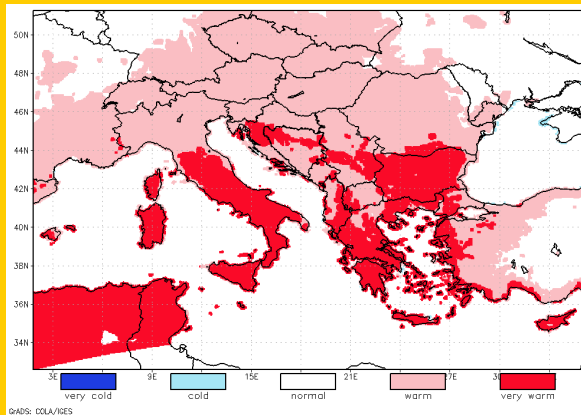


DROUGHT MONITORING BULLETIN

July 2023

HOT SPOT

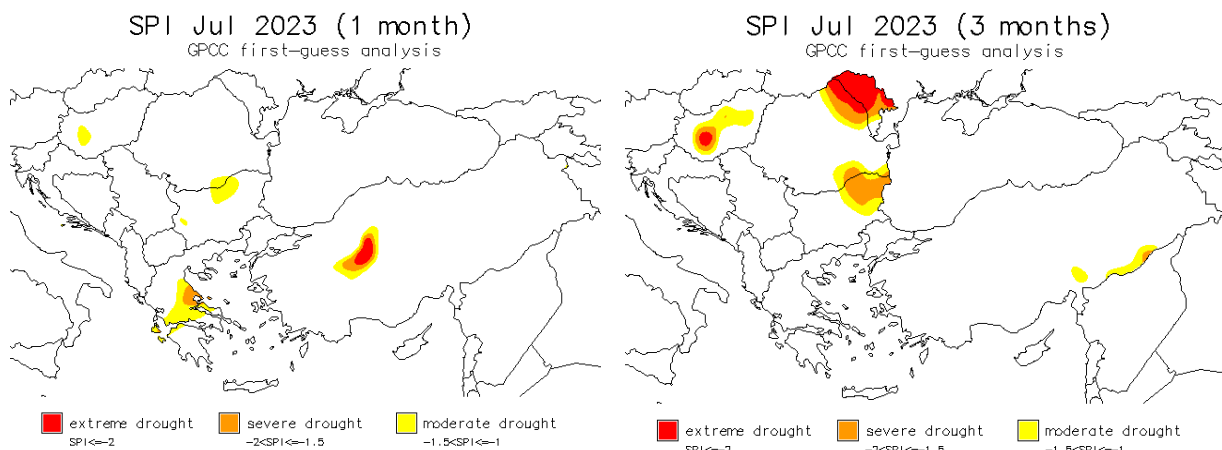


July was a very warm month across Balkan Peninsula excluding Moldova, as monthly mean air temperature was at least 1.5 °C above the long-term average. Over the region's central and southern third July was 2.5 to 3 °C warmer than normal, locally in southern Greece and Bulgaria even higher. It ended up as one of the hottest of local records across a great part of the region, as indicated by the figure on the left showing **July mean air temperature** in percentile classes on the base of 1991–2020.

STANDARDIZED PRECIPITATION INDEX

Drought situation with regard to the precipitation level is presented by Standardized Precipitation Index (SPI). The SPI calculation is based on the distribution of precipitation over long time periods (at least 30 years) and can be calculated at various time scales that reflect the impact of drought on the availability of water resources. The long-term precipitation record is fit to a probability distribution, which is then normalised so that the mean (average) SPI for any place and time period is zero. SPI values above zero indicate wetter periods and values less than zero indicate drier periods. Only the dry part of the extreme anomalies is presented on the maps.

Standardized precipitation index for **July 2023** is shown in figures below. SPI for a one-month period indicates possible drought conditions which can have impact on vegetation, while SPI for a three-month period can be indicative also for surface water status.



Most of the region did not lack precipitation this July, as it brought average or even higher than normal precipitation amount, according to SPI. However, precipitation deficit was evident over some localised areas across the region, including western Hungary and northern Bulgaria with moderate lack of rain, and central Greece where precipitation deficit this July suggested moderate to severely dry conditions. Lack of rain was the greatest in limited area in central-western Turkey causing extremely dry conditions.

A 3-month overview of precipitation conditions between May and July reveals rainfall rate was noticeably lower than normal across most of Moldova and northeastern Romania where the 3-monthly deficit ranked among the highest in last decades, mostly on the account of extremely dry May and June, and over central-western Hungary where persistent lack of rain throughout all three months indicated severely to extremely dry conditions of the past 3 months. Northeastern Bulgaria also received noticeably less rain than normal, especially in June and July, resulting in severely dry conditions as well. Moderate lack of rain throughout May and June along southern Turkey resulted in moderately dry conditions of the past three months.

AIR TEMPERATURE AND SURFACE WATER BALANCE

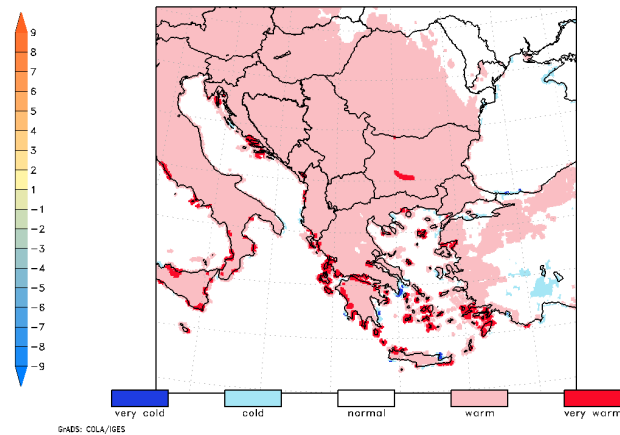
Figures in this section present anomalies of the average air temperature and accumulated surface water balance as well as their classified values in percentile classes for a 60-day period from 31 May to 29 July 2023.

AVERAGE AIR TEMPERATURE
ANOMALY (°C)
31 MAY – 29 JULY 2023



SHADES: COLA/IGES

AVERAGE AIR TEMPERATURE
PERCENTILE CLASSES
31 MAY – 29 JULY 2023

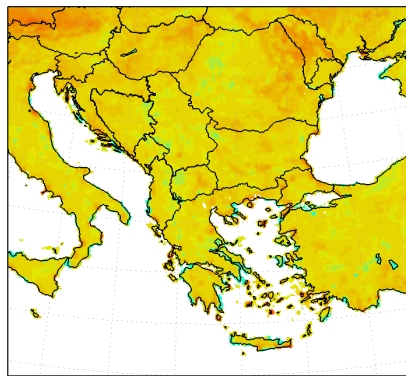


SHADES: COLA/IGES

Across Moldova and most of Turkey, July air temperatures ranged about the average throughout the entire month, or only temporarily and locally exceeded it for up to 2 °C, while elsewhere anomalies fluctuated greatly this July. In its early days, July air temperatures were more or less average for this time of year, while mid-July brought air temperatures a lot warmer than normal for this time of year. They exceeded the average for up to 6 °C over Croatia, Bosnia and Herzegovina, Serbia, Montenegro and parts of eastern Albania, western Bulgaria and Aegean Turkey, and anomalies of 3-5 °C prevailed in outward direction across the rest of the Balkan Peninsula. In last dekad of the month, air temperature anomalies generally decreased and while they remained 3-5 °C warmer than normal across Greece throughout the rest of the month, they mostly fell down to 1-3 °C above the average across Aegean Turkey, Albania, North Macedonia, Bulgaria and southern Serbia, or normalised across the northern half of the region. While June air temperatures were average across central Balkan Peninsula or colder than normal

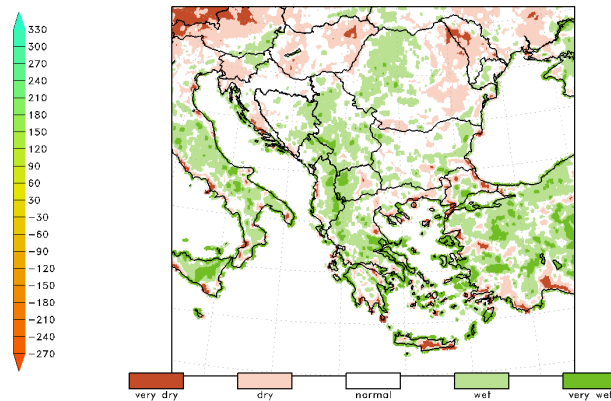
across the region's north-east and south, July was noticeably warmer than usual across vast part of the region, altogether resulting in 60-day mean air temperature up to 2 °C higher than long-term mean across the entire western part of Balkan Peninsula from Slovenia to western half of Greece but also over central Hungary, southern Serbia, western North Macedonia, Bulgaria and southern and western Romania. Elsewhere, the changing air temperature conditions throughout June and July mostly averaged out to normal values for this 60-day period of the year.

ACCUMULATED WATER BALANCE
ANOMALY (mm)
31 MAY – 29 JULY 2023



GHAS: COLA/IES

ACCUMULATED WATER BALANCE
PERCENTILE CLASSES
31 MAY – 29 JULY 2023



GHAS: COLA/IES

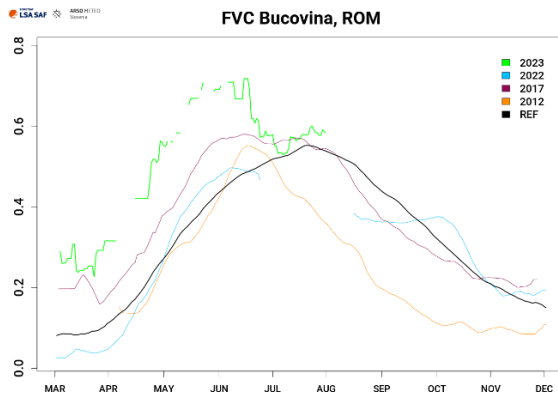
Much of the central and southern Balkan Peninsula and Turkey recorded average surface water balance in the June-July period, with quite some localised areas experienced even wetter than normal surface water balance conditions for this time of year and recorded a surplus of up to 150 mm, locally even higher. Meanwhile, outer parts of the region recorded noticeable deficit over the 2-month period, especially the northern belt stretching from Adriatic Sea to the Black Sea. The accumulated deficit reached between 120 and 180 mm over much of Hungary, northeastern Romania and Moldova and was the highest in the region and one of the highest of the local long-term records. Also much of Slovenia, Croatia, parts of Bulgaria, central North Macedonia, eastern Greece and Mediterranean Turkey experienced drier than normal surface water balance levels, at this time of the year it would normally be up to 90 mm higher.

REMOTE SENSING - FRACTION OF VEGETATION COVER

Fraction of vegetation cover (FVC) is a vegetation index based on multi-channel remote sensing measurements (data from EUMETSAT's LSA SAF data base is used for products in this bulletin). FVC shows fraction of the total pixel area that is covered by green vegetation, which is relevant for applications in agriculture, forestry, environmental management and land use, it has also proved to be useful for drought monitoring. Values vary according to the vegetation stage and to the damages of possible natural disasters (including drought). FVC values are in general low at the beginning of the growth season, the highest at full vegetation development, then FVC slowly drops with vegetation senescence. Line shape depends on the sort of vegetation at the given location.

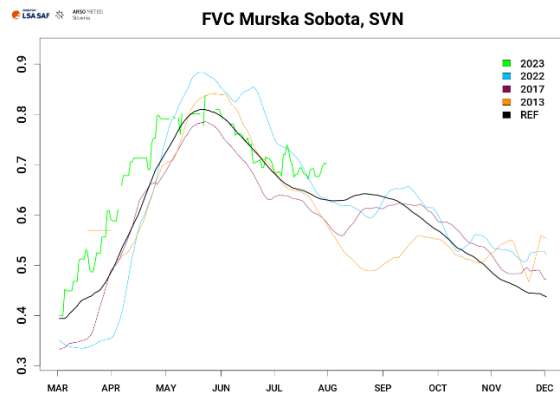
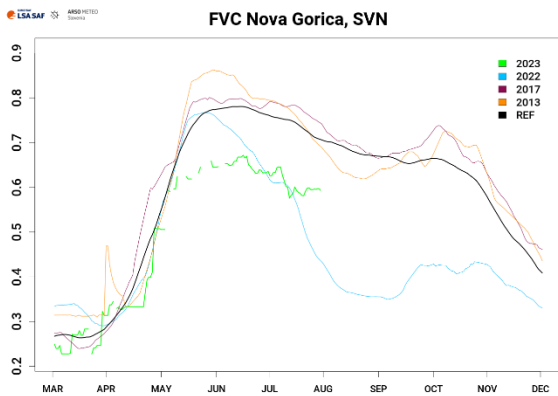
Graphs below present the **vegetation situation** as recorded **on 31 July 2023** at selected locations across southeastern Europe. FVC values for year 2023 are presented as a green line. Graphs also include reference line (2004–2022) in black, and lines in light blue (year 2022), magenta (year 2017) and orange (year 2012, or 2013 for Slovenia) for comparison. Missing values or their sharp decline can be linked to prolonged cloudy weather, extreme weather events, snow blanket or changes to product by the product provider.

ROMANIA



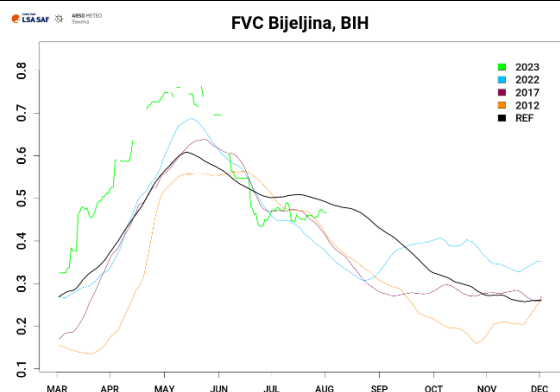
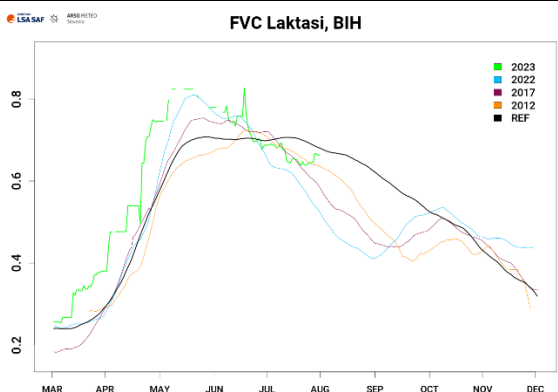
After an abundant level of vegetation cover in Bucovina, northern Romania early in the season and its continuation throughout spring months when fraction of cover with green vegetation exceeded the normal by 30 %, a rapid decline can be observed in second half of June. FVC values fell by 25 % in that time, which still ranked about the long-term average for this time of year. July weather conditions slightly restored vegetation growth, which at the end of July remained more or less average.

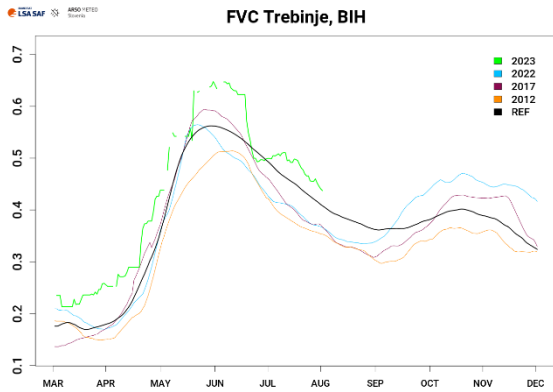
SLOVENIA



Vegetation growth in Nova Gorica, western Slovenia more or less followed its usual development in first months of spring but from May onward further growth was held back as peak FVC values remained stagnant between 60 and 65 %, which is up to 15 % lower than normal. Senescence phase saw FVC values decline at the regular rate through June and July. In Murska Sobota, northeastern Slovenia, vegetation season began earlier than normal and spring weather conditions supported further growth, thus resulting in above-average level of cover in first months of spring. May weather conditions did not allow further abundance, resulting in stagnation at the peak level and entering senescence at its usual rhythm throughout June. Further senescence was halted by wet and warm July, keeping constant level of cover.

BOSNIA AND HERZEGOVINA (REPUBLIC OF SRPSKA)

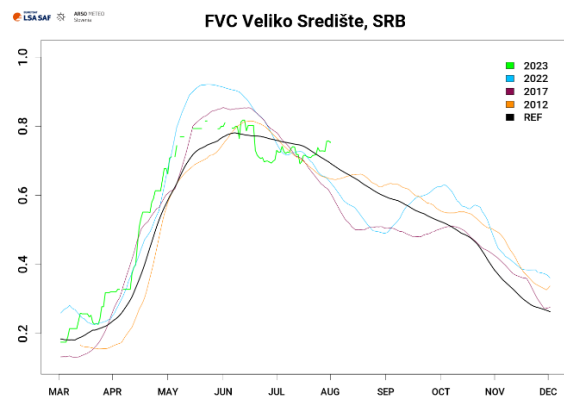
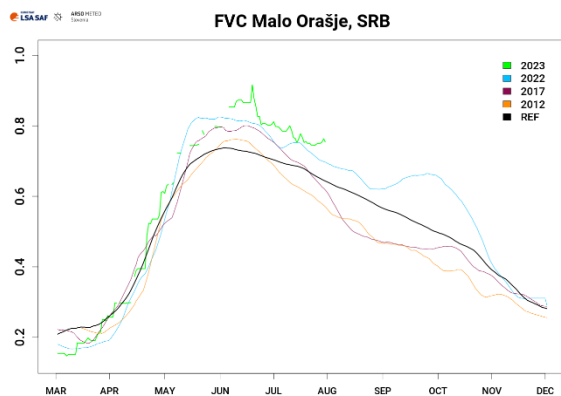




Vegetation season began early this year in Laktasi and Bijeljina along the northern Bosnia and Herzegovina, fraction of cover with green vegetation was already 10–20 % higher than normal by early April. Vegetation growth continued at its regular rate, resulting in exceeding the peak cover by up to 15 % by mid-May. Since then, unfavourable weather conditions sped up the senescence phase due to which fraction of cover with vegetation fell below the average level before the end of June.

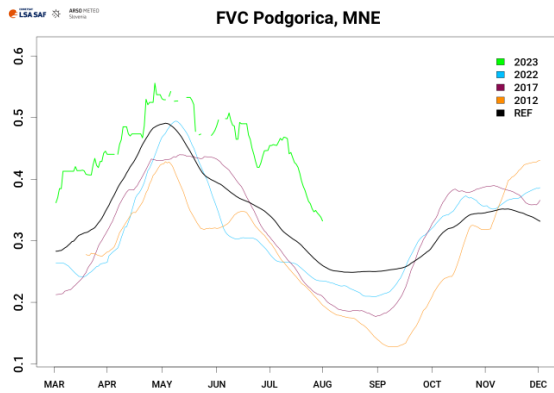
At both locations July weather conditions stagnated further senescence. Also in Trebinje, southern Bosnia and Herzegovina, vegetation season began up to a month earlier than normal although further growth and development progressed at the slower rate than usual. In second half of spring, fraction of vegetation cover was still slightly above the average for this time of year and remained so throughout early summer as well. Mid-June FVC values show sharp decline in vegetation cover while late June saw slight recovery and, according to FVC, senescence phase appear to have progressed at its usual rate throughout July.

SERBIA



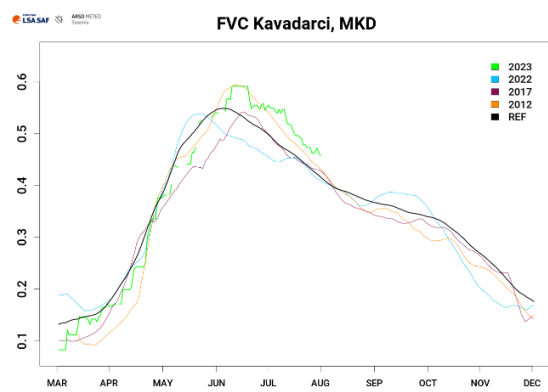
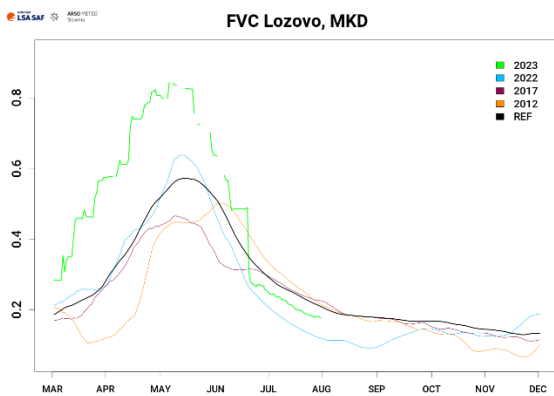
Fraction of cover with green vegetation was in late winter in Malo Orasje, central Serbia lower than normal but was compensated with an earlier onset of vegetation season, which this year began approximately 2 weeks ahead of its usual time. Vegetation development progressed at the usual rate, meaning the level of cover with vegetation continued to follow well its reference levels from April onward. Weather conditions throughout spring proved favourable for further growth and development even beyond its usual peak time and this year peaked a month later and with approximately 10 % higher FVC values. A sharp decline occurred in mid-June although overall level of cover remained above-average in comparison to the long-term, and throughout July continued its senescence phase at the regular rate. In Veliko Srediste, northeastern Serbia, vegetation season also began earlier than normal and vegetation growth progressed at the usual rate. It peaked at its usual time with marginally higher level of cover with green vegetation. A sudden drop in FVC to under-average values can be observed in mid-June, followed by a more or less constant vegetation cover throughout July, indicating the senescence phase has not yet fully begun.

MONTENEGRO



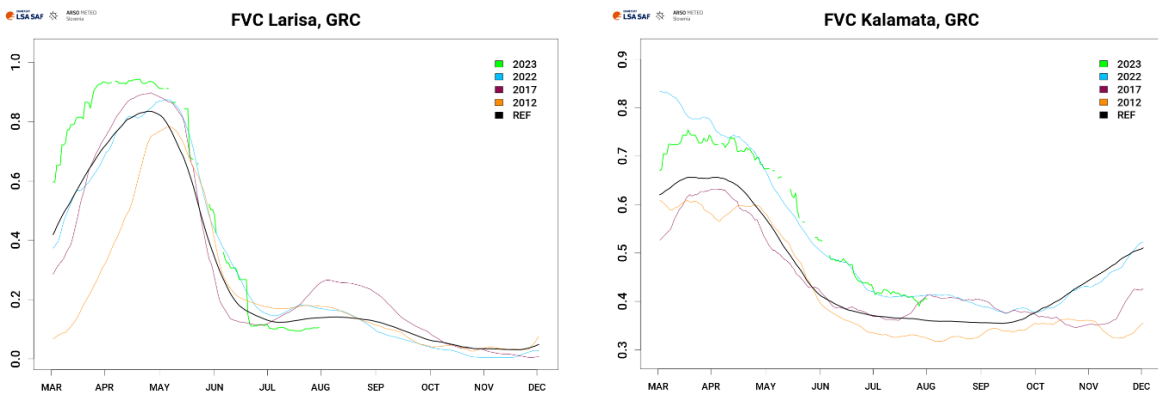
In Podgorica, southern Montenegro, fraction of cover with green vegetation was in early March already up to 10 % higher than normal, and although vegetation growth was slower than usual in first half of spring it peaked at the regular time with slightly above-average FVC. Several episodes of sudden decline and recovery occurred throughout May and June, altogether averaging about a senescence line still approximately 15 % above the long-term average. Unfavourable weather conditions in July resulted in rapid decline in FVC in second half of July but still remained above-average.

NORTH MACEDONIA



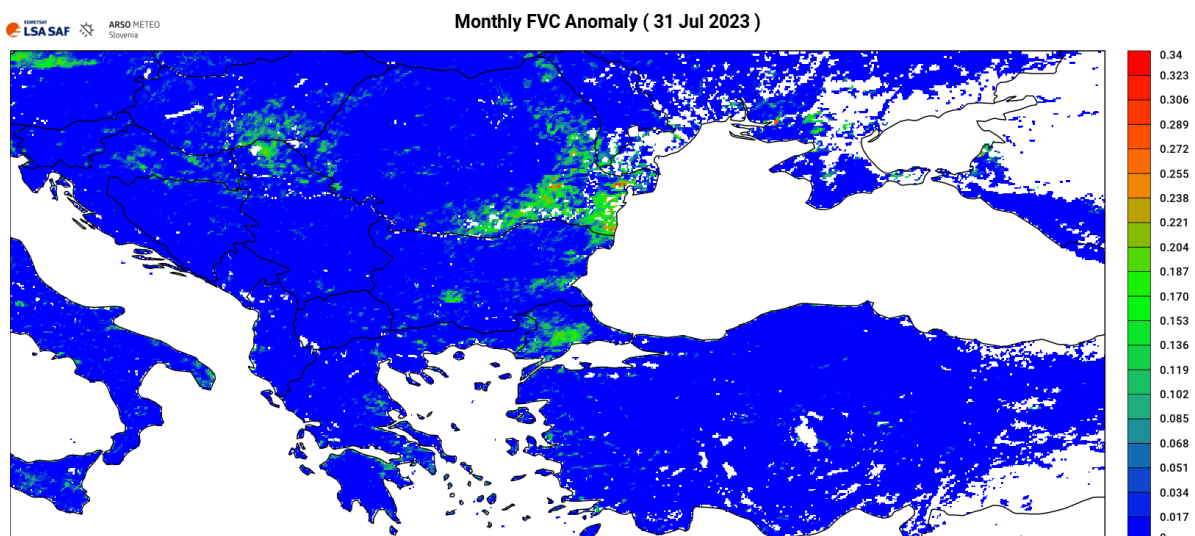
Vegetation season began almost a month earlier in Lozovo, central North Macedonia with weather conditions in first half of spring further boosting vegetation growth. By early May when vegetation development usually peaks, fraction of units covered with green vegetation was already 25 % greater than normal. Later on, weather conditions were not as favourable and caused a rapid decline, from a coverage of over 80 % in mid-May down to 25 %, or under-average, by the end of June. July weather conditions were favourable enough to support regular rate of senescence again. Vegetation development in Kavadarci, southern North Macedonia was in March and April nearly average but further development was slightly held back throughout May. Seasonal peak was reached in first half of June, up to 2 weeks later than normal. Consequently, also senescence phase began later than normal, resulting in slightly above-average level of cover with green vegetation throughout July.

GREECE



Spring weather conditions proved favourable for abundant level of cover with green vegetation at both locations in Greece. March FVC values were in Larisa, central Greece approximately 20 % higher than normal and remained above-average during its seasonal peak in late April, exceeding it by 10 %, meaning a selected plot was nearly entirely covered with green canopy. Seasonal peak lasted slightly longer than normal, followed by a regular rate of senescence at first but mid-June saw some drastic decline in level of cover as it was suddenly brought down to below the average. July weather conditions appeared to support regular vegetation development for this time of year. Also in Kalamata, southern Greece, vegetation experienced favourable conditions for growth and development this season and peak time was also exceeded by approximately 10 %. Senescence phase began at its usual time in late April and progressed at the normal rate, meaning that due to a higher level of cover at its peak time FVC values remained about 10 % higher throughout the rest of the season so far.

Figure below shows negative anomaly of **accumulated 30-day FVC values** as recorded on **31 July 2023** in comparison to the past 19 years (2004-2022), and is used experimentally.



Across much of the region , fraction of cover with green vegetation was in July about the usual level for this time of year, with only scattered isolated locations recording slight decline

compared to the long-term. However, across much of the Pannonian Basin, especially northern Bosnia and Herzegovina and northern Serbia, as well as in southeastern Romania and in parts of central and eastern Bulgaria and Bosphorus Turkey, FVC values were noticeably lower than usual and suggest healthy vegetation would normally cover 10–20 % greater part of the unit area, in localised areas across southeastern Romania up to 30 % greater than it did this July.

DROUGHT IMPACT REPORTS

GREECE

In July 2023, Greece experienced remarkable hot-dry-windy weather conditions. As a result, forest fires occurred in many areas, with the most disastrous in the island of Rhodes (SE Greece), in the island of Kerkyra (NW Greece), in Karystos (Evia), in Magnesia (central Greece), in Couvara (Attica), in Loutraki (NE Peloponnese) and Viotia (central Greece).

Based on Copernicus data, almost 500,000 acres were burnt in Greece in July. The island of Rhodes is counting more than 175,000 burnt acres, while areas in Attica, Magnesia, Loutraki and Viotia were also severely damaged ^[1,4]. According to CAMS, between July 1 and July 25, gas emissions reached 1 megaton of carbon. This is a 21-year record level, almost double the previous record, which referred to the same period in 2007. This figure is equivalent to the pollution produced by 222,500 cars in a year ^[2, 3].

[1] <https://gr.euronews.com/2023/07/30/ellada-karboyno-ton-ioulio-panw-apo-miso-ekatommyrio-stremmata>

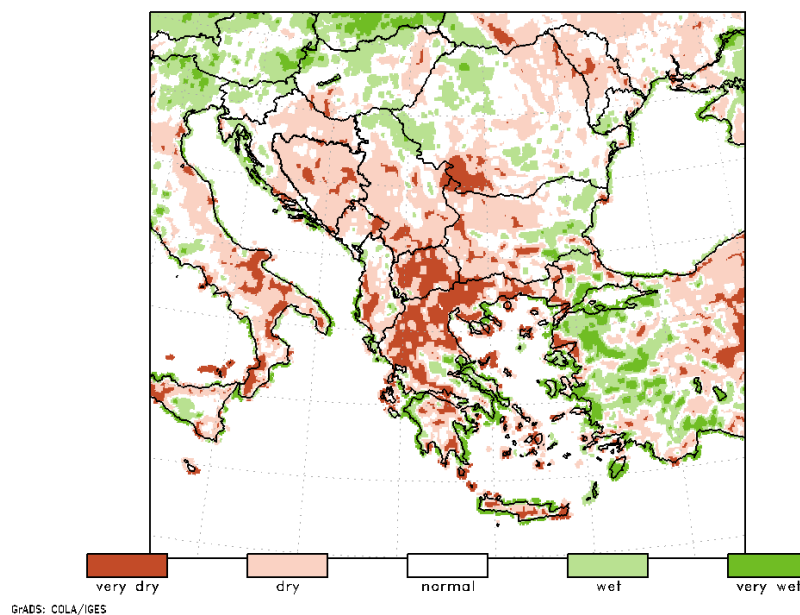
[2] <https://www.kathimerini.gr/life/environment/562539652/copernicus-gia-ellada-se-ypsilo-21-eton-oi-ekpompes-aerion-apo-tis-foties/>

[3] <https://www.tovima.gr/2023/08/04/stiles/sok-ton-ioulio-kaike-stin-ellada-ektasi-megalyteri-apo-to-londino/>

[4] <https://gr.euronews.com/2023/07/17/greece-heatwave-update>

OUTLOOK

Figure below shows model simulations of the **60-day accumulated surface water balance anomaly** in historical percentile classes for the time period **from 10 July to 7 September 2023**.



In comparison to the previous state, surface water balance is expected to generally worsen over much of the region, with the exception of Slovenia and central Hungary where forecast surface water balance is going to change from noticeable deficit to wet conditions, as well as western Turkey where surface water balance is expected to remain unchanged. Elsewhere, conditions are expected to shift from wet or at least average to noticeable deficit, as the forecast surface water balance indicates dry to very dry conditions over a vast part of central and southern Balkan Peninsula and across central Turkey, especially across the entire northern Greece, North Macedonia and southwestern Romania where extremely low levels of 60-day surface water balance are expected to rank among the driest 5th percentile of local records. Over the rest of continental Greece, Albania, entire central Balkan Peninsula including continental and southern Croatia, most of Romania and Moldova, surface water balance deficit ranking among the driest 35th to 5th percentile are expected.

Methodology

DMCSEE Drought monitoring bulletin is based on numerical weather prediction (NWP) model simulations over SE Europe, SPI index calculations, remote sensing product and public media drought impact reports. Precipitation data is provided by Global Precipitation Climatology Centre (GPCC; <https://www.dwd.de/EN/ourservices/gpcc/gpcc.html>) shown against the average of the 1961-1990 time period. NWP simulations are performed with Non-hydrostatic Mesoscale Model at ~7 km spatial resolution (NMM; <http://www.dtcenter.org/wrf-nmm/users/>). Historical model climatology in terms of air temperature and surface water balance is computed with NMM on the base of 1 January 1991 to 31 December 2020 time period, using European Centre for Medium Range Weather Forecast (ECMWF) ERA5 dataset (<http://www.ecmwf.int/en/forecasts/datasets/reanalyses-datasets/era5>) as input for simulations. Long-term averages (1991-2020), used for comparison of current weather conditions, are obtained from simulated dataset. Comparison of current values against long-term average or in percentile classes (the two extreme classes with a 5-percent range, and each of the middle three classes with a 30-percent range) provides a signal on potentially ongoing drought. Remote-sensing product in the bulletin is based on the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) Land SAF MSG Daily Fraction of Vegetation Cover product (<https://landsaf.ipma.pt/en/products/vegetation/fvc/>), presented for the checked and confirmed locations and using long-term averages from 2004 to the last full year (currently to 2022). Information on drought impacts are obtained from freely available online reports of national authorities and media newspapers.