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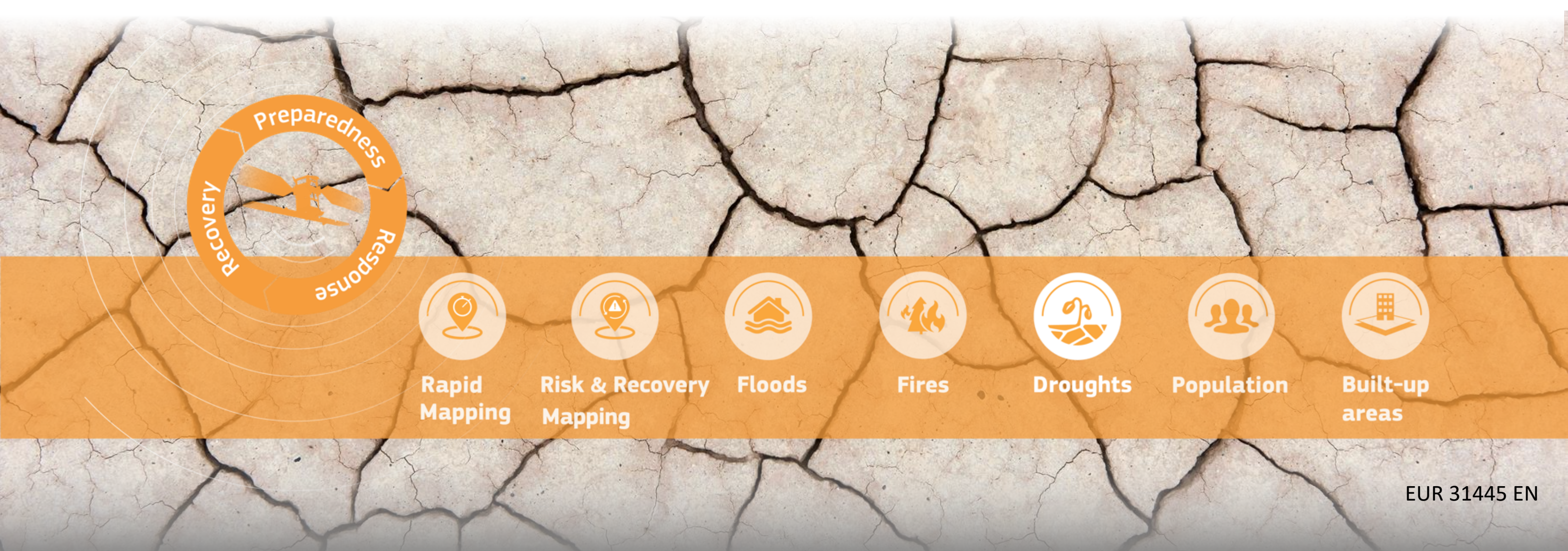
Drought in the Maghreb and Türkiye February 2023

GDO Analytical Report

2023



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Joint Research Centre

GDO Analytical Report

Drought in the Maghreb and Türkiye - February 2023

JRC Global Drought Observatory (GDO) of the Copernicus Emergency Management Service (CEMS) - 28/02/2023

GDO Analytical Report

Drought in the Maghreb and Türkiye - February 2023

JRC Global Drought Observatory (GDO) of the Copernicus Emergency Management Service (CEMS) - 28/02/2023

Executive summary

- A severe lack of precipitation affects both the Maghreb and Türkiye with impacts on soil moisture and rivers flow.
- In mid-December 2022 a prolonged warm-spell affected the Maghreb and partially Türkiye. As of February 2023, winter has been warm and dry over most of the Mediterranean.
- In the Maghreb, drought conditions caused delays to the sowing of cereals, a reduction in the sown area (in Morocco) and below to well-below average biomass accumulation in most of wheat and barley cultivated areas.
- The compound effects of the catastrophic earthquakes of February 2023 in Türkiye and Syria and of the drought may exacerbate impacts on water availability for human, agricultural and energy use. Monitoring the evolution of the drought is important to estimate the potential impacts and support risk reduction strategies.

Combined Drought Indicator (CDI)

In the Mediterranean region, after the extreme 2022, two large areas already raise concerns for their dry conditions and the potential impacts on agriculture.

The Combined Drought Indicator (CDI) points to warning and alert conditions in the Maghreb, affecting almost the whole agricultural land (Fig. 1).

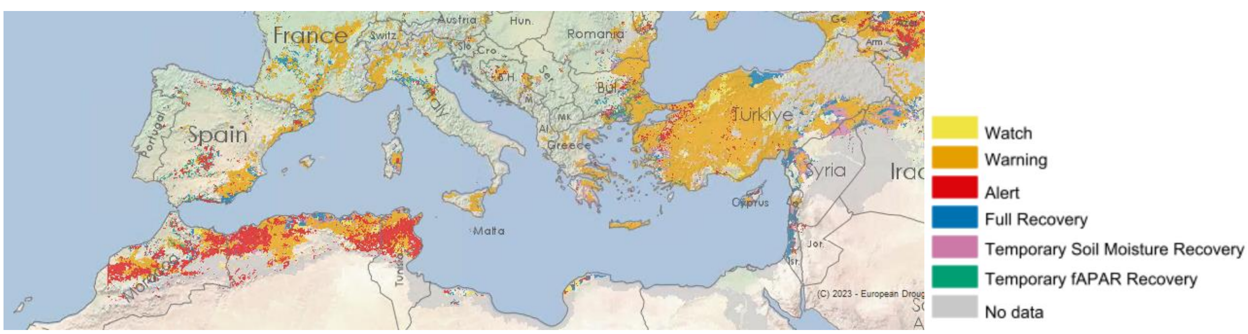

Figure 1: *CDI computed for the first 10-day period of February 2023 based on a combination of precipitation, soil moisture and vegetation conditions indicators[1].*

In the western Maghreb, vegetation and crops have been already affected at the beginning of the crop cycle, after a long-lasting precipitation shortage occurred in autumn. In the eastern Maghreb, the phenological cycle of winter cereals is slightly delayed. Türkiye is largely under warning conditions according to the CDI. This reflects the severe lack of precipitation and drier-

[1] For more details on CDI and the other indicators used in the report see the Appendix at the end of the document.

than-normal soil moisture conditions. The crop season has not started yet, but the current situation may pose a threat.

Standardized Precipitation Index (SPI)

Most of the eastern Maghreb and Türkiye have been affected by negative precipitation anomalies in the three months ending in January 2023. The drought in Maghreb has worsened and expanded towards the central-eastern regions. The highest negative anomalies are detected in north-eastern Algeria, northern Tunisia, and most of Türkiye (SPI-3, Fig. 2). At the beginning of February 2023 a slight reduction of the negative precipitation anomaly is detected (not shown) and its further evolution should be monitored. SPI-24 shows less severe anomalies in western Türkiye but the eastern regions have extremely dry values. The anomaly of SPI-24 in the Maghreb is as severe as the one of SPI-3 confirming the long duration of the drought, lasting for more than one year (Fig. 3).

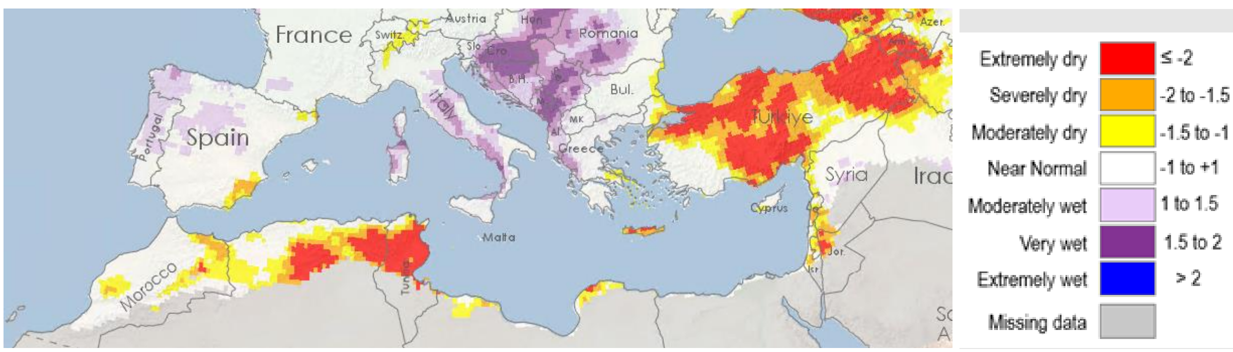

Figure 2: *Standardized Precipitation Index SPI-3, three months ending in January 2023.*

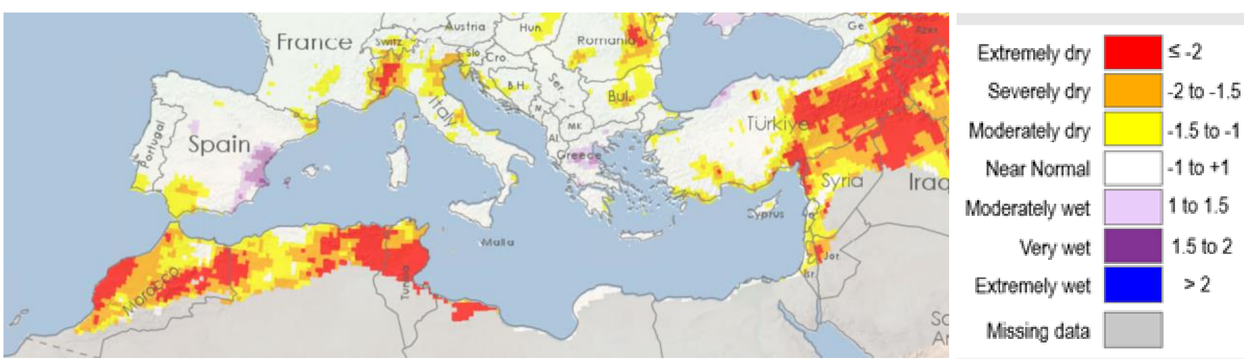

Figure 3: *Standardized Precipitation Index SPI-24, 2 years ending in January 2023.*

Temperature

High temperatures increase evapotranspiration, making substantially worse drought severity and water scarcity.

Most of the Maghreb regions experienced a prolonged warm-spell, with a peak in mid-December 2022 (Fig. 4). The persistence, intensity, and spatial extent of the warm spell were extremely severe and exacerbated the effects of the drought on soil and likely, where relevant, on crops. The extent of the area affected by the warm spell slowly reduced at the beginning of 2023.

In the same period, central, northern and western regions of Türkiye experienced shorter and less intense warm spell (Fig. 4) with less relevant impacts on vegetation.

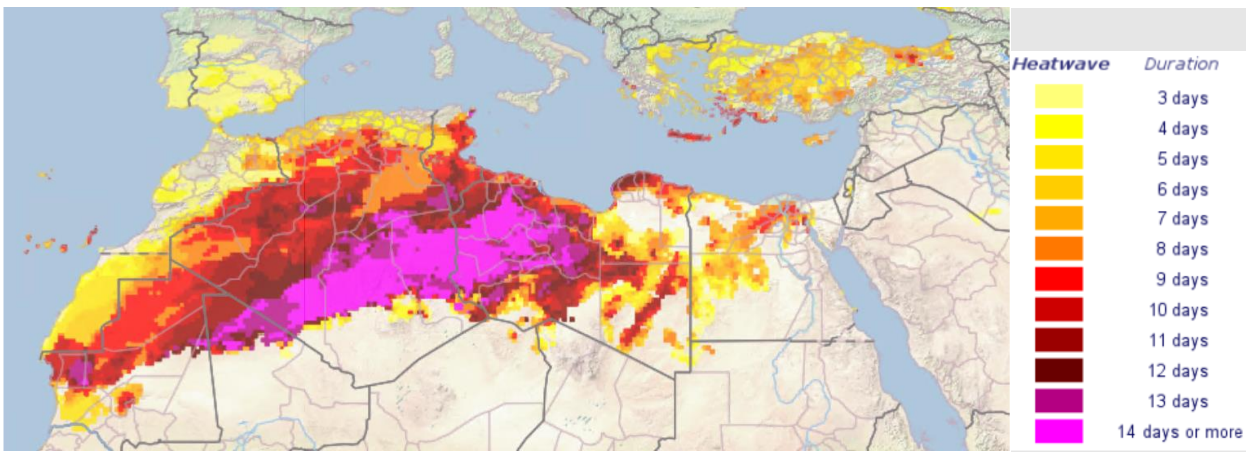

Figure 4: *Duration (days) of the identified warm spell according to the Heat and Cold Wave Index (HCWI). Yellow to purple colours represent increasing duration. Map issued for 2022 December 12th.*

The average 30-day moving average temperature anomaly was positive (from +1 to +3 °C) for almost all of the Mediterranean at December 20th 2022, with increasing values up to +6 °C in south-eastern Morocco, central and southern Algeria, southern Tunisia, western Libya and Türkiye (Fig. 5).

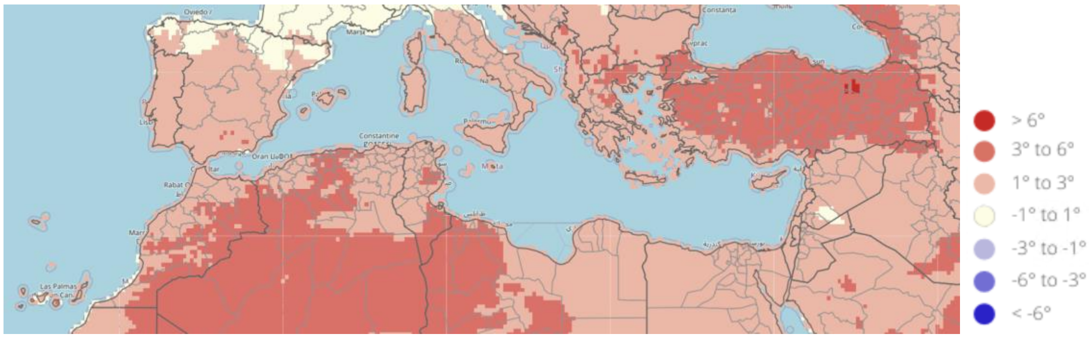

Figure 5: *Monthly mean temperature anomaly (ERA5) for mid-December 2022. Source: ASAP - Anomaly Hotspots of Agricultural Production[2].*

Soil moisture

The soil moisture anomaly is markedly negative in the central and eastern Maghreb due to the long-lasting lack of precipitation and the winter 2022 warm-spell. In Türkiye the impact on soil moisture is severe due the recent dry period combined with the warm spell. The most affected regions are northern Algeria, northern Tunisia and central-western Türkiye. Data are coherent with the negative SPI patterns. Large areas have a Soil Moisture Index Anomaly below -2 (corresponding to the driest class of EDO indicator, Fig. 6)

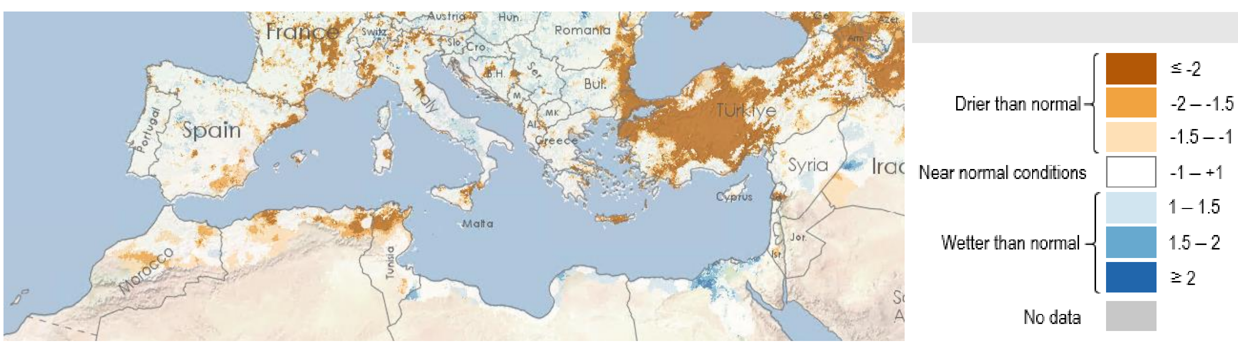

Figure 6: *Soil Moisture Index Anomaly, beginning of February 2023.*

Biomass

Vegetation stress is detected over large agricultural areas in Morocco, central and eastern Algeria and central Tunisia. The most severe impacts are mainly detected over the north-western Algeria and northern Tunisia. In Türkiye, higher than usual photosynthetic activity is detected due to the above-average temperatures of January together with, in south-eastern regions, an early

[2] https://mars.jrc.ec.europa.eu/asap/

development. Drought conditions hampered vegetative growth in most of the regions but their impacts are not yet visible on biomass accumulation (Fig. 7).

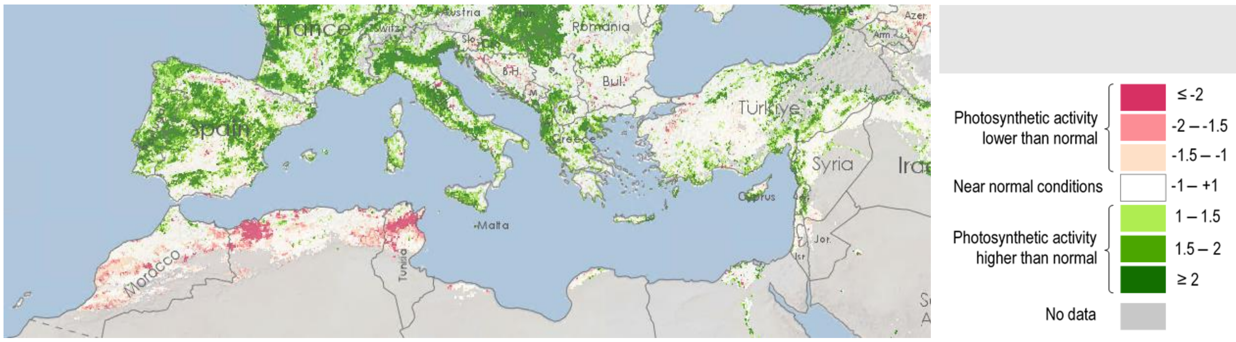

Figure 7: *fAPAR anomaly, beginning of February 2023.*

River flow

At the beginning of February 2023, the Low-Flow Index (LFI; Fig. 8) shows critical values mainly over Tunisia, northern Algeria and the whole of Türkiye. Higher risk is detected in eastern Türkiye, north-western Algeria and Tunisia.

Figure 8: *Low-Flow Index (LFI) at the beginning of February 2023. A Low-Flow Index of 0 corresponds to no drought and a value of 1 to the highest drought hazard.*

Large-scale atmospheric conditions

December 2022 was characterized by strong anomalous cyclonic circulation in the lower troposphere (850 hPa) located west of the Iberian Peninsula combined with anomalous anticyclonic circulation over the eastern Mediterranean. This atmospheric configuration induced southerly wind anomalies over the Maghreb region (Fig. 9, upper panels), leading to the advection of relatively warm and dry air from the Sahara, and was likely the main cause of the warm spell at the beginning of the month (Fig. 4) and the lack of precipitation in the area (Fig 2.).

The 2-year anomalies for the period 2021-2022 show a general increase in geopotential (850 hPa) in line with the long-term warming trend (Fig. 9 lower left panel). The increase is especially marked over western and central Europe, the Mediterranean and northern Africa. Despite the clear differences in the monthly and 2-year geopotential anomalies, the wind velocity anomalies show a very similar circulation, that is more advection of Saharan air into the Maghreb region (Fig. 9 lower left panel). This anomalous circulation is likely causing the low precipitation in the last 2 years (Fig. 3).

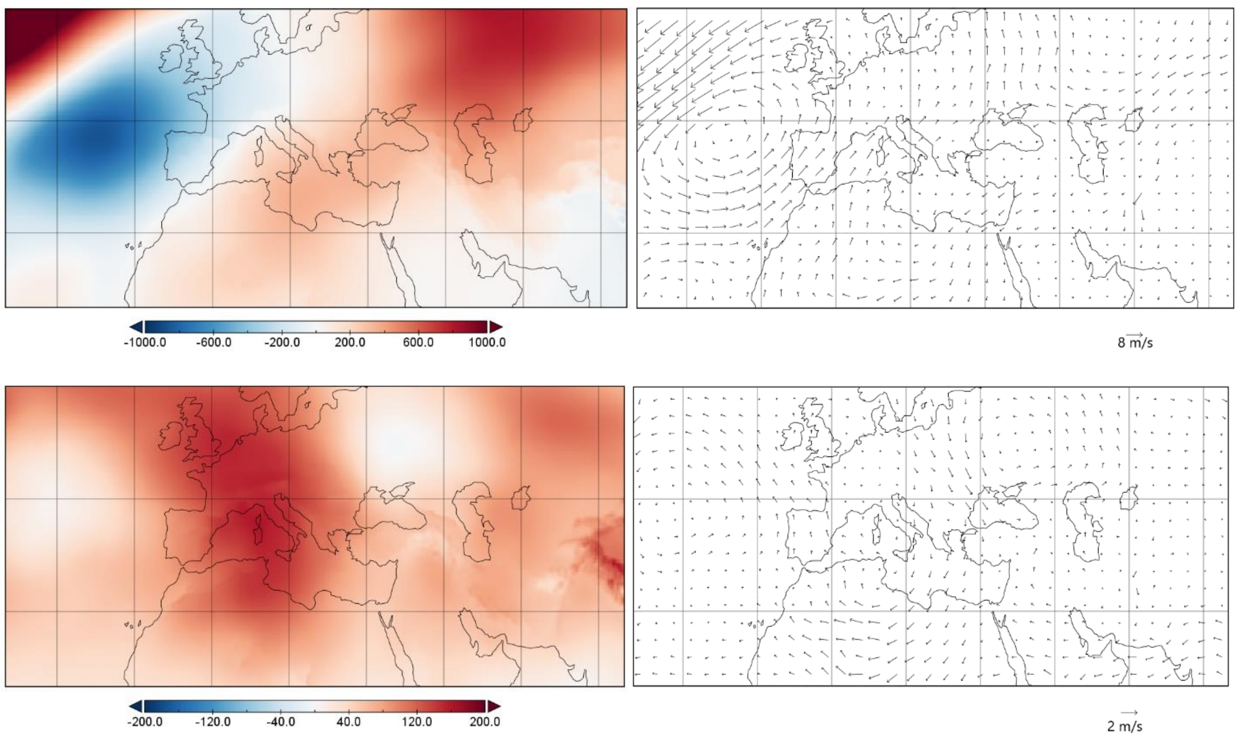

Figure 9: *Upper panel: geopotential (*left figure, m^2/s^2) and *wind velocity (right figure, m/s) anomalies at 850 hPa for December 2022. Lower panel: geopotential* (left figure, m^2/s^2) and *wind velocity (right figure, m/s) anomalies at 850 hPa for the 2-year period 2021-2022. Reference climatological period 1959-2021. Source of data: ERA5.*

Seasonal forecast

For the whole Mediterranean close-to-average conditions are predicted from February to April 2023 (Fig. 10). This may alleviate in the coming months the drought conditions, but a close monitoring is required to analyse the beginning of the growing season in Türkiye and the one ongoing in the Maghreb.

Seasonal forecasts of mean temperature and precipitation up to April 2023 from the ECMWF SEAS5 and other modelling centres[3] point to likely warmer-than usual conditions in the whole Mediterranean, but for precipitation some variability is noticeable between the models' predictions, ranging from slightly drier to slightly wetter conditions. Close monitoring is required to better understand the possible impacts expected for the forthcoming growing season.

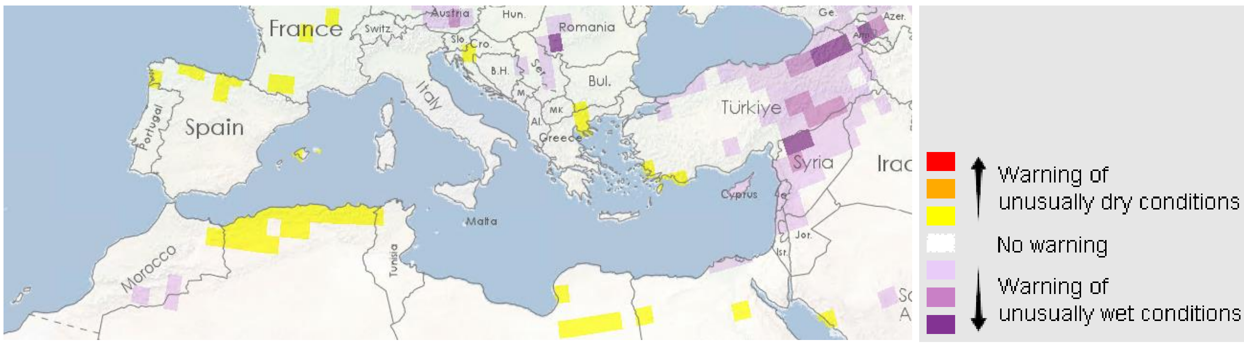

Figure 10: *Indicator for Forecasting Unusually Wet and Dry Conditions from February to April 2023 (based on ECMWF SEAS5).*

ECMWF SEAS5 long-range meteorological data are used by the Global Flood Awareness System (GloFAS) to produce seasonal forecasts of river flow. GloFAS seasonal forecast for the coming 4 months (February-May 2023) predicts relatively high probability of low flows over the whole northern Africa, where the probability of low flow exceeds 90%. In Türkiye, critical predictions are more local and less severe (Fig. 11). This forecast is based on LISFLOOD-OS hydrological model[4] and GloFAS operational version v3.2[5]. The model calibration made use of historical observations of discharge from 1226 gauge stations[6].

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

[4] De Roo, A., C. Wesseling, and W. van Deursen. 2000. Physically based river basin modelling within a GIS: the LISFLOOD model, Hydrological Processes, 14, 1981–1992. Doi: 10.1002/1099-1085(20000815/30)14:11/12<1981::AID-HYP49>3.0.CO;2-F; ec-jrc/lisflood-code: Lisflood OS - LISFLOOD (github.com)

[5] https://confluence.ecmwf.int/display/COPSRV/GloFAS+versioning+system

[6] Alfieri, L., Lorini, V., Hirpa, F. A., Harrigan, S., Zsoter, E., Prudhomme, C., and Salamon, P.: A global streamflow reanalysis for 1980–2018, J. Hydrol., 6, 100049, https://doi.org/10.1016/j.hydroa.2019.100049, 2020.

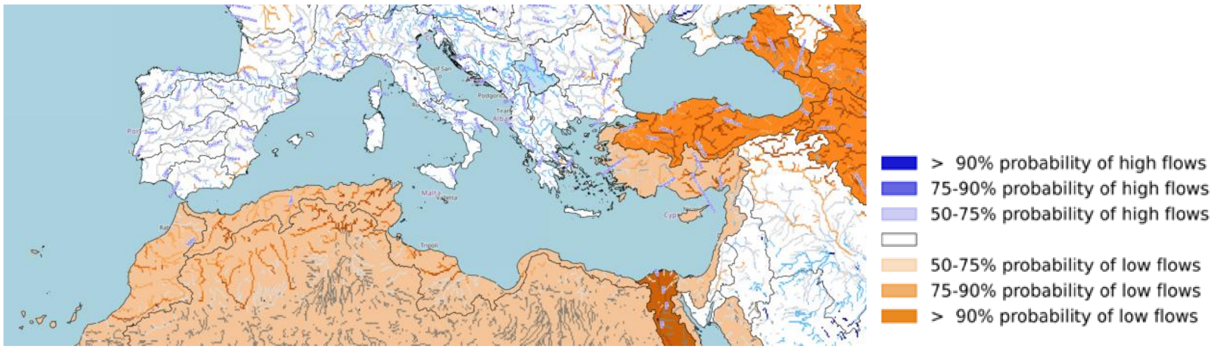

Figure 11: *Maximum probability [%] of high (> 80th percentile) or low (< 20th percentile) river flow during the 4 month forecast horizon for basins overview and for river network, issued on February 1st 2023. Source: Global Flood Awareness System (GloFAS) https://www.globalfloods.eu.*

Reported impacts

According to the Anomaly Hotspots of Agricultural Production (ASAP) January 2023 assessments[7]:

- In Morocco, due to the lack of precipitation since October 2022, winter cereals growth lags behind and biomass is below average, even if the conditions appear to be better than those observed in January 2022.
- In Algeria, total rainfall is one of the lowest since the 2001-2002 crop season and, despite the above average temperatures, the growth of winter wheat and barley lags behind and biomass is well below the average.
- In central Tunisia, biomass of cereals is below average as total rainfall since October 2022 is the lowest of the last 22 years, but in the three main producing areas of the northern Tunisia crop biomass is now close to average.

According to the February issue of the JRC MARS Bulletin on North Africa[8], in large parts of the Maghreb cereal yield potential has been negatively affected by drought. An overall delay in crop development and below-average crop biomass accumulation were recorded in most of the main cereal-producing regions of Morocco, a wide belt across Algeria, and the northern-eastern and central regions of Tunisia. Rain is urgently needed to avoid further losses. Yield forecasts for wheat in the Maghreb are estimated to be -24% to -15% compared with the last 5-year average, while they range from -30% to -10% for barley. More specifically (Fig. 12):

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[7] https://mars.jrc.ec.europa.eu/asap/index.php

[8] https://publications.jrc.ec.europa.eu/repository/handle/JRC132778

- Drought conditions caused in **Morocco** delays to sowing together with a reduction in the sown area. Below-average biomass accumulation in most agricultural areas is also detected. The season will be further compromised if it will not rain in the coming weeks.
- Persistent dry conditions hampered the start of the cropping season and slowed crop biomass accumulation during the early vegetative stages in **Algeria**. Almost all major production areas have below average performance. Sowing was delayed by 2-3 weeks in the eastern regions and by almost 10 days in the central and western ones.
- Biomass accumulation in **Tunisia** is below to well below average in many important cereal-producing regions, with high risk of crop failure in the regions of Siliana and Zaghouan. Further water shortages could compromise the cereal season.

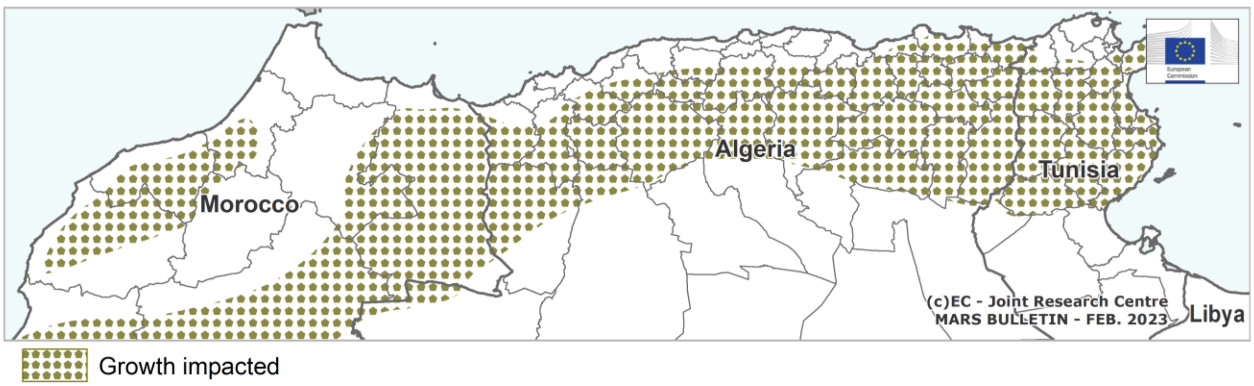

Figure 12: *Areas of concern – crop impacts. It is based on observed data from December 1st 2022 until February 10th 2023 – Source: JRC MARS Bulletin on North Africa, February 2023 [8].*

It has been reported that the Maghreb is likely to suffer water stress in the coming months because the lack of precipitation caused a reduced filling rate of reservoirs. The Algerian government took urgent measures to reducing water wastage and rationing water use.

In central Türkiye, it has been reported about one month delay of the sowing dates compared to the previous year, as soil conditions were too dry. December 2022 has been reported as the hottest of the last 52 years. Moreover, the warm winter reduced the snow accumulation raising concern for future lack of melting contribution for runoff and infiltration.[9] The crop season is advanced only in the south-eastern regions, where potential biomass accumulation was hampered by the winter drought. However, since the beginning of February there may be beneficial effects due to the occurred precipitation. Currently, crops' water demand is limited but will soon increase and irrigation will be needed to sustain growth. Due to the January winter

[9] https://www.dha.com.tr/gundem/kuraklik-tarimsal-ekim-tarihlerini-sarkitti-2205329

drought, reservoirs are below 50% filling level as of mid-February casting concerns about water availability for irrigation during spring and summer[10].

The area across the Türkiye-Syria border (south-eastern Anatolia) is one of the most important irrigated area of the region. Among the huge impacts of the catastrophic earthquakes that hit Türkiye and Syria in February 2023, damages to dams and river infrastructures have been reported followed by consequent floods.[11] Regarding the Yarseli Dam (located in southern Türkiye near the border with Syria), UN OCHA reports (12 February) that the water level of the Orontes/Asi River has risen and submerged a number of houses in the aftermath of the earthquakes of 06 February. "*People have also been forced to move out of their houses due to recent flooding. The water level of the Orontes river has reportedly risen and submerged homes following the collapse of a dam in the aftermath of the earthquakes. More than 30,000 displacement movements were recorded in north-west Syria over three days from 6 February to 8 February*".[12] Also the Maydanki (Afrin) Dam in Syria was affected as it was exposed to moderate shaking intensity[13]. In Türkiye, the Sultansuyu Dam was affected by the earthquake in the Pazarcık district of Kahramanmaraş and the Malatya Governorate announced that the reservoir has been discharged. [14]

These are immediate impacts of the earthquakes, but there may be also negative effects on water resources, because reservoirs cannot be used to store water for the dry season. Also in case of minor damages, not causing a dam-break, the required reduction of the safely storable water volume may be the only feasible measure to reduce risks, with the drawback of reducing water availability.

[10] https://www.haberturk.com/baraj-doluluk-oranlari-istanbul-13-subat-2023-barajlardaki-doluluk-oranlarinda-son-durum-istanbul-da-barajlarin-yuzde-kaci-dolu-3565184

[11] JRC Technical Report, M7.8 and M7.5 Earthquakes in Türkiye and Syria, JRC Scientific Analysis: Update#3, Santini M. et al., 2023 https://www.gdacs.org/Public/download.aspx?type=DC&id=261

[12] https://reliefweb.int/report/Türkiye/earthquake-Türkiye-and-north-west-syria-flash-update-no-5-10-february-2023

[13] https://reliefweb.int/report/turkiye/turkiyesyria-acaps-thematic-report-profiles-earthquake-affected-governorates-13-february-2023

[14] https://www.cnnturk.com/turkiye/deprem-sonrasi-baraj-yikilmasi-ya-da-patlamasi-nedir-baraj-nasil-patlar-sultansuyu-baraji-nerede

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 (or even 24-month) period for hydrological drought, when rivers fall dry and groundwater tables lower.

The **Heat and Cold Wave Index** (HCWI) is used to detect and monitor periods of extreme-temperature anomalies (i.e., heat and cold waves) that can have strong impacts on human activities, health and ecosystem services such as sprouting of crops. It is based on the persistence for at least three consecutive days of events with both daily minimum and maximum temperatures (T_{min} and T_{max}) above the 90^{th} percentile daily threshold (for heat waves) or below the 10^{th} percentile daily threshold (for cold waves). For each location, the daily threshold values for T_{min} and T_{max} are derived from a 30-year climatological baseline period (1991-2020), using the GloFAS/ERA5 derived temperature data.

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. FAPAR anomalies, and specifically negative deviations from the long-term average, are associated with negative 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.

Check https://edo.jrc.ec.europa.eu/factsheets for more details on indicators.

Glossary of terms and acronyms:

ASAP	Anomaly Hotspots of Agricultural Production
CDI	Combined Drought Indicator
CEMS	Copernicus Emergency Management Service
EDO	European Drought Observatory
EC	European Commission
ECMWF	European Centre for Medium-Range Weather Forecasts
ERA5	ECMWF Reanalysis v5
ERCC	European Emergency Response Coordination Centre
fAPAR	Fraction of Absorbed Photosynthetically Active Radiation
GDO	Global Drought Observatory
GloFAS	Global Flood Awareness System
HCWI	Heat and Cold Wave Index
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
VIIRS	Visible Infrared Imaging Radiometer Suite

EDO indicators versioning:

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

Combined Drought Indicator (CDI), v.2.2.1
fAPAR (fraction of Absorbed Photosynthetically Active Radiation) Anomaly (VIIRS), v.1.0.0
Low-Flow Index (LFI), v.2.1.0
Soil Moisture Index Anomaly (SMA), v.2.1.2
Indicator for Forecasting Unusually Wet and Dry Conditions, v .1.0.0
Heat and Cold Wave Index (HCWI), v. 1.0.0
Standardized Precipitation Index SPI ERA5 (1/4-dd resolution), v.1.0.0

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