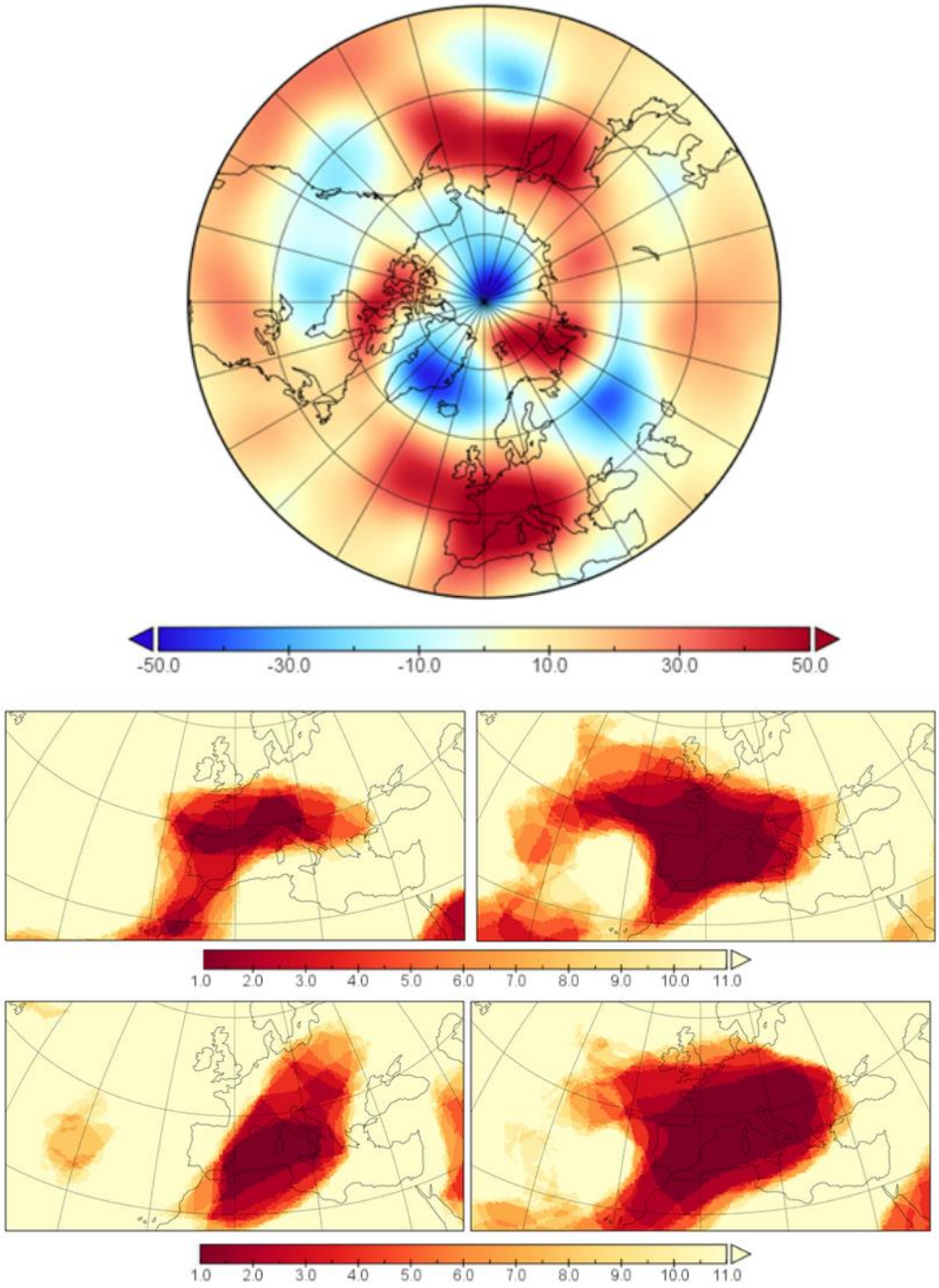

Figure 8: May - July 2022 large-scale atmospheric conditions. Top panel: mean anomalies of geopotential height at 500 hPa (gpm) from the ECMWF ERA5 reanalysis during the entire period. The reference climatology is 1991-2020. Bottom panel: ranking of the mean 2022 geopotential height anomalies at 500 hPa in May (upper left), June (bottom left), July (upper right) and May-July (bottom right). A value of one means that the average geopotential height for a given period of 2022 is the highest since 1950.

Rainfall 11-17 August

All the previous sections are based on the available data up to the 10th of August 2022. However, in the period 11-17 August 2022, precipitation events finally occurred in many areas of Europe (Fig. 9). These events may help alleviating the drought conditions. However, in some areas the observed severe-to-extreme thunderstorms may have limited the beneficial effects. Additional challenges, damages and losses were reported due to these extreme events.

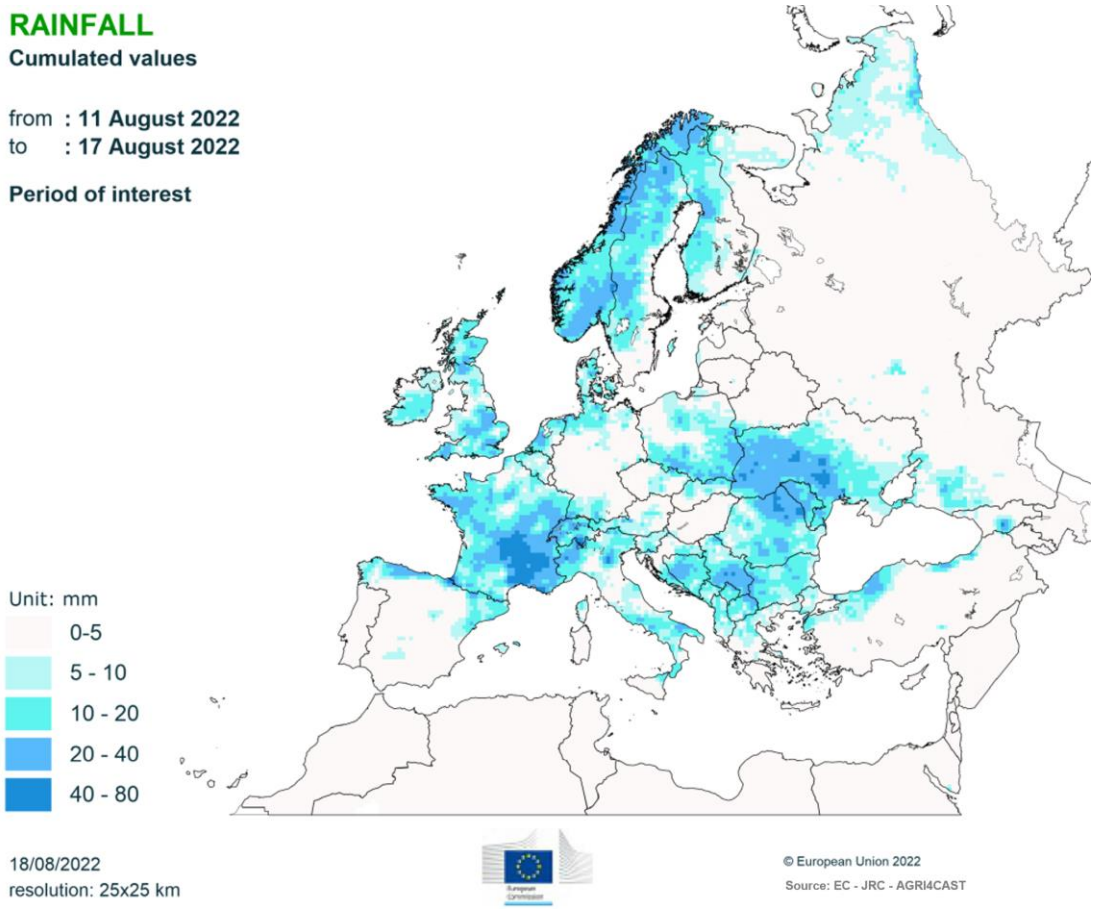

Figure 9: Total precipitation from the 11th to the 17th of August 2022. Gridded observational data from JRC (MARSMet)[6],

[6] https://agri4cast.jrc.ec.europa.eu/DataPortal

Seasonal forecast

For most of Europe, after a long sequence of unusually dry forecasts, close to normal conditions are predicted from August to October 2022 (Fig. 10). This may not be enough to fully recover from the deficit cumulated in more than half a year, but it will alleviate the critical conditions of many European regions and of the affected sectors. Severely drier than normal weather conditions are predicted only over western Spain, eastern Portugal, and along the Croatian coast. Less severe dry conditions are forecasted over the Alps.

In the western Euro-Mediterranean region, some risks may persist. Seasonal forecasts of mean temperature and precipitation up to November 2022 from the ECMWF SEAS5 and the other modelling centres[7] point to likely to occur warmer- and drier-than usual conditions in the western Euro-Mediterranean region.

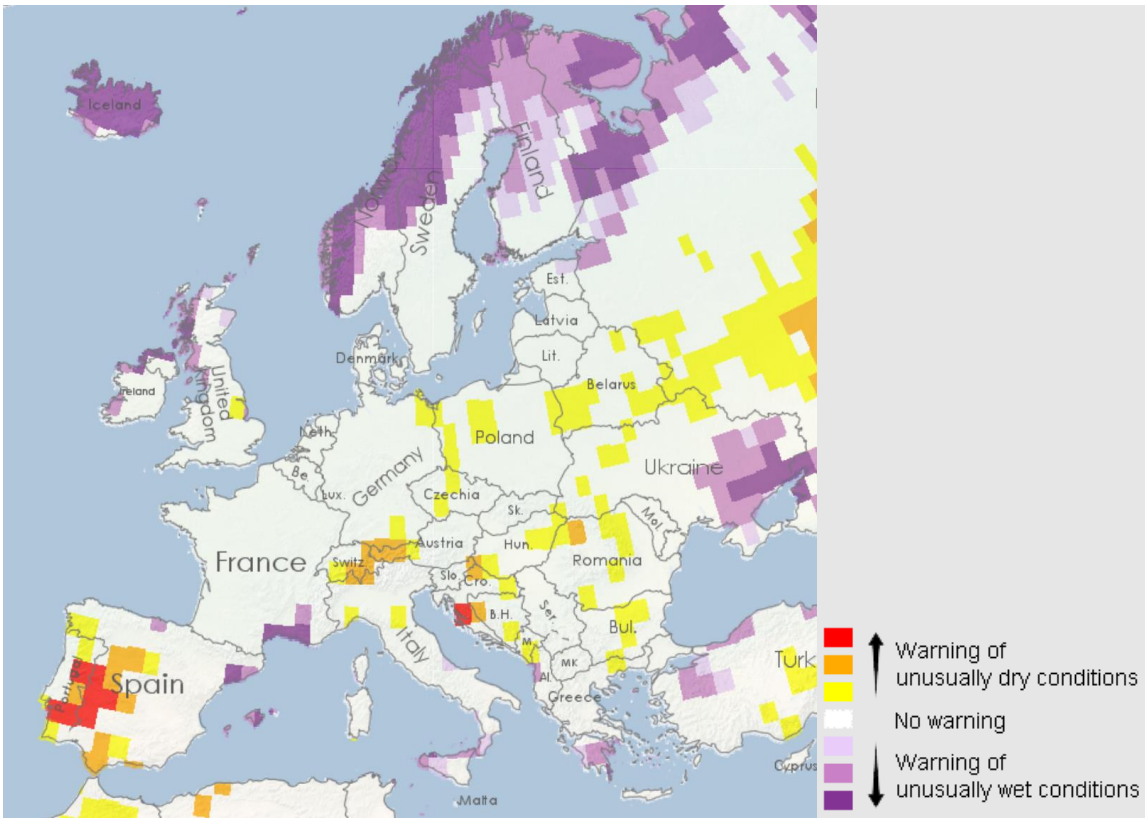

Figure 10: *Indicator for forecasting unusually wet and dry conditions from August to October 2022 (based on ECMWF SEAS5).*

[7] https://climate.copernicus.eu/seasonal-forecasts

Reported impacts

According to the August 2022 edition of the JRC MARS Bulletin on Crop Monitoring in Europe[8], the exceptional water stress and heat stress have substantially reduced yields of the main crops. The EU yield forecasts for grain maize, soybean, and sunflowers are the most affected, with reductions (with respect to the last 5 years average) estimated to be, respectively: -16%, -15%, -12%.

In Italy, the Po river Basin Authority confirmed the current classification at the highest level of drought severity[9]. Recent precipitation granted a slight improvement of the hydrological conditions of the Po river and for the first time from the beginning of this summer discharges raised around the historical minimal values and the inland salt intrusion from the Po delta has decreased. Water resource management is still critical and difficult to balance among different usages and demands, but at least a couple of thermo-electric power plants have partially resumed operations[10]. Hydro power energy potential stored in water reserves in the north is still slowly decreasing and remains less than half of the observed amount in the last few years[11].

In France, more than 100 municipalities have water supply issues and drinking water is delivered by truck. 66 French departments are at the highest drought warning level of "crisis" with at least 93 departments at one of the top three levels of warning for drought.[12] Severe impacts are also related to wildfire and according to the European Forest Fire Information System[13], more than 60,000 hectares of land have burned since the beginning of 2022, already more than double of 2021 and about 4.6 times the average of the last ten years (2012 – 2021). Nuclear operator EDF at the beginning of August reduced its power output at a plant in south-western France due to high river temperatures on the Garonne, and it has issued rolling warnings for reactors along the Rhone river.[14]

[8] https://publications.jrc.ec.europa.eu/repository/search?query=mars+bulletins&filter=YEAR%3A2022
[9] https://www.adbpo.it/osservatorio-permanente/ https://www.adbpo.it/emergenza-siccita-distretto-del-po-portate-ancora-molto-basse-prelievo-non-ridotto-cuneo-salino-a-quota-record-306-km-e-assenza-di-piogge-con-temperature-altissime/
[10] https://www.adbpo.it/siccita-fiume-po-per-la-prima-volta-da-inizio-estate-le-portate-tornano-ai-livelli-minimi/
[11] https://transparency.entsoe.eu/generation/r2/waterReservoirsAndHydroStoragePlants/show
[12] https://www.euronews.com/my-europe/2022/08/05/more-than-100-french-towns-without-drinking-water-amid-historic-drought
[13] https://effis.jrc.ec.europa.eu/
[14] https://www.reuters.com/world/europe/temperatures-rise-france-tackles-its-worst-drought-record-2022-08-07/

In the Netherlands severe impacts related to Rhine low flows are affecting commercial navigation, dike stability, water distribution and sea water intrusion issues.[15] Reduction of ships load is affecting coal and oil transport[16].

In Spain, water stored in reservoirs is at around 58% the 10-year mean for the period, while some southern regions (e.g. Andalucía and Extremadura) are estimated to be around 30% the 10-year mean levels[17]. Conditions are also extremely favourable for wildfires, as confirmed by EFFIS[20].

In Portugal, hydroelectric energy stored in water reservoirs is less than half the average of the previous five years[18]. The status of water storage for irrigation is worsening and all reservoirs decreased. In most cases water storage is expected to be sufficient to complete the irrigation cycle for crops, but about 25% of reservoirs are under significant deficit and may not fulfil the irrigation needs.[19]. Hazard of forest fires is high-to-extreme over most of the country[20].

[15] See also: https://edo.jrc.ec.europa.eu/documents/news/GDO-EDODroughtNews202208_Netherlands.pdf

[16] https://www.spiegel.de/wirtschaft/unternehmen/rhein-niedrigwasser-behoerde-haelt-einstellung-des-schiffsverkehrs-fuer-unwahrscheinlich-a-46827655-4f52-4f2c-951a-a519a12421de

[17] https://www.embalses.net/
[18] https://transparency.entsoe.eu/generation/r2/waterReservoirsAndHydroStoragePlants/show
[19] https://sir.dgadr.gov.pt/reservas
[20] https://effis.jrc.ec.europa.eu/apps/effis_current_situation/

Appendix

The Combined Drought Indicator (CDI) of the European Drought Observatory (EDO) is used to identify areas that may be affected by agricultural drought. The CDI is derived by combining the Standardized Precipitation Index (SPI), the Soil Moisture Index Anomaly (SMA), and the FAPAR anomaly. Areas are classified according to three primary drought classes: (1) "Watch", indicating that precipitation is less than normal; (2) "Warning", indicating that also soil moisture is in deficit; and (3) "Alert", indicating that also vegetation shows signs of stress. Three additional classes – namely "Full Recovery", "Temporary Soil Moisture Recovery" and "Temporary fAPAR Recovery" – identify the stages of drought recovery processes in terms of its impacts on soil moisture and vegetation.

The Standardized Precipitation Index (SPI) provides information on the intensity and duration of the precipitation deficit (or surplus). SPI is used to monitor the occurrence of drought. The lower (i.e., more negative) the SPI, the more intense is the drought. SPI can be computed for different accumulation periods: the 3-month period is often used to evaluate agricultural drought and the 12-month period for hydrological drought, when rivers fall dry and groundwater tables lower.

Lack of precipitation induces a reduction of soil water content. The Soil Moisture Anomaly index provides an assessment of the deviations from normal conditions of root zone water content. It is a direct measure of drought associated with the difficulty of plants in extracting water from the soil.

The satellite-based fraction of Absorbed Photosynthetically Active Radiation (FAPAR) monitors the fraction of solar energy absorbed by leaves. It is a measure of vegetation health and growth. FAPAR anomalies, and specifically negative deviations from the long-term average, are associated with possible drought impacts on vegetation.

The Low-Flow Index (LFI) is based on the daily river water discharge simulated by the LISFLOOD hydrological model. It captures consecutive periods of unusually low streamflow. It compares the consequent water deficit during those periods with the historical climatological conditions.

The indicator for 'forecasting unusually wet and dry conditions' provides early risk information for Europe. The indicator is computed from forecasted SPI-1, SPI-3, and SPI-6 derived from the ECMWF seasonal forecast system SEAS5.

Glossary of terms and acronyms:

CEMS	Copernicus Emergency Management Service
EDO	European Drought Observatory
EC	European Commission
ECMWF	European Centre for Medium-Range Weather Forecasts
EFFIS	European Forest Fire Information System
ENTSO-E	European Network of Transmission System Operators for Electricity
ERA5	ECMWF Reanalysis v5
ERCC	European Emergency Response Coordination Centre
FAPAR	Fraction of Absorbed Photosynthetically Active Radiation
GDO	Global Drought Observatory
JRC	Joint Research Centre
LFI	Low-Flow Index
MARS	Monitoring Agricultural ResourceS
SMA	Soil Moisture Index (SMI) Anomaly
SMI	Soil Moisture Index
SPI	Standardized Precipitation Index
WMO	World Meteorological Organization

EDO indicators versioning:

The GDO/EDO indicators appear in this report with the following versions:

EDO Combined Drought Indicator, v.2.1.0
EDO FAPAR (fraction of Absorbed Photosynthetically Active Radiation) Anomaly, v.1.3.2
GDO Indicator for forecasting unusually wet and dry conditions v .1.0.0
EDO Low Flow Index (LFI), v.2.1.0
EDO Soil Moisture Anomaly (SMA) (version 2.1.1)
Standardized Precipitation Index SPI ERA5 (1/4-dd resolution)

Check https://edo.jrc.ec.europa.eu/download for more details on indicator versions.

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