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Drought in Europe April 2025

GDO Analytical Report

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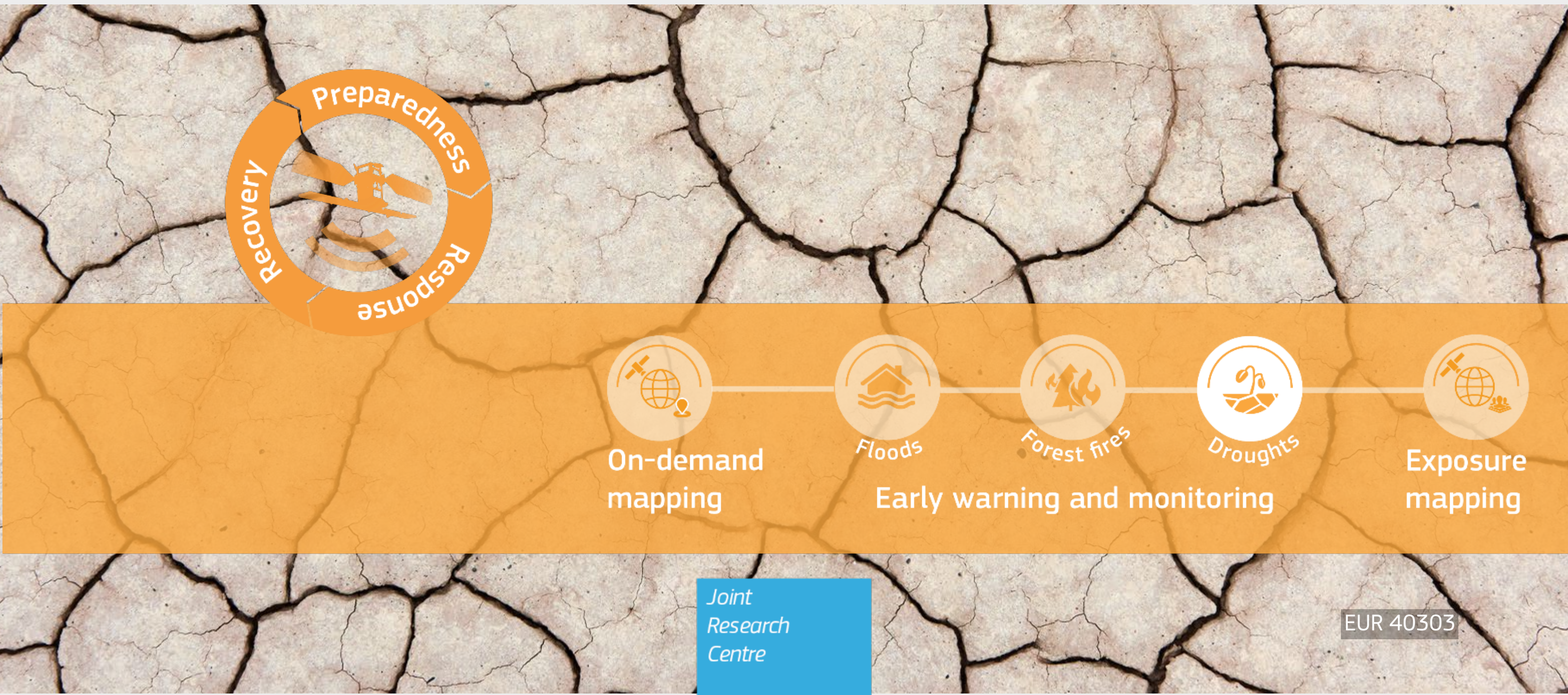
2025



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Drought in Europe - April 2024

JRC Global Drought Observatory (GDO) of the Copernicus Emergency Management Service (CEMS) – GDO/EDO data up to 10/04/2025

Drought in Europe - April 2025

JRC Global Drought Observatory (GDO) of the Copernicus Emergency Management Service (CEMS) – GDO/EDO data up to 10/04/2025

Abstract

- Drought conditions are affecting large parts of eastern and southern Europe, the Mediterranean region, and the Baltic countries. Northern Africa and the Middle East are severely affected too.

- Recent above-average temperatures in Scandinavia, the Baltic countries, the Alps, the eastern Mediterranean and the whole eastern Europe exacerbated the effect of the prolonged lack of precipitation.

- Low flows are affecting rivers mostly in eastern Europe, in the Baltic Sea region, in northern Germany, Benelux, and in Türkiye. The most recent observed data for the Rhine River show an initial critical stage for inland navigation.

- Impacts on vegetation are most likely to emerge in the coming months if these conditions will persist. The current positive anomaly may depend on an anticipated growth triggered by higher-than-average temperatures. The already affected areas are mostly in the Mediterranean region.

- Seasonal forecasts point to a warmer than average and dry north (wet south) in spring/early summer 2025, despite large uncertainty in the precipitation forecasts.

Introduction

This study is part of the collection *GDO analytical reports* focused on the analysis of drought events affecting Europe as well as the other regions of the world. These studies build on data and information retrieved and processed within the European and Global Drought Observatories (EDO and GDO) of the Copernicus Emergency Management Service (CEMS). The Observatories aim at detecting, monitoring, and predicting droughts by using a suite of indices and indicators characterising different aspects and phases of a drought. The information is usually complemented with additional sections on impacts, large-scale circulation, and other relevant factors.

Combined Drought Indicator (CDI)

By late March, drought conditions are gradually deteriorating across eastern, south-eastern, and central Europe, with the Mediterranean and the Middle East continuing to experience severe and prolonged drought in large areas. In the Iberian Peninsula, intense winter and spring rainfall led to extreme impacts and vegetation damages in some parts of the south-eastern region.

According to the Combined Drought Indicator (CDI) [1] for late March 2025 (Fig. 1), central, eastern, and south-eastern Europe as well as the eastern Mediterranean region are experiencing broadening warning drought conditions. Similar conditions are also estimated over scattered areas in southern Italy, and emerging in north-western Europe (Sweden, Ireland, the UK). Alert drought conditions are already estimated in the Mediterranean region, e.g. in most of North Africa, Cyprus, central and south-eastern Türkiye, and the Middle East.

[1] For more details on the CDI, and the other GDO and EDO indicators of drought-related information used in the report, see the Appendix at the end of the document.

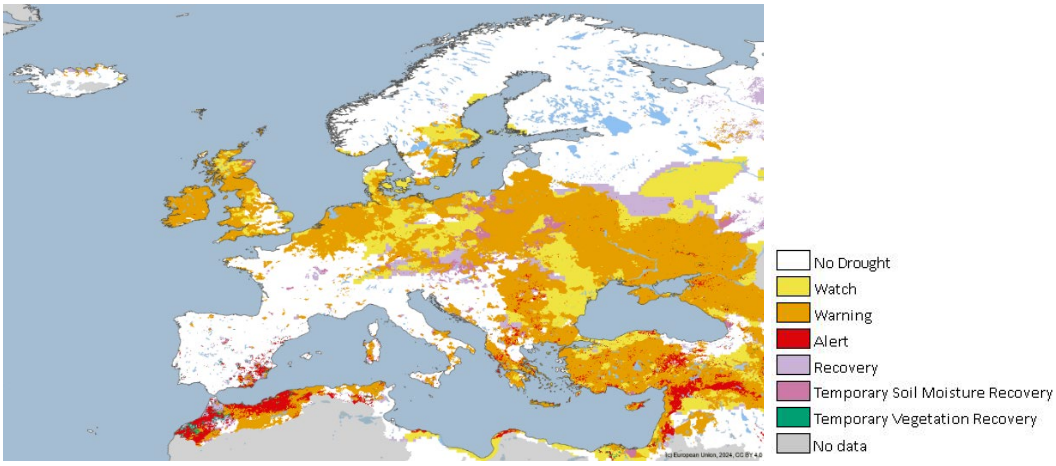

Figure 1: *The Combined Drought Indicator (CDI), based on a combination of indicators of precipitation, soil moisture, and vegetation conditions, for late March 2025.*[1]

Standardized Precipitation Index (SPI)

In late March 2025, SPI-3 (i.e. SPI computed for an accumulation period of 3 months)[2] shows wetter than normal conditions mainly over the Iberian Peninsula and in some limited areas of France and Italy. Dry anomalies are detected in most of the eastern Mediterranean region, eastern Europe, south-western Russia, the northern side of the Alps, some regions in Germany, Benelux, Denmark, and the northern UK and Ireland. (Fig. 2).

At the same time SPI-1 (i.e. SPI computed for an accumulation period of 1 month)[2] shows very dry anomalies in the last month accumulated in northern Germany, Benelux, Denmark, southern Scandinavia, most of the UK and Ireland, central-western and eastern Türkiye, and southern Ukraine (Fig. 3). This pattern, also considering the previous three months, points to a potential critical evolution in terms of drought risks for the coming months.

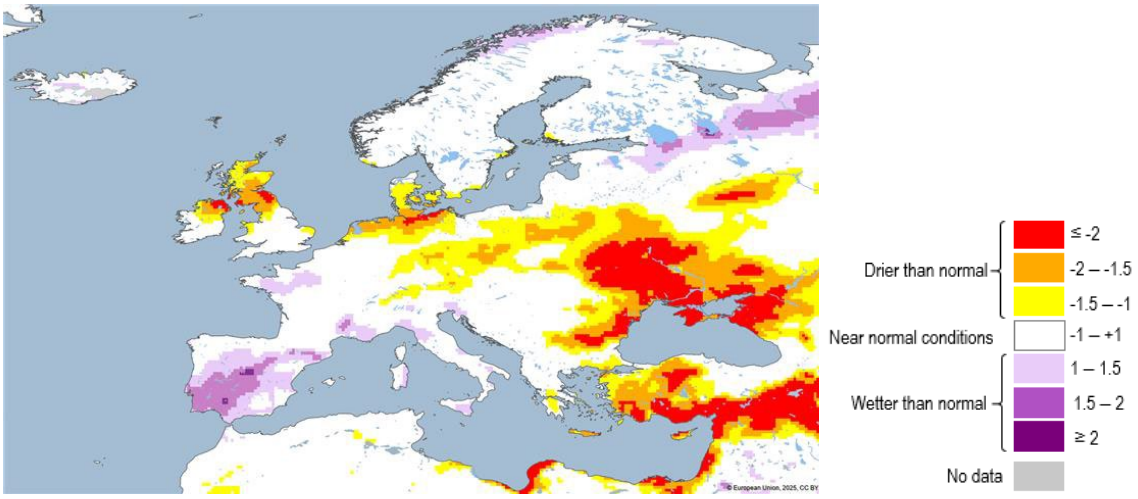

Figure 2: *Standardized Precipitation Index (SPI-3), for the 3-month accumulation period ending in late March 2025.*[2]

[2] For more details on the SPI, and the other GDO and EDO indicators of drought-related information used in this report, see the Appendix at the end of the document.

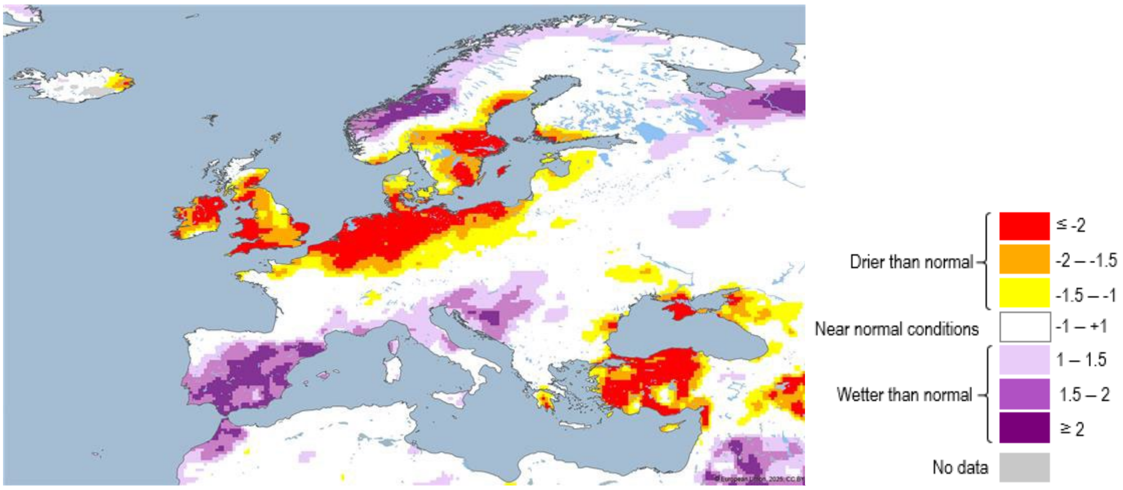

Figure 3: *Standardized Precipitation Index (SPI-3) for the 1-month accumulation period for late March 2025.*[2]

Temperature

In January-March 2025, most of Europe experienced above-average temperatures. Positive temperature anomalies affected mostly the Alps, northern Scandinavia, eastern and south-eastern Europe with anomalies above 3 °C. In western Russia, temperature anomaly peaks above 5 °C were observed. The rest of Europe was experiencing positive anomalies mostly comprised between 1 °C and 2 °C. Only north-eastern France, the central and southern UK, and Ireland experienced close to average temperatures (Fig. 4).

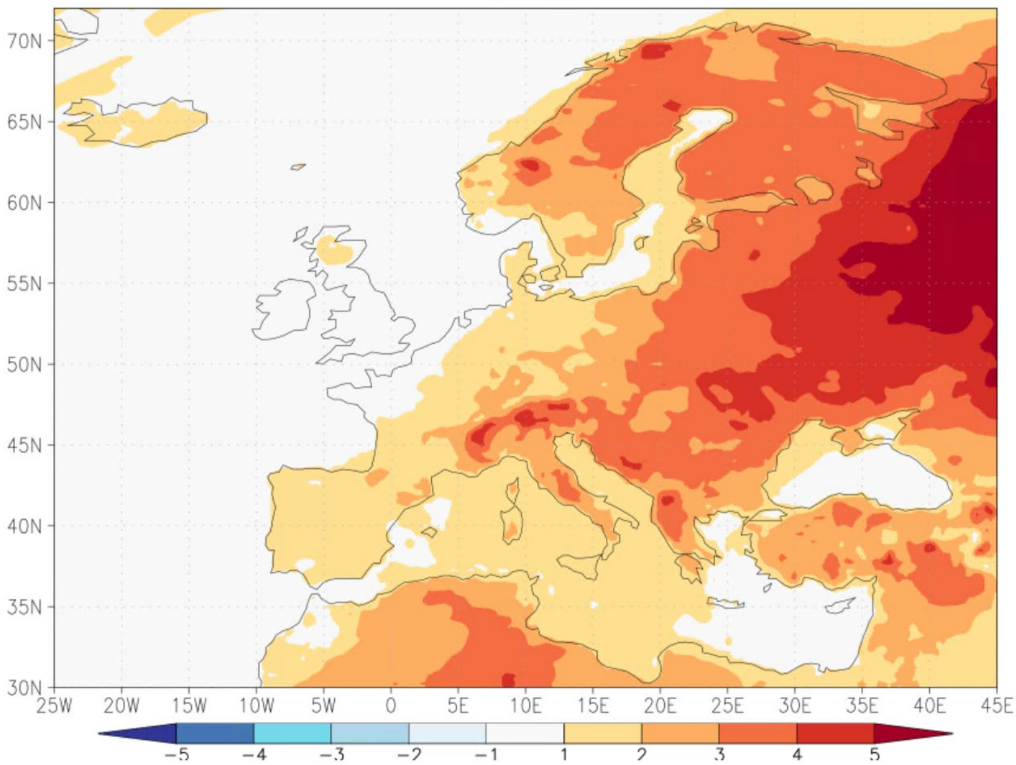

Figure 4: *Average temperature anomalies (ERA5, baseline 1991-2020) for January-March 2025. Source: The KNMI Climate Explorer.*[3]

[3] The KNMI Climate Explorer: https://climexp.knmi.nl

Drought in Europe - April 2025

JRC Global Drought Observatory (GDO) of the Copernicus Emergency Management Service (CEMS) – GDO/EDO data up to 10/04/2025

Soil moisture

In late March 2025, the Soil Moisture Index Anomaly[4] shows negative anomalies over most of the eastern Mediterranean region and northern Africa pointing to drier than usual soil conditions (Fig. 5). These conditions are mainly due to a combination of low precipitation and high temperatures. This pattern is consistent with the one of the precipitation deficit accumulated in the previous months, as shown by the SPI-3 and SPI-1 maps (see Figs. 2 and 3). Some of the regions with the strongest negative precipitation anomalies were also affected by higher temperatures, which accelerated water loss from the soil due to increased evapotranspiration. Some areas show a Soil Moisture Anomaly below -2, corresponding to a very strong negative anomaly and being the driest class for this indicator.

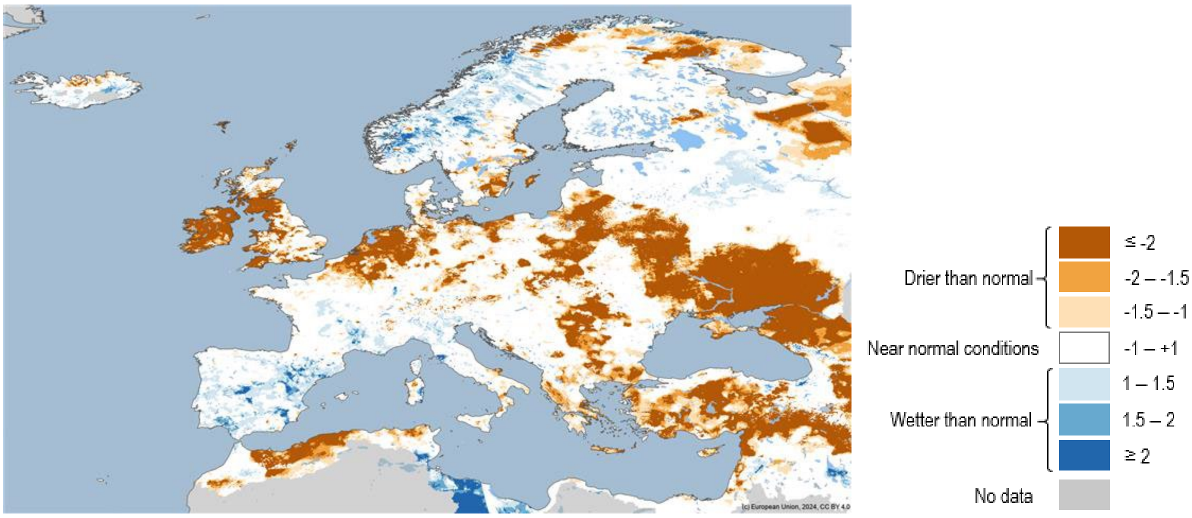

Figure 5: *Soil Moisture Index Anomaly for late March 2025.*[4]

Hydrology

In early April 2025, the Low-Flow Index (LFI)[5] highlights critical hydrological drought hazard conditions mainly in eastern France, Germany, south-eastern Baltic Sea regions, the western Alps, and in large areas of eastern Europe (especially in Poland), eastern Mediterranean region, and western Russia. Similar conditions affect, locally, some areas of southern Scandinavia, the UK, and Ireland (Fig. 6). The flow reduction clearly correlates with the lack of precipitation over the last months, as shown by the SPI-3 and the SPI-1 (Figs. 2 and 3). It is worth to note the fast change in river flow conditions with respect to the previous 10-day period (late March 2025, Fig. 7). While in Türkiye there has been a decrease in the hazard, a fast worsening of low-flow conditions has emerged in Germany, Poland and the southern Baltic Sea region. In particular, it is noticeable the change from almost no hazard in late March 2025 (Fig. 6) to high hazard in early April 2025 (Fig. 7) along almost the whole Rhine River.

[4] For more details on the Soil Moisture Anomaly indicator, and the other GDO and EDO indicators of drought-related information used in this report, see the Appendix at the end of the document.

[5] For more details on the Low-Flow Index (LFI), and the other GDO and EDO indicators of drought-related information used in the report, see the Appendix at the end of the document.

Drought in Europe – April 2025

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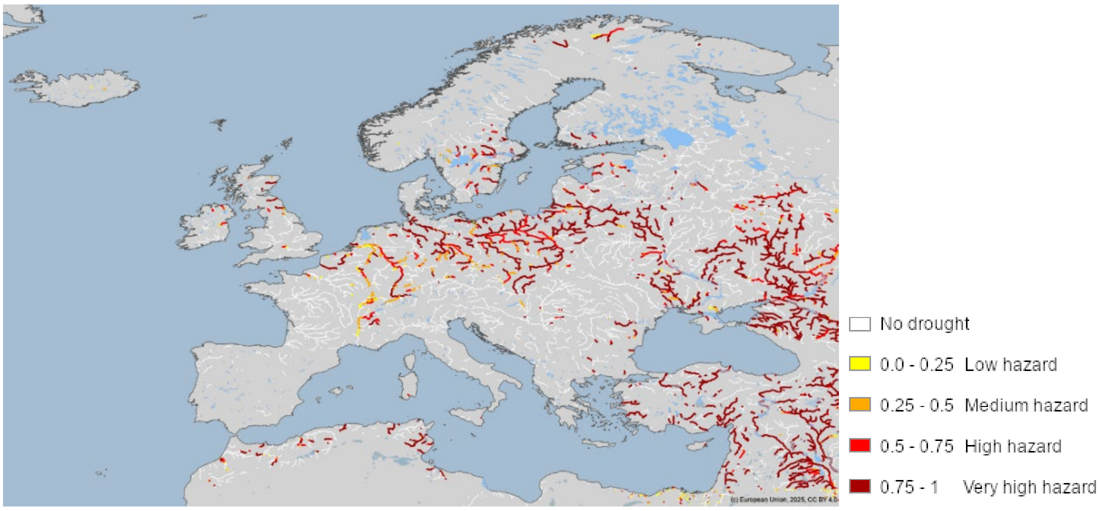

Figure 6: *Low-Flow Index (LFI) for early April 2025. LFI ranges from 0 (no drought) to 1 (very high drought hazard).*[5]

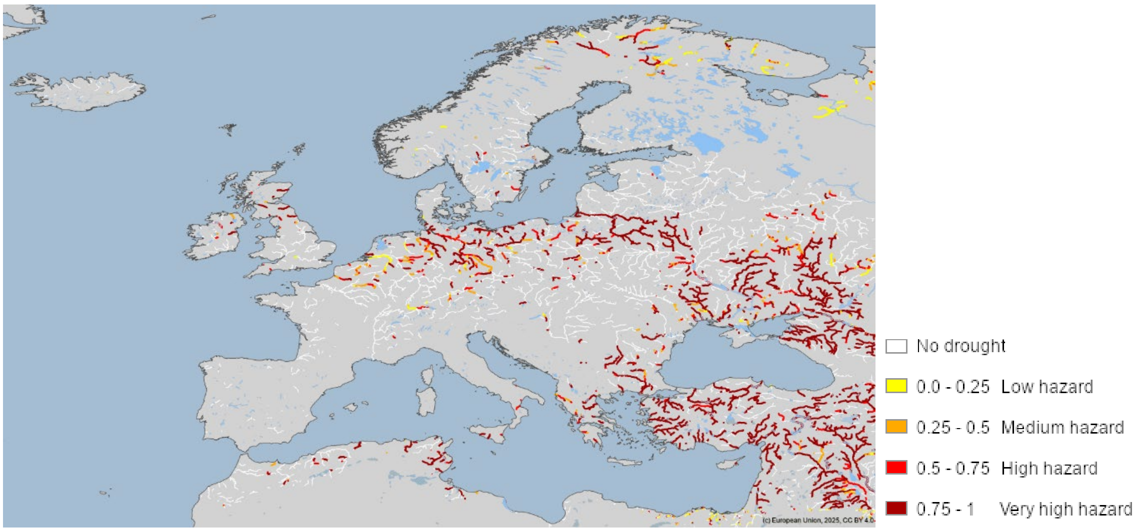

Figure 7: *Low-Flow Index (LFI) for late March 2025. LFI ranges from 0 (no drought) to 1 (very high drought hazard).*[5]

The Rhine River, as shown by both the LFI and the observed river discharge data, is affected by moderate low-flow levels (Fig. 8). Observed data, provided by the International Commission for the Protection of the Rhine (ICPR), in the upstream river denote frequent low flow levels. As the Rhine basin has been affected by a severely dry initial part of spring and a moderate dry winter, discharge has been shrinking causing multi-sectorial impacts and concerns for the months ahead. Critical conditions and warnings have been already reported for commercial navigation in the Middle Rhine.

Drought in Europe - April 2025

JRC Global Drought Observatory (GDO) of the Copernicus Emergency Management Service (CEMS) – GDO/EDO data up to 10/04/2025

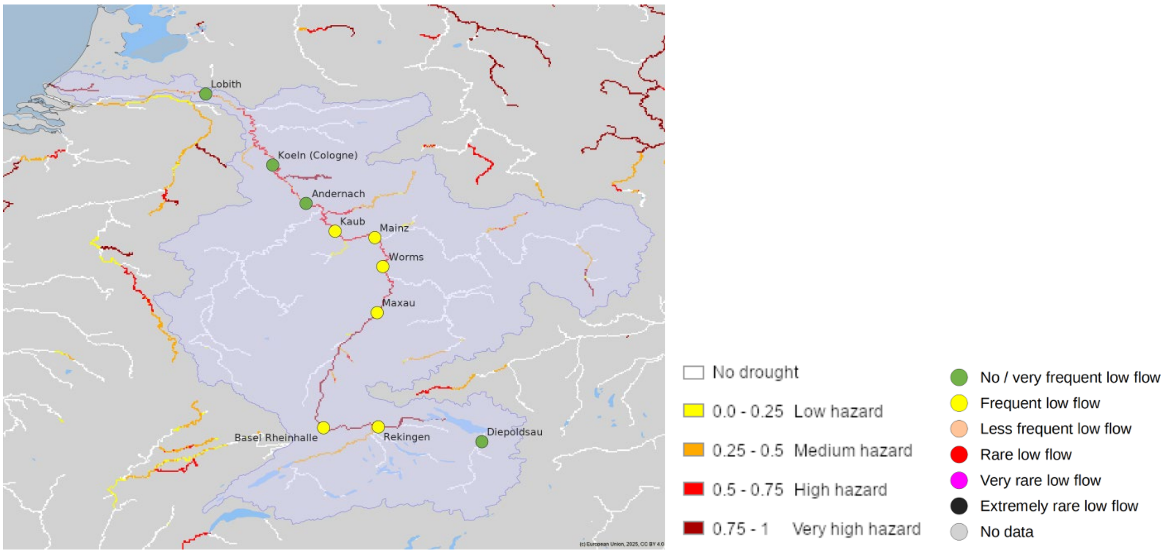

Figure 8: *Low-Flow Index (LFI) at early April 2025 compared to low flow assessment based on ICPR observed data. A Low-Flow Index of 0 corresponds to no drought and a value of 1 to the highest drought hazard level.*

In the Copernicus Sentinel-2 images acquired on 6 April 2024 and 11 April 2025 (Fig. 9), the difference in the Rhine River near Cologne is visible. The 2025 image shows an increase in exposed sandbanks along the river due to its lower water level.

Figure 9: *Signs of drought of Rhine River near Cologne. European Union, Copernicus Sentinel-2 imagery.*

Vegetation

In late March 2025, the satellite-derived fAPAR (fraction of Photosynthetically Active Radiation) anomaly indicator[6] shows vegetation stress mainly over northern Africa, western Syria and south-eastern Türkiye (Fig. 10). Most of Europe still shows good vegetation conditions. These positive fAPAR anomalies may reflect an anticipated vegetation development and may result later in critical impacts for crops and vegetation depending on the evolution of the drought.

Dedicated information on the agricultural yield forecast for Europe are provided in the JRC MARS (Monitoring Agricultural ResourceS) Bulletins[7].

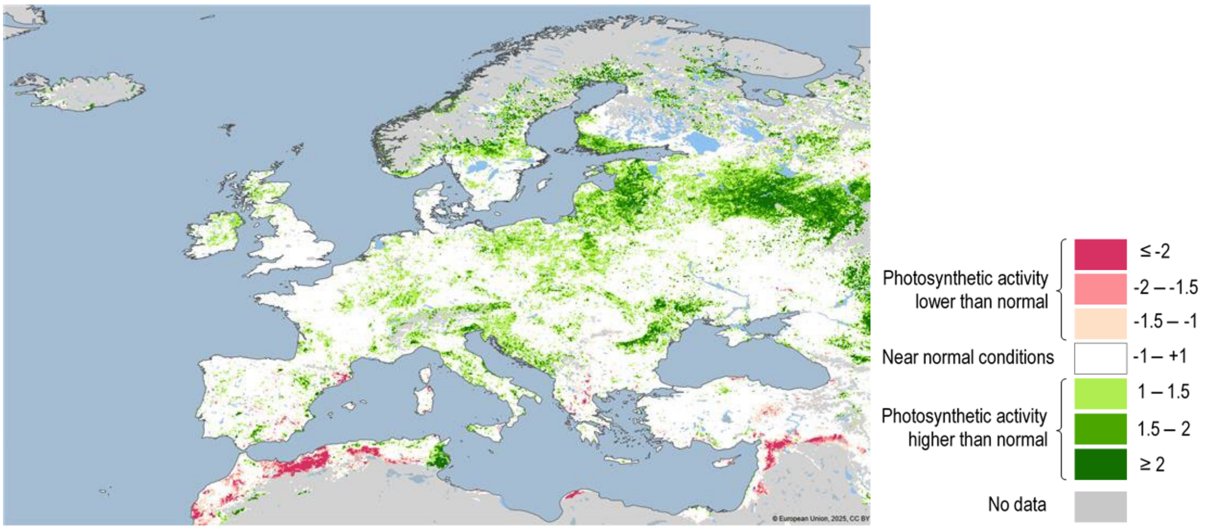

***Figure* 10:** *Satellite-derived* fAPAR *anomaly indicator (measuring photosynthetic activity of vegetation), for late March 2025.*[6]

Seasonal forecast

Multi-system forecasts for the coming months, from April to June 2025 (Fig. 11), highlight drier than normal conditions over the UK, Ireland, northern France, Benelux, northern Germany, Denmark, southern Scandinavia, and the whole Baltic Sea region. Wetter than average conditions are predicted in the Iberian Peninsula, central Italy, the eastern Alps, and Greece.

[6] For more details on the satellite-derived Fraction of Absorbed Photosynthetically Active Radiation (fAPAR) anomaly indicator, and the other GDO and EDO indicators of drought-related information used in the report, see the Appendix at the end of the document.
[7] https://joint-research-centre.ec.europa.eu/monitoring-agricultural-resources-mars/jrc-mars-bulletin_en

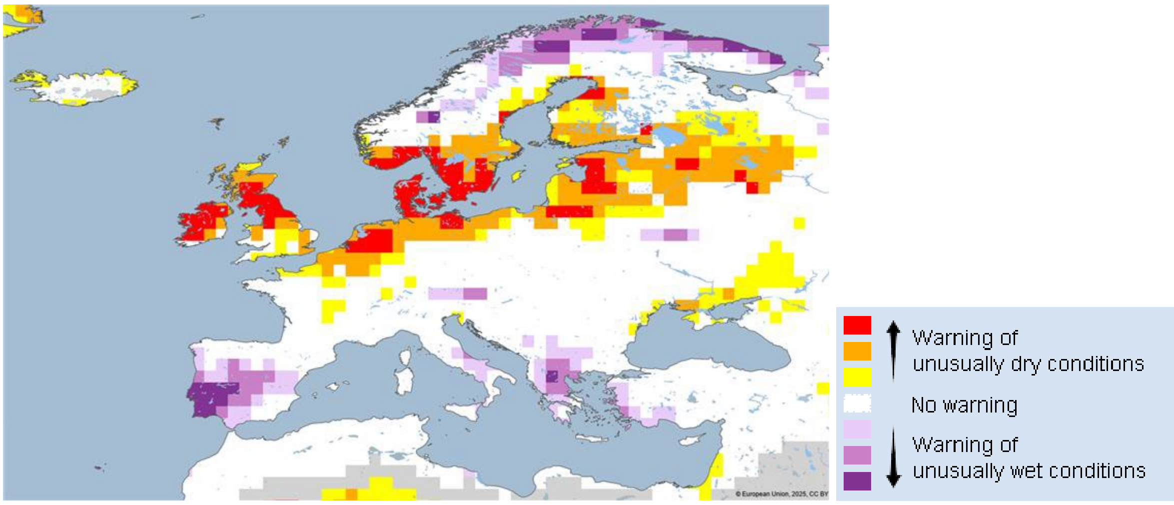

Figure 11: *Multi-system Indicator for Forecasting Unusually Wet and Dry Conditions, April – June 2025, based on dynamic forecasting systems from seven producing centres : ECMWF (European Centre for Medium-Range Weather Forecasts), CMCC (Centro Euro-Mediterraneo sui Cambiamenti Climatici), DWD (Deutscher Wetterdienst), ECCC (Environment and Climate Change Canada), Météo France, NCEP (USA National Centers for Environmental Prediction), UKMO (UK Meteorological Office). The baseline conditions comprise the years 1993-2016[8].*

By looking at the single-system forecasts, there is an overall agreement on the wetter and drier than usual conditions in the Iberian Peninsula and southern Scandinavia, respectively. On the contrary, the disagreement of the forecast in the rest of the continent is high and the different modelling systems (that compose the multi-system indicator) tend to predict different conditions. To visually illustrate these uncertainties, here, we show three modelling systems showing forecasts: in line with the multi-system (Fig. 12a), extensively drier than average (Fig. 12b), wetter than average in broad areas (Fig. 12c).

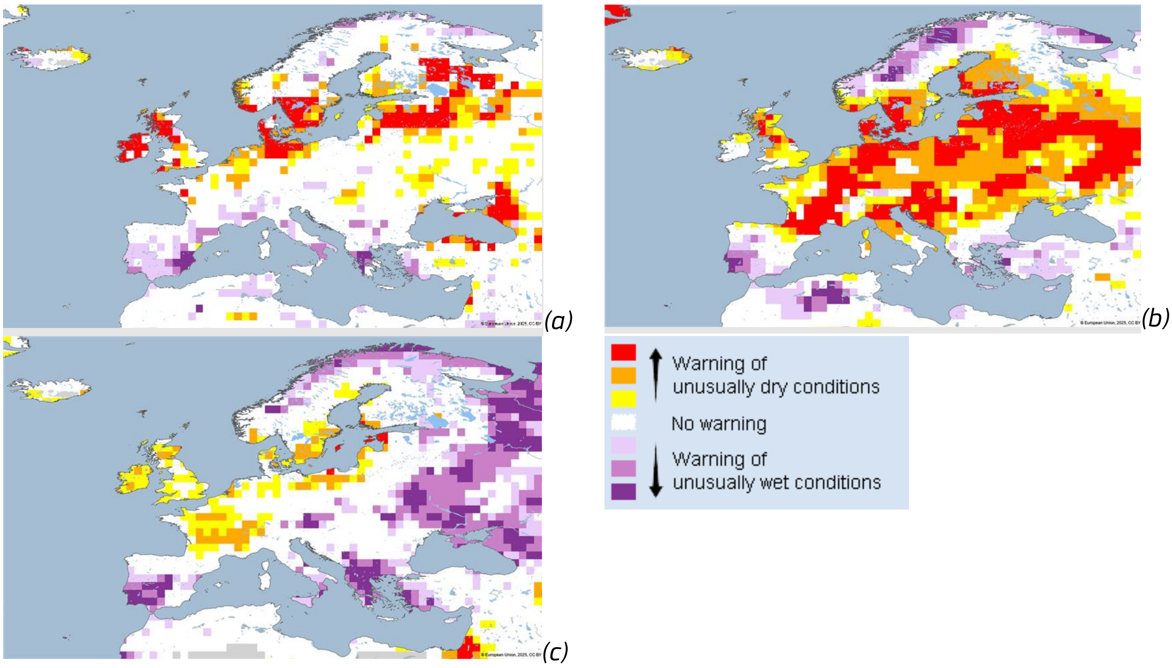

Figure 12: *Indicator for Forecasting Unusually Wet and Dry Conditions, April – June 2025, based on dynamic forecasting systems from: Météo France (a), ECCC (b), ECMWF (c).[8]*

[8] For more details on the Indicator for Forecasting Unusually Wet and Dry Conditions, and the other GDO and EDO indicators of drought-related information used in the report, see the Appendix at the end of the document.

Based on the Copernicus Climate Change Service (C3S) seasonal forecasts[9] (not shown here), warmer than usual conditions are likely to occur in Europe up to July 2025. Precipitation forecasts are generally close to average. Disagreement between prediction systems indicate uncertainty in the seasonal precipitation forecasts. Close monitoring is required to assess the severity and the extent of the impacts over the coming season.

As shown in Figure 13, most of eastern Europe is expected to be affected by low flow anomalies throughout May 2025, with extreme low flow anomalies potentially affecting south-eastern Scandinavia, western Russia, and south-eastern Türkiye. In the regions highlighted in Figure 13, the prolonged lack of precipitation and warmer than average temperatures are potentially affecting river flows, with direct impacts on agriculture, ecosystems, navigation and energy production. Water resource management should be planned cautiously, to limit impacts and to identify actions to be taken.

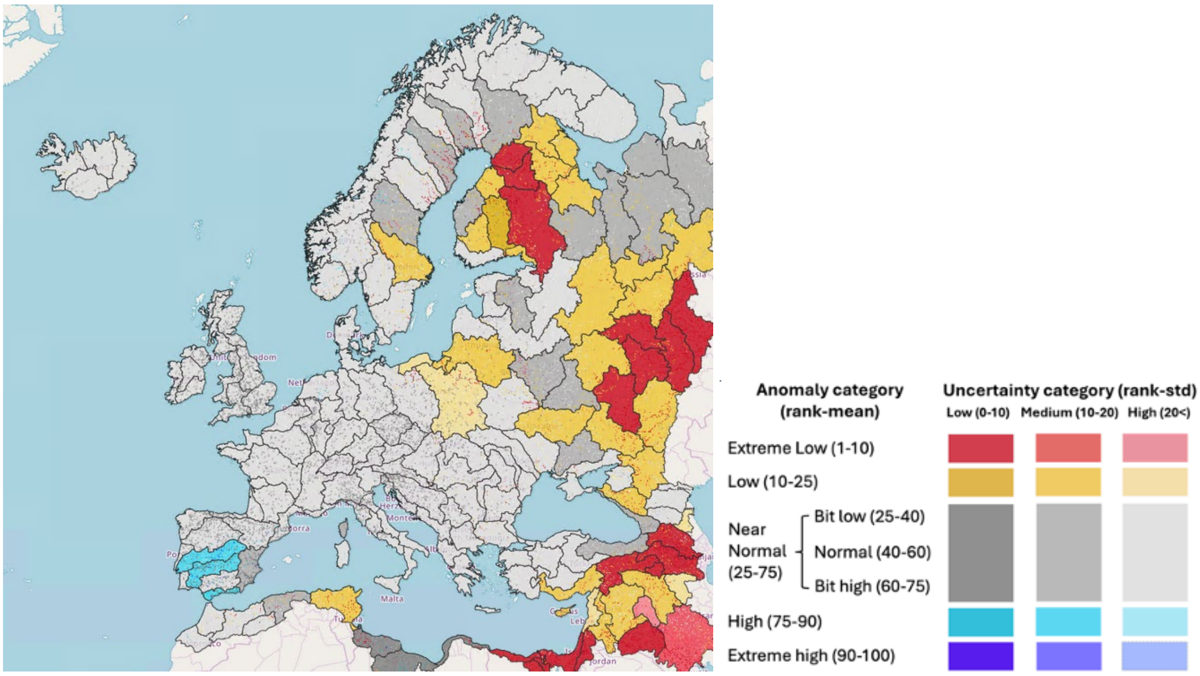

Figure 13: *Seasonal hydrological forecast anomaly and uncertainty for May 2025 step (within the 7 months simulation run from April to October 2025), with information aggregated by major river basin. Different colours indicate the level of anomalies, while the colour intensity shows the confidence level in the anomalies, with the lighter colours highlighting lower confidence. The forecast anomaly and uncertainty signals are derived by comparing the real-time ECMWF SEAS5 forecasts to the 99th-value percentile climatology. The climatology is generated using ECMWF SEAS5 reforecasts over a 20-year period.*[10] *(See also Technical Note below).*

Technical note:

- *The regions displayed in Fig. 13 are 204 major basins within the EFAS (European Flood Awareness System) domain, the basin delineation was done semi-automatically, and the basin borders align with the 1 arcmin (~1.5 km) LISFLOOD river network in EFAS. This allows large-scale variability in weather to be captured, and forecast information to be summarized. The map in Fig. 13 shows the forecast river flow anomaly per region for May 2025 step within the 7 months simulation run from April to October 2025. Different colors indicate the level of anomalies, while the color intensity shows the confidence level in the anomalies, with the lighter colors highlighting lower confidence.*

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

[10] Source: The CEMS European Flood Awareness System (EFAS): https://www.efas.eu, documentation at EFAS sub-seasonal and seasonal forecasting - Copernicus Emergency Management Service - CEMS - ECMWF Confluence Wiki

- *The analysis results shown in Fig. 13 are based on the LISFLOOD hydrological model outputs driven by 51 ensemble members of the ECMWF (European Centre for Medium-Range Weather Forecasts) SEAS5 (Seasonal Forecasting System 5) seasonal forecast. More information on LISFLOOD: De Roo et al., 2000. "Physically based river basin modelling within a GIS: the LISFLOOD model". Hydrological Processes, 14, 1981–1992. Additional and updated information: Open Source Lisflood (*https://ec-jrc.github.io/lisflood/*)*

Reported impacts

The European JRC MARS Bulletin - Crop Monitoring in Europe, of June 2024[11] reported that water deficit and dry soil conditions are prevailing in areas such as Romania, Bulgaria, Hungary, and northern Germany, where crops need stable water availability to maintain their potential. Frost and water excess have also affected smaller areas, with severe frost events observed in eastern Germany and western Poland, and excess precipitation in southern and western Europe, including southern Portugal, southern Spain, northern and central Italy, and northern France, leading to waterlogging and hindered field operations. Additionally, Ukraine is experiencing a country-wide precipitation deficit, with negative impacts on crops in the eastern regions. Türkiye is facing cold and dry weather. The winter crop season of the western Maghreb region is compromised due to late rainfall. Despite these challenges, most of these events have not yet resulted in irreversible impacts on yields, but the situation remains critical and crops urgently need more water to maintain good yield potential.

According to GEOGLAM (Group on Earth Observation Global Agricultural Monitoring) Crop Monitor bulletins of March 2025[12] winter wheat conditions vary across regions, with generally favourable conditions in Europe, although prolonged dry weather has negatively impacted yields in parts of Bulgaria and Romania. In Türkiye, conditions remain favourable despite recent cool and dry weather that has slowed crop growth. In contrast, warm and dry weather in the Russian Federation has caused winter wheat to break dormancy early. In Ukraine, an unusually warm winter has led to early vegetation growth, but varied soil moisture conditions pose a risk to yields, highlighting the need for careful monitoring of weather conditions to ensure a successful harvest.

The observed Rhine River discharge at the Kaub station[13], compared to the navigation threshold[14] (Fig. 14), shows a marked and fast lowering of the discharge (and consequently of the water level), reaching, by early April 2025, the limit for regular inland navigation. Since early April 2025, some navigation limitations have been already in place, as the water level near Kaub dropped to 76 cm (below the critical 78 cm threshold) severely impacting inland navigation. Cargo ships can no longer sail fully loaded, causing delays, reduced transport capacity, and increased costs, particularly affecting energy-intensive industries reliant on waterborne supplies.[15] According to the current evolution and the forecasts, limitations to navigation will likely persist or could even become more restrictive in the coming weeks. At the start of the second half of April, the Rhine water level is expected to continue falling due to lack of precipitation, worsening navigation and business conditions. Restrictions on shipping routes are already in place, and the low water level is also affecting drinking water supply and ecological balance. Light rain is forecasted for the third week of April, but it is unlikely to provide significant relief.[16]

[11] https://publications.jrc.ec.europa.eu/repository/handle/JRC141319

[12] https://www.cropmonitor.org/

[13] Source: discharge data collected by the CEMS Hydrological Data Collection Centre (data provider: Bundesanstalt fuer Gewaesserkunde, http://www.bafg.de/)

[14] Source: navigation threshold from the Central Commission for the Navigation of the Rhine (CCNR; https://inland-navigation-market.org/)

[15] https://www.daswetter.com/nachrichten/aktuelles/rhein-bei-kaub-rutscht-unter-kritische-marke-was-jetzt-passiert-trifft-nicht-nur-schiffe-sondern-ganz-deutschland.html

[16] https://www.hna.de/welt/unter-kritische-grenze-wetter-experte-schlaegt-alarm-welche-folgen-jetzt-drohen-rheinpegel-faellt-zr-93678088.html

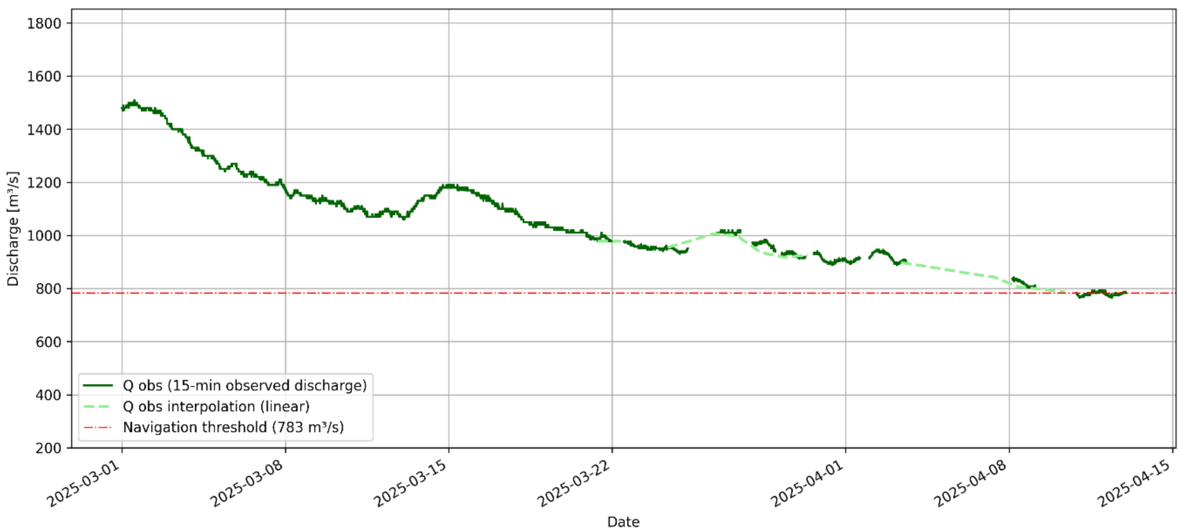

Figure 14: *Observed hydrograph from near real-time data of river discharge of the Rhine at Kaub (Lon: 7.76; Lat = 50.09) from 1 March 2025 to 13 April 2025*[13]*. Large data gaps (longer than half day) are linearly interpolated to show the trend. The navigation (low-flow) threshold is equivalent to a water level of 78 cm at Kaub (threshold updated in 2022)*[14].

Appendix: GDO and EDO indicators of drought-related information

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 less than normal precipitation; (2) "Warning", indicating that also soil moisture is in deficit; (3) "Alert", indicating that also vegetation shows signs of stress. Three additional classes – i.e. "Recovery", "Temporary Soil Moisture Recovery" and "Temporary Vegetation Recovery" – identify the stages of drought recovery processes in terms of 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 (or even 24-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 Index Anomaly** 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. Negative fAPAR anomalies with respect to the long-term average are associated with negative impacts on vegetation.

The **Multi-system 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 seven components: ECMWF (European Centre for Medium-Range Weather Forecasts), CMCC (Centro Euro-Mediterraneo sui Cambiamenti Climatici), DWD (Deutscher Wetterdienst), ECCC (Environment and Climate Change Canada), Météo France, NCEP (USA National Centers for Environmental Prediction), UKMO (UK Meteorological Office).

Check https://drought.emergency.copernicus.eu/factsheets for more details on the indicators

Drought in Europe - April 2025

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Glossary of terms and acronyms

C3S: Copernicus Climate Change Service
CDI: Combined Drought Indicator
CEMS: Copernicus Emergency Management Service
CMCC: Centro Euro-Mediterraneo sui Cambiamenti Climatici
DWD: Deutscher Wetterdienst
EC: European Commission
ECCC: Environment and Climate Change Canada
ECMWF: European Centre for Medium-Range Weather Forecasts
EDO: European Drought Observatory
EFAS: European Flood Awareness System
ERA5: ECMWF Reanalysis v5
EU: European Union
fAPAR: Fraction of Absorbed Photosynthetically Active Radiation
GDO: Global Drought Observatory
GEOGLAM: Group on Earth Observation Global Agricultural Monitoring
GIS: Geographic Information System
ICPR: International Commission for the Protection of the Rhine
JRC: Joint Research Centre
KNMI: Royal Netherlands Meteorological Institute
LFI: Low-Flow Index
MARS: Monitoring Agricultural Resources
NCEP: USA National Centers for Environmental Prediction
SEAS5: Seasonal Forecasting System 5
SMA: Soil Moisture Index (SMI) Anomaly
SMI: Soil Moisture Index
SPI: Standardized Precipitation Index
UKMO: UK Meteorological Office
VIIRS: Visible Infrared Imaging Radiometer Suite

GDO and EDO indicators versioning

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

GDO, EDO indicator	Version
▪ *Combined Drought Indicator (CDI)*	*v.4.0.0*
▪ *Soil Moisture Index (SMI) Anomaly (SMA)*	*v.3.0.2*
▪ *fAPAR (fraction of Absorbed Photosynthetically Active Radiation) Anomaly (VIIRS)*	*v.3.0.0*
▪ *Indicator for Forecasting Unusually Wet and Dry Conditions, Multi-System*	*v.1.3.0*
▪ *Indicator for Forecasting Unusually Wet and Dry Conditions, ECCC*	*v.2.0.0*
▪ *Indicator for Forecasting Unusually Wet and Dry Conditions, ECMWF*	*v.2.1.0*
▪ *Indicator for Forecasting Unusually Wet and Dry Conditions, Météo-France*	*v.1.1.0*
▪ *Standardized Precipitation Index (SPI) (ERA5)*	*v.2.0.0*
▪ *Low-Flow Index (LFI)*	*v.3.1.0*

Check https://drought.emergency.copernicus.eu/download for more details on indicator versions.

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Drought in Europe - April 2025

JRC Global Drought Observatory (GDO) of the Copernicus Emergency Management Service (CEMS) – GDO/EDO data up to 10/04/2025

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