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Drought in Central America and Mexico August 2023

GDO Analytical Report

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Emergency Management Service

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Drought in Central America and Mexico - August 2023

JRC Global Drought Observatory (GDO) of the Copernicus Emergency Management Service (CEMS) - GDO data up to 10/08/2023

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Executive summary

- A severe drought is currently affecting Central America and Mexico, due to an extremely dry period. The spatial-temporal evolution of the ongoing drought shows a shift from south-east to north-west.
- Heatwaves are exacerbating the impact of the lack of precipitation, and the average temperature is abnormally high for the season.
- Soil moisture and vegetation conditions are severely affected, with negative anomalies over large areas of the region.
- Crop damages and losses have caused the Acute Food Insecurity to rise to crisis level (i.e. IPC Phase 3)[1] in most of Central America.
- Wildfire danger is high mainly in the central-northern part of Mexico.
- The drought is affecting both navigation, including in the Panama Canal, and energy production, with severe economic impacts. River flow forecasts suggest that these impacts are likely to get worse.
- Seasonal forecasts point definitively to warmer than average months. As for precipitation, the uncertainty is high. Close monitoring of the drought evolution, and proper water use plans, are needed.

Standardized Precipitation Index (SPI)

Severe negative anomalies of precipitation are currently affecting many parts of Central America and southern North America. The SPI-3 (i.e. SPI for an accumulation period of 3 months) shows extremely dry conditions in most of Mexico, Guatemala, El Salvador, Central Panama, and western Cuba (Fig. 1).[2]

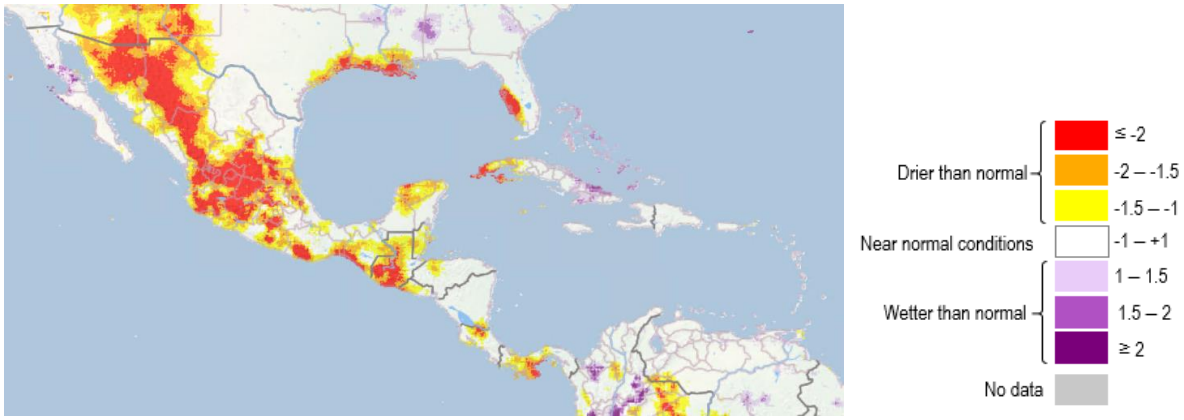

Figure 1: *Standardized Precipitation Index SPI-3 for the 3-month accumulation period ending on 10 August 2023.*[2]

The sequence of SPI-3 from April to July 2023 (Fig. 2) shows that the drought began in Honduras and Panama in April 2023, expanded to most of eastern Central America in May, and finally affected also most of Mexico in June-July. The negative precipitation anomaly only partially improved in August 2023 (see Fig. 1) in the eastern part of Central America (Honduras, Nicaragua and Guatemala), but meteorological drought conditions have persisted over the whole region. The drought seems to be slowly moving from south-eastern towards north-western regions, but it is still in its initial stage. SPI-6 (accumulation period of 6 months, not shown here) shows the same intensity and pattern as SPI-3, confirming the recent onset of the drought in April-May 2023.

[1] https://www.ipcinfo.org/ipcinfo-website/ipc-overview-and-classification-system/ipc-acute-food-insecurity-classification/

[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.

Drought in Central America and Mexico - August 2023

JRC Global Drought Observatory (GDO) of the Copernicus Emergency Management Service (CEMS) - GDO data up to 10/08/2023

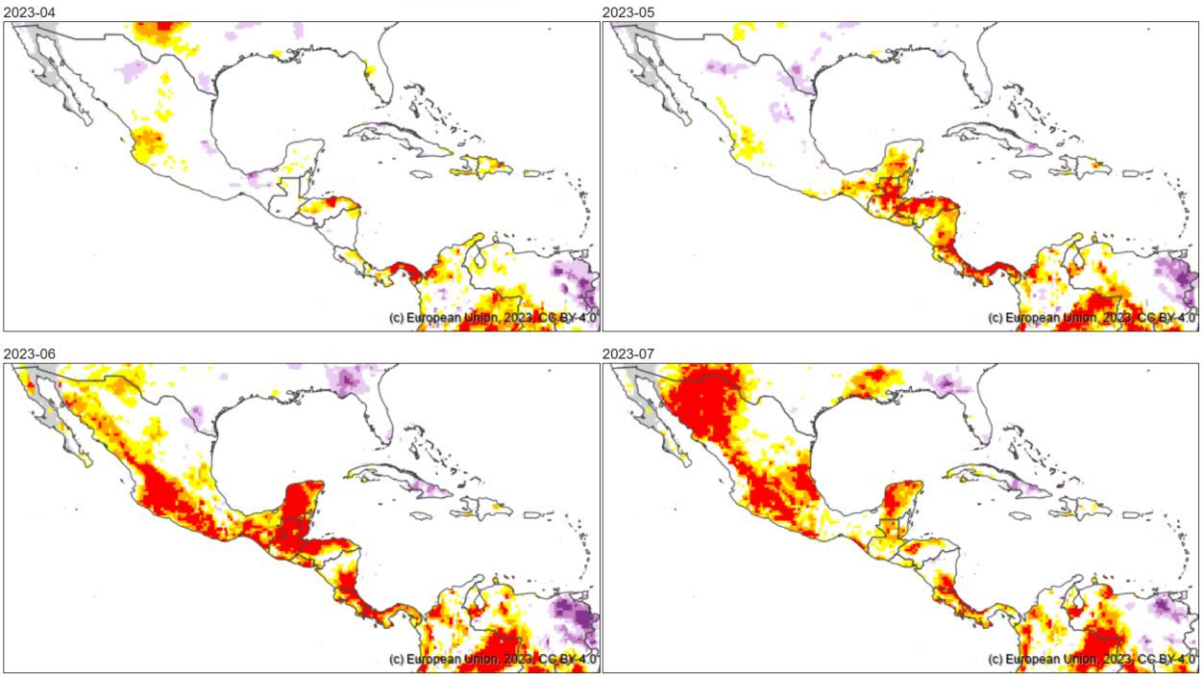

Figure 2*: Standardized Precipitation Index (SPI-3), for 3-month accumulation periods. Panels: April to July 2023.*[2]

The extent of the ongoing drought ranges from Central America to southern North America. Its spatial and temporal dynamics can be estimated using a recently developed method for tracking drought events.[3] This method was used to identify the areas under meteorological drought, and to show the evolution of the drought starting from southern regions in May (Fig.3a), expanding to almost all of Central America and Mexico in June (Fig. 3b), and moving to central and northern Mexico in July (Fig. 3c). The provisional clusters highlighted in Fig. 3c in particular, may further develop into consolidated clusters if meteorological drought conditions persist.

Temperature

Most of Central America and southern North America experienced prolonged above-average temperatures from May to July 2023. In these regions the 3-month average temperature anomaly (baseline 1991-2020) generally ranged between 0.5 °C and 1 °C, and was above 1.5 °C for Guatemala and Central Mexico (Fig. 4). These long-lasting and intense heatwaves worsened the effect of the precipitation deficit on the soil moisture content.

According to the Heat and Cold Wave Index (HCWI)[4], on 16 July 2023 a severe heatwave hit northern and central-eastern Mexico, the Yucatan peninsula, and Cuba, with a duration longer than two weeks (Fig. 5).

[3] The method is based on a generalized three-dimensional density-based clustering algorithm (DBSCAN). See: Cammalleri, C., and A. Toreti, 2023: A Generalized Density-Based Algorithm for the Spatiotemporal Tracking of Drought Events. J. Hydrometeor., 24, 537–548, https://doi.org/10.1175/JHM-D-22-0115.1.

[4] For more details on the Heat and Cold Wave Index (HCWI), and the other GDO and EDO indicators of drought-related information used in this report, see the Appendix at the end of the document.

Drought in Central America and Mexico - August 2023

JRC Global Drought Observatory (GDO) of the Copernicus Emergency Management Service (CEMS) - GDO data up to 10/08/2023

Figure 3: *Spatial-temporal tracking of the meteorological drought during 2023.[3] (a) End of May, (b) June, and (c) July. Data source: SPI data derived from the ERA5 precipitation reanalysis.*

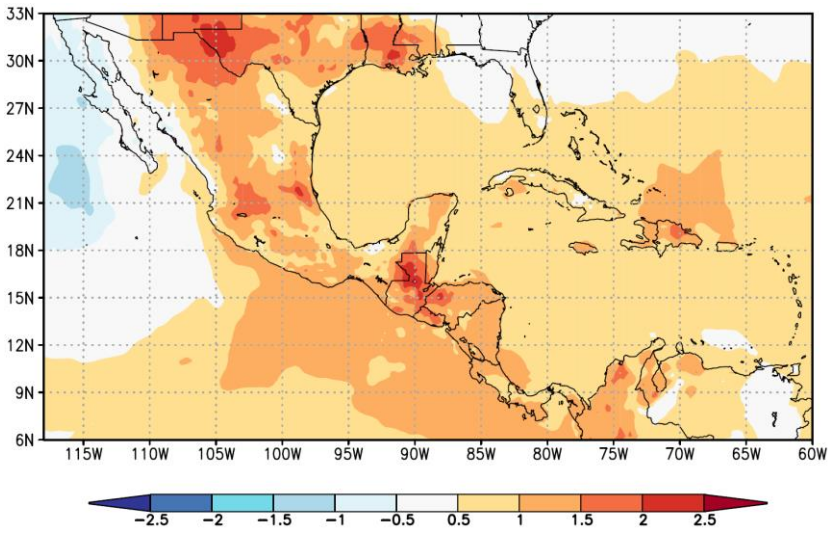

Figure 4: *Average temperature anomaly (ERA5) computed for the period May - July 2023 (baseline 1991-2020). Source: The KNMI Climate Explorer.[5]*

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

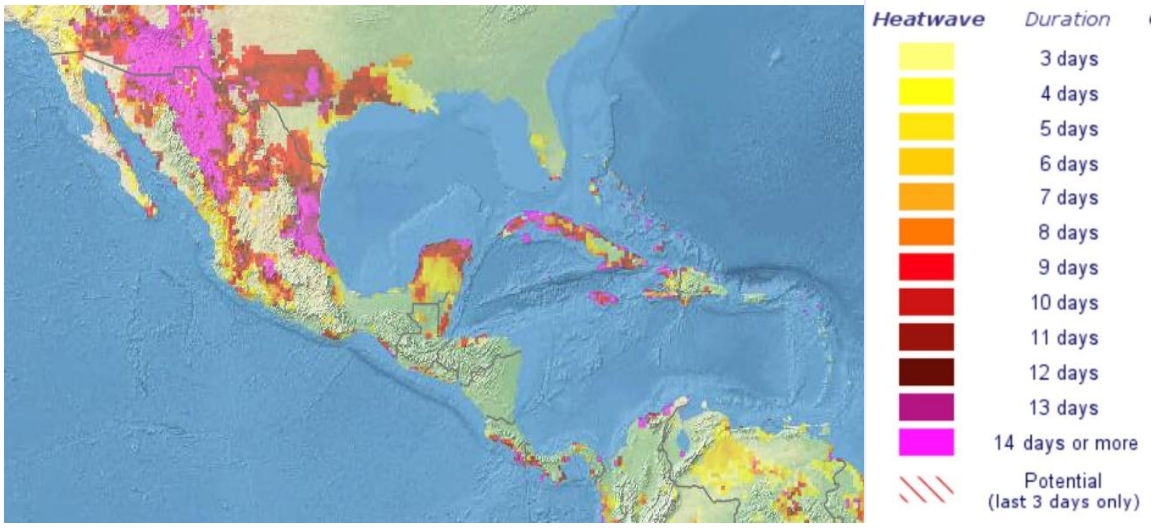

Figure 5: *Duration (in days) of the heatwave computed on 16 July 2023, based on the Heat and Cold Wave Index (HCWI). As can be seen, the heatwave affected Mexico, Cuba, Jamaica and the Southwestern United States. The yellow to purple colour scheme represent increasing duration of heat wave events.*[4]

Soil moisture

At the beginning of August 2023, soil moisture anomalies were remarkably negative in northern and Central Mexico, Central Guatemala, eastern Costa Rica, and Panama (Fig. 6). This is the result of a combination of low precipitation and high temperatures in the previous months. The drier-than-normal soil moisture pattern is consistent with the precipitation deficit of the previous months (i.e. SPI-3, see Fig. 1 and Fig. 2 - July). Moreover, the regions with the strongest negative precipitation anomalies were also the ones affected by higher positive temperature anomalies. This combination contributed to an exacerbated water loss from the soil due to stronger evapotranspiration potential. Large areas in Mexico show soil moisture anomalies below -2, corresponding to the driest class of the GDO indicator (Fig. 6).[6]

Regarding the evolution of soil moisture anomalies (Fig. 7), these initially affected Guatemala, Honduras, Nicaragua, and Panama in May and beginning of June 2023, then expanded to southern Mexico in mid-June, and finally affected most of Mexico in June-July. Conditions in July in the south-eastern countries slightly improved. A peak of severity in the central regions can be seen at the end of June – beginning of July.

[6] For more details on the Soil Moisture Anomaly, 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 6: *Soil Moisture Anomaly, beginning of August 2023.*[6]

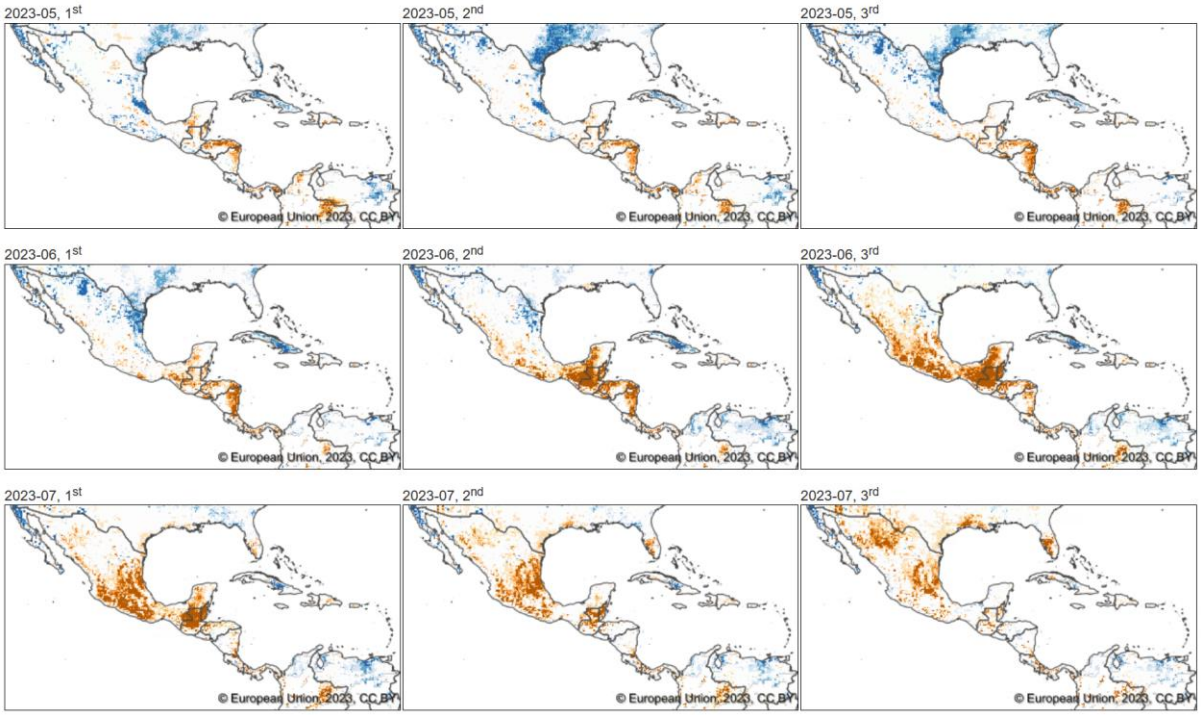

Figure 7: *Soil Moisture Anomaly, 10-day periods from May to July 2023.*[6]

Vegetation biomass

At the beginning of August 2023, the satellite-derived fAPAR anomaly indicator shows severe vegetation stress over north-western Mexico, Central Mexico, and Yucatan peninsula (Fig. 8). More sparse and less severe vegetation stress affect north-eastern Mexico, Guatemala, and northern Honduras. These critical and widespread conditions are due to the combined severe lack of precipitation and higher than normal temperatures.

The evolution of fAPAR anomalies from May to July 2023 (Fig. 9) indicates a fast and progressive increasing of vegetation stress, starting from northern Honduras, Nicaragua, and Yucatan peninsula in May 2023, and expanding to wider regions, including southern Mexico by June 2023, and most of Mexico by July 2023. The

widest extent of negative anomalies was reached at the end of July 2023, when almost the entire Central America and Mexico had significantly below-normal photosynthetically activity levels. At the beginning of August (Fig. 8), the situation slightly improved in the south-eastern countries.[7]

Figure 8: *Satellite-derived fAPAR anomaly indicator, measuring photosynthetic activity of vegetation, at the beginning of August 2023.*[7]

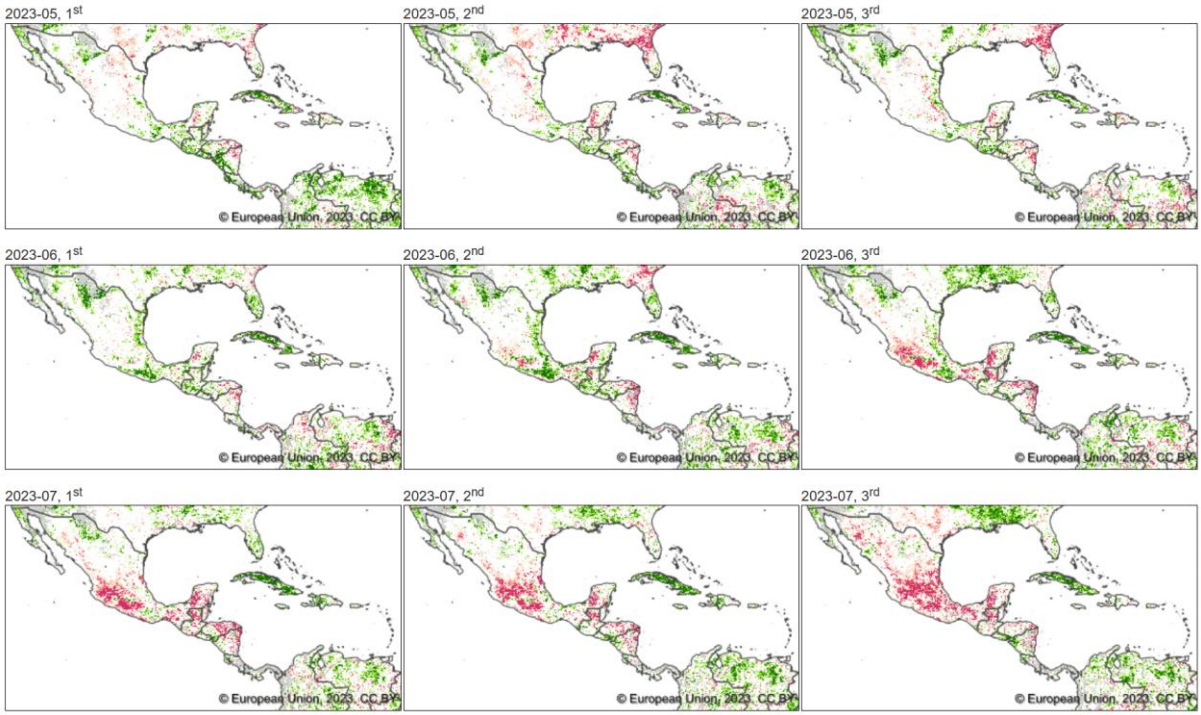

Figure 9: *Satellite-derived fAPAR anomaly indicator, measuring photosynthetic activity of vegetation, 10-day periods from May to July 2023.*[7]

[7] For more details on the satellite-derived 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.

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JRC Global Drought Observatory (GDO) of the Copernicus Emergency Management Service (CEMS) - GDO data up to 10/08/2023

Large-scale atmospheric conditions

Precipitation in summertime in Mexico and Central America is largely affected by El Niño Southern Oscillation (ENSO). On average (1951-2016), a deficit in precipitation throughout most of the region during El Niño summers (June-August) are observed. In 2023, El Niño was officially declared by the WMO on 4 July[8], but warmer than average Sea surface temperatures have been observed since spring in the eastern tropical Pacific. During El Niño events, the eastern and central tropical Pacific waters become warmer than average, the trade winds weaken or reverse, and the typical location of deep atmospheric convection located around northern South America and Central America is displaced westwards towards the central Pacific impacted by the warmer waters. As a result, sinking dry air establishes in the tropical parts of the American continent leading to below-average convective activity and precipitation in the region. A leading cause of low rainfall and elevated temperatures in Central America and Mexico in the past months is likely to be the emergence and establishment of El Niño phenomenon.

Fire danger forecast

The wildfire hazard is a direct consequence of the elevated temperature anomalies and surface dryness, combined with the availability of fuel (i.e. dry litter and wood). The CEMS Global Wildfire Information System (GWIS) provides mapping services of the fire danger forecast all over the World.[9] A high-to-extreme danger is shown over the central-northern Mexico up to 25 August 2023 (Fig. 10).

Figure 10: *Fire danger forecast expressed by the Fire Weather Index up to 25th August 2023. Data source: Global Wildfire Information System (GWIS)[9].*

Seasonal forecast

From August to October 2023, drier than average conditions (baseline 1981-2016) are predicted in Central and north-western Mexico, as shown in Fig. 11, and slightly drier-than-usual conditions are predicted for eastern Honduras, Nicaragua, Costa Rica, and Panama. Close to average conditions are predicted for southern Mexico,

[8] https://public.wmo.int/en/media/press-release/world-meteorological-organization-declares-onset-of-el-ni%C3%B1o-conditions

[9] https://gwis.jrc.ec.europa.eu/

Guatemala and western Honduras. According to Copernicus C3S seasonal forecasts[10], warmer than usual conditions are likely in the whole Central America, with large positive anomalies, up to November 2023. Precipitation forecasts are close to average conditions, although there is a large variability between models (even ranging from very wet to very dry forecast in some regions). Close monitoring is required to better understand the impacts over the coming season.

The probability of occurrence of low flows for rivers from August to November 2023 is high, mainly in Mexico, as shown in Fig. 12.[11] The prolonged lack of precipitation, severe heatwaves, and warmer-than-average forecast are likely to reduce river flows further, with direct impacts on agriculture, ecosystems and energy production. Water resource management should be cautiously planned to limit impacts and identify adaptation strategies.

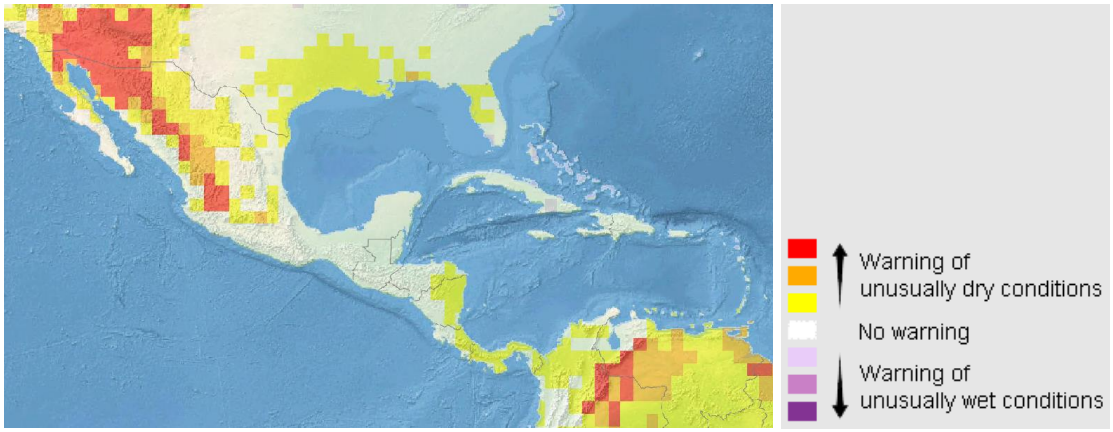

Figure 11: *Indicator for Forecasting Unusually Wet and Dry Conditions, Aug-Oct 2023 (based on ECMWF SEAS5).*[12]

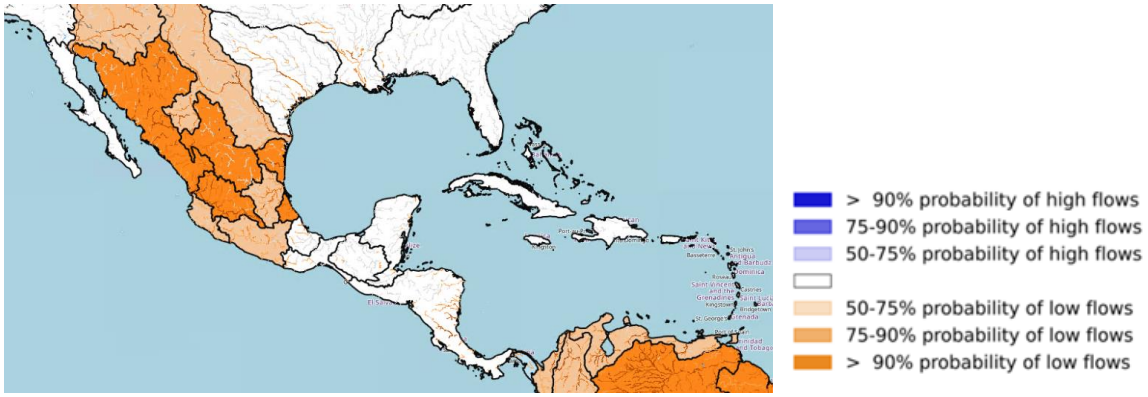

Figure 12: *Maximum probability [%] of high (> 80th percentile) or low (< 20th percentile) river flow, during the 4-month forecast horizon (August-November 2023) for basins and river network. Source: CEMS Global Flood Awareness System (GloFAS).*[13]

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

[11] The analysis is based on the open source LISFLOOD hydrological model outputs driven by 51 ensemble members of the ECMWF SEAS5 forecast. For more information: https://ec-jrc.github.io/lisflood/

[12] 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.

[13] https://www.globalfloods.eu

Reported impacts

In Central America (El Salvador, Honduras, and Guatemala), critical conditions during the past years have reduced reserves of basic grains for many poor households. The ongoing drought, combined with the high prices, is likely to cause a reduction of the size and / or number of meals, and is driving acute food insecurity quickly to the crisis phase (i.e. IPC Phase 3)[1], for June-September 2023. The precipitation deficit and high temperature are associated with El Niño.[14]

Honduras declared an indefinite Red Alert for 140 municipalities due to meteorological drought in June. In El Salvador, significant crop losses (15-25%) are reported.[15]

The drought has affected hydro-power generation in El Salvador, with a reduction of about 26% compared to 2022. Similar critical conditions are affecting the surrounding countries.[16]

Drought is also having negative impacts on navigation and shipping. The Panama Canal had to reduce the maximum charge and the number of the ships. The result is that delivery time and costs are increasing, with effects on international market prices. [17]

[14] FEWS NET. Latin America and the Caribbean Food Security Outlook. July 2023: Irregular weather disrupts the harvest in Central America, while Haiti continues to face gang violence that drives Emergency (IPC Phase 4) food security outcomes. In Venezuela, low incomes continue to limit access to food. 2023.

[15] https://reliefweb.int/report/ecuador/latin-america-caribbean-weekly-situation-update-14-august-2023

[16] https://www.prensa-latina.cu/2023/08/17/sequia-disminuye-generacion-electrica-en-el-salvador

[17] https://www.reuters.com/business/environment/historic-drought-hot-seas-slow-panama-canal-shipping-2023-08-21/

Appendix: GDO and EDO indicators of drought-related information

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 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 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 the indicators.

Glossary of terms and acronyms

ASAP	Anomaly Hotspots of Agricultural Production
CEMS	Copernicus Emergency Management Service
EDO	European Drought Observatory of CEMS
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 of CEMS
GloFAS	Global Flood Awareness System of CEMS
GRACE	Gravity Recovery and Climate Experiment
JRC	Joint Research Centre
LFI	Low-Flow Index
MARS	Monitoring Agricultural Resources
SMA	Soil Moisture Anomaly
SPI	Standardized Precipitation Index
TWS	Total Water Storage
VIIRS	Visible Infrared Imaging Radiometer Suite
WMO	World Meteorological Organization

GDO and EDO indicators versioning

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

GDO, EDO indicator	Version
▪ fAPAR (fraction of Absorbed Photosynthetically Active Radiation) Anomaly (VIIRS)	*v.1.0.0*
▪ Ensemble Soil Moisture Anomaly (SMA)	*v.3.0.1*
▪ Indicator for Forecasting Unusually Wet and Dry Conditions	*v .1.1.0*
▪ Standardized Precipitation Index (SPI)	*v.1.0.0*
▪ Heat and Cold Wave Index (HCWI)	*v.1.0.0*
▪ Meteorological Drought Tracking (ERA5)	*v.1.0.0*

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Drought in Central America and Mexico - August 2023

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