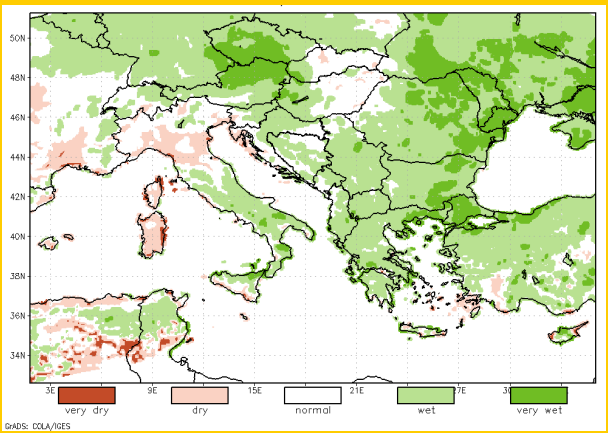
DROUGHT MONITORING BULLETIN

April 2023

HOT SPOT

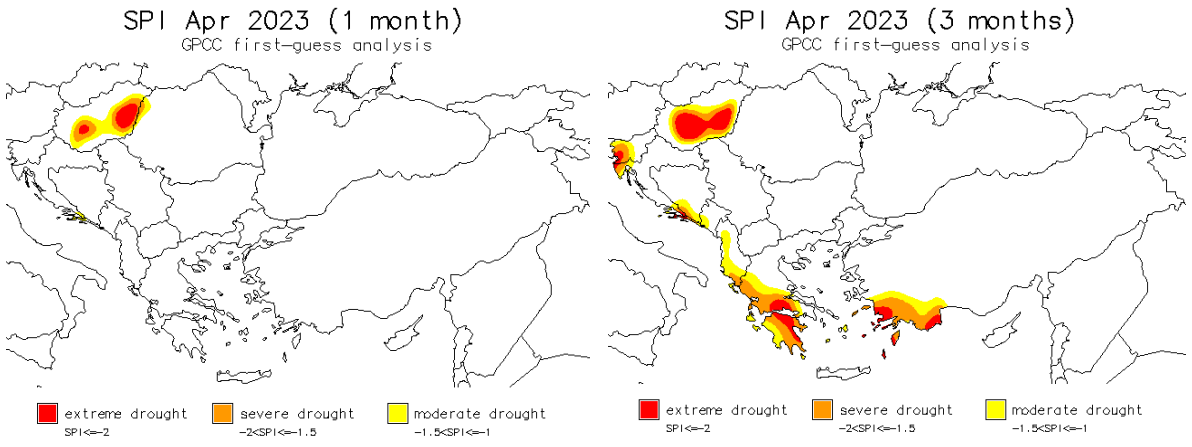


In terms of monthly mean air temperature and precipitation received, April could be described as wet and cold across most of the region, resulting in wetter than normal monthly levels of surface water balance. Figure on left shows **surface water balance for April 2023 in percentile classes** on the base of 1990-2020. Across eastern half of Hungary, along the Adriatic Sea and over parts of southern Turkey, precipitation level ranged about the average or in localised areas even slightly below it, indicating dry surface water balance conditions in April.

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 **April 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.



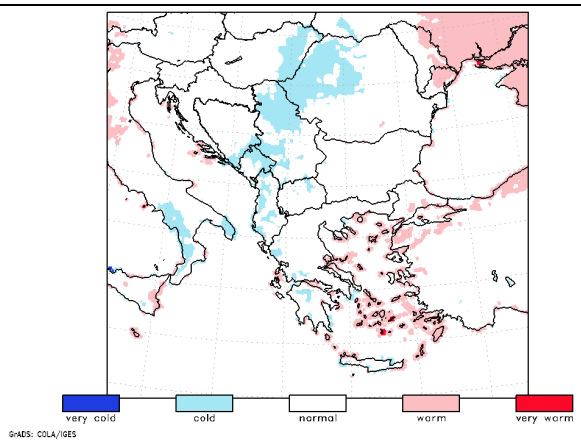
SPI for April shows considerable precipitation deficit over much of the Hungary, mostly its southern half and over its east, indicating this part of the country was experiencing severe to extreme drought conditions this April. In March, only localised areas from Moldova to central Greece and over western Hungary experienced moderate precipitation deficit, while in February noticeable lack of precipitation was present over much of the southern half of the region, causing extreme drought conditions over western half of Turkey, Greece, Albania, most of Northern Macedonia but also over eastern parts of Romania and Bulgaria. Meanwhile, lack of precipitation over Slovenia and Hungary indicated moderate to severe levels of drought. SPI3 for April therefore shows severe to extreme drought condiitons over the last three months across most of Hungary, western Slovenia over to Croatia, western and southern Greece as well as southwestern Turkey, mostly on the account of dry February, in Hungary also dry April.

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 2 March to 30 April 2023**.*

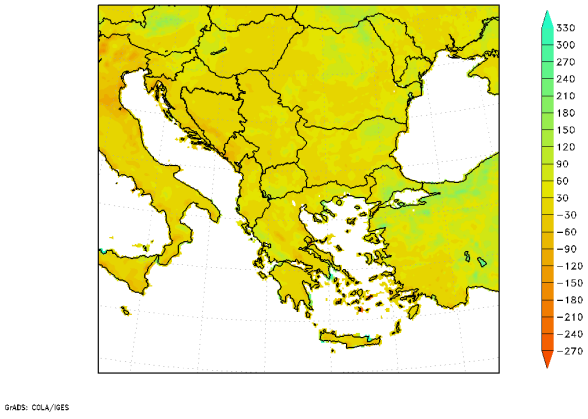
AVERAGE AIR TEMPERATURE ANOMALY (°C)
2 MARCH – 30 APRIL 2023

AVERAGE AIR TEMPERATURE PERCENTILE CLASSES
2 MARCH – 30 APRIL 2023

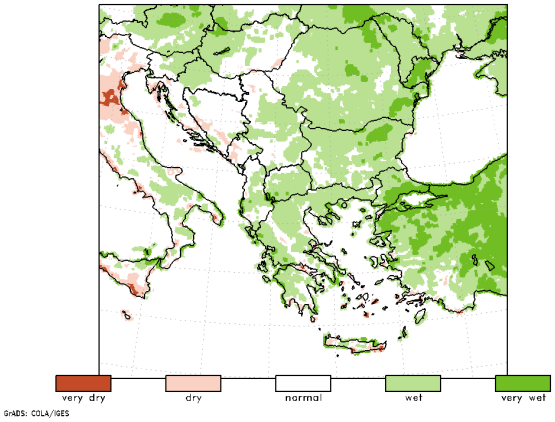


After warmer than normal March, April began with the coming of much colder than usual air temperatures from the north-west. The average air temperature of its first 10 days stood 3-5 °C below the early April normal over a wider northwestern half of Balkan Peninsula, stretching as far inland as Montenegro, Serbia and northeastern Romania. Mid-April saw some relief in air temperature conditions as they mostly returned to normal for this time of year, however, colder than normal weather of up to 2 °C below the average prevailed over Slovenia, southern Albania, Greece and southwestern Turkey. It remained up to 2 °C colder than normal in a wide belt from Slovenia to Greece and in Bulgaria through the rest of the month, end of April again brought colder than normal air temperatures across the region's north and east. They fell up to 3 °C below the average over eastern Hungary, Romania, Moldova, eastern and southern Serbia and Turkey, in localised areas across Romania-Moldova border and in central Turkey they stood up to 4 °C below the average. Since air temperatures throughout all March were generally warmer than normal across the region, the 60-day mean air temperature of the March-April period shows little deviation from the long-term normal, not more than 1 °C in either side, averaging out the changing air temperature conditions occurring throughout March and April.

ACCUMULATED WATER BALANCE ANOMALY (mm)
2 MARCH – 30 APRIL 2023



ACCUMULATED WATER BALANCE PERCENTILE CLASSES
2 MARCH – 30 APRIL 2023



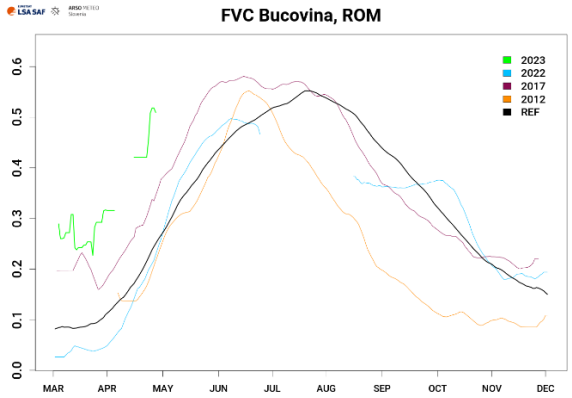
April level of surface water balance was well above the average across vast part of the region, driven mostly by higher than normal precipitation amount this month. Surplus was especially high over eastern parts of Balkan Peninsula, from Moldova to northwestern Turkey where it classified among the wettest 5 % of local long-term records for April. Meanwhile, areas along the Adriatic Sea and southwestern Turkey recorded deficit in surface water balance. As March proved to be drier than normal across vast part of central and southern Balkan Peninsula, the accumulated surface water balance of March-April period ranged mostly about the average values for this time of year or with surplus of up to 60 mm. Noticeable 60-day surplus between 120-180 mm was present over northern Romania, northeastern Bulgaria, across most of Turkey and in western Greece, mostly on the account of wet April, while area along the Adriatic Sea stretching from Croatia to Montenegro recorded accumulated deficit of up to 90 mm.

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 lower at the beginning of the growth season, the highest at the full vegetation development, then FVC slowly drops with vegetation senescence. Line shape depends on the sort of vegetation at the given location.

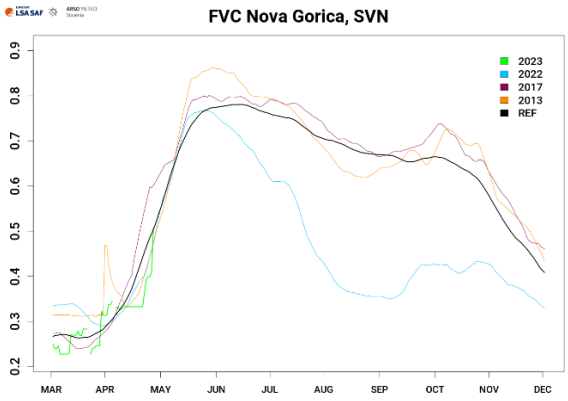
Graphs below present the **vegetation situation** as recorded **on 28 April 2023** at selected locations across Southeastern Europe. FVC values for year 2023 are presented as a green line. Graphs also include reference line (2004–2022) in black, and lines in light blue (year 2022), magenta (year 2017) and orange (year 2012, or 2013 for Slovenia) for comparison. Possible missing values or their sharp decline could be a result of a prolonged cloudy weather, extreme weather events, snow blanket or changes to product by the product provider.

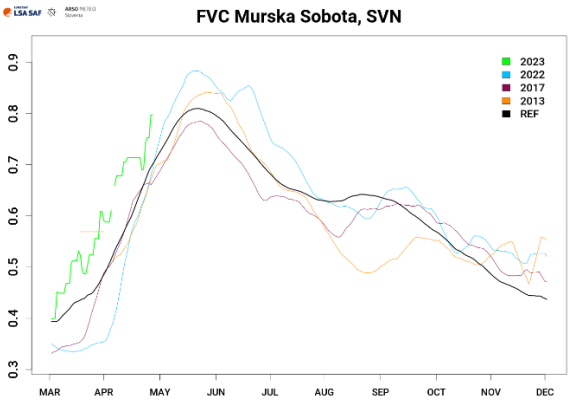
ROMANIA



At the beginning of March, fraction of cover with vegetation in Bucovina, northern Romania was more than twice as high as normal, and spring weather conditions proved favourable for vegetation growth. With the regular onset of growing season and its usual growth rate it means FVC values remained above-average, with vegetation covering approximately twice as great fraction of unit as normal also at the end of April.

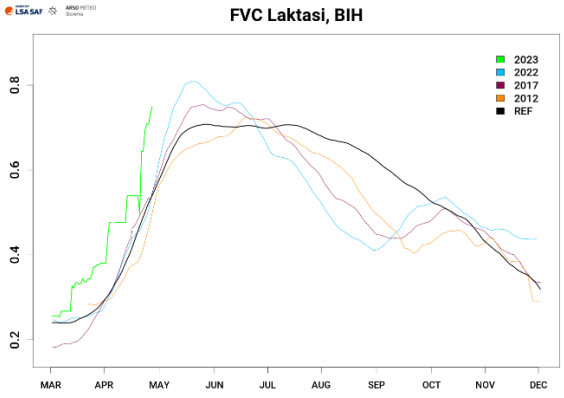
SLOVENIA

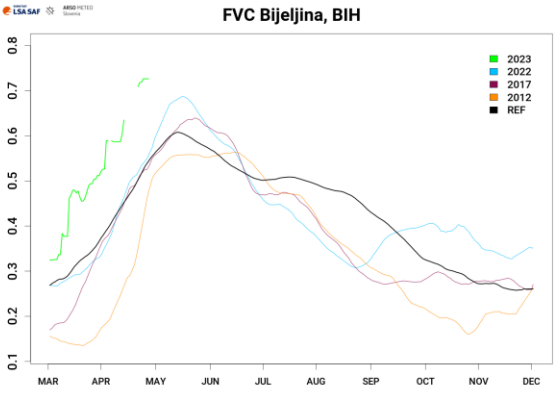


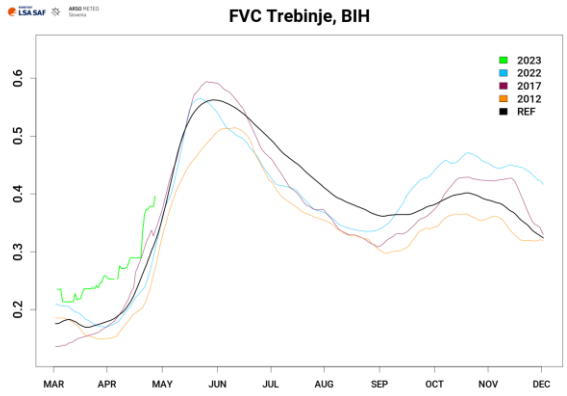


Vegetation cover was slighty lower than normal at the beginning of spring in Nova Gorica, western Slovenia. As vegetation development began in March, it was followed by a noticeable stagnation at the beginning of April. Further vegetation growth restored again at the end of April and caught up to its usual fraction of cover at the end of the month. Meanwhile in Murska Sobota, northeastern Slovenia, spring weather conditions boosted vegetation growth early in March, and with constant progression in its growth, the vegetation cover more or less continuously exceeded the average level by approximately 10 % throughout March and April.

BOSNIA AND HERZEGOVINA (REPUBLIC OF SRPSKA)

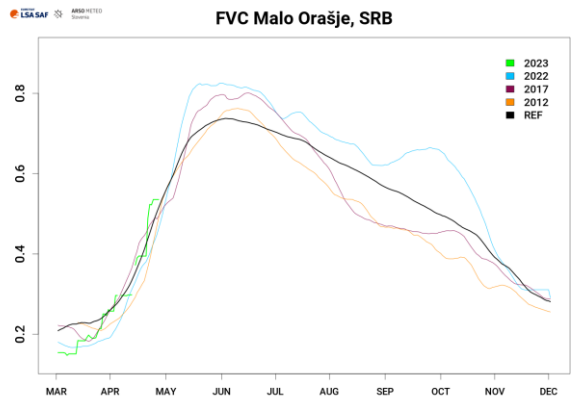


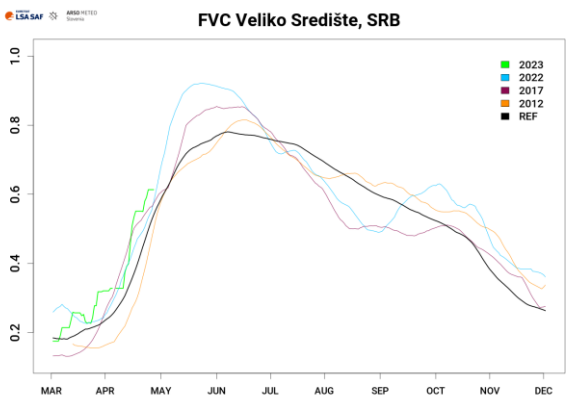




In Laktasi and Biljeljina along northern Bosnia and Herzegovina, vegetation season began approximately 2-3 weeks earlier than normal, resulting in vegetation cover exceeding the regular levels throughout March and April by up to 10 % in Laktasi and up to 20 % in Bijeljina. Also in Trebinje, southern Bosnia and Herzegovina, vegetation cover was above-average at the beginning of vegetation season although further growth throughout March and early April progressed at the lower rate than normal. End of April saw some boost in vegetation growth, leaving vegetation covering approximately 10 % higher fraction of unit than normal at this time of year.

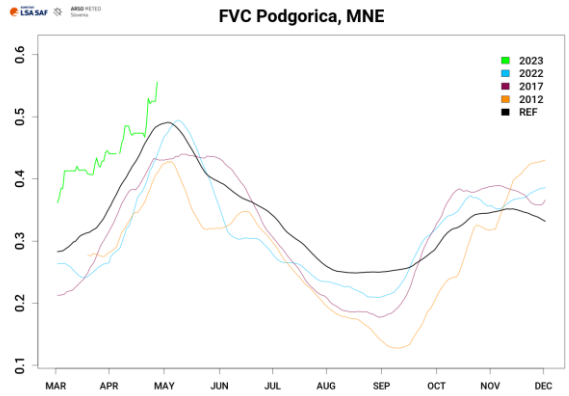
SERBIA





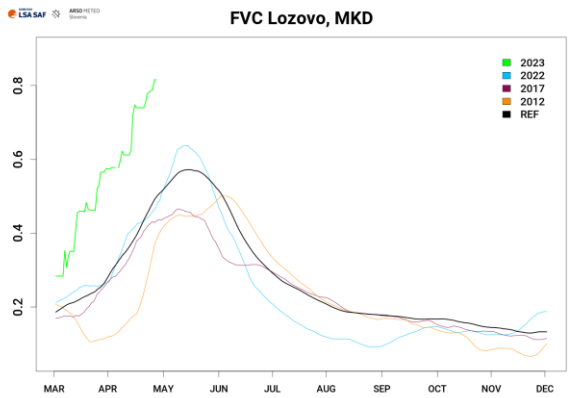
In Malo Orasje, central Serbia, fraction of cover with vegetation was at the beginning of spring approximately half the level it normally is at that time. Vegetation growth began as usual in mid-March and progressed at its normal rate of growth, following well the usual development throughout March and April. Meanwhile, in Veliko Srediste, northeastern Serbia vegetation season began slightly earlier than normal, however, unfavourable weather conditions stagnated growth at the end of March and early April. Further vegetation development continued well in second half of April, reaching its usual levels slightly ahead of its regular time.

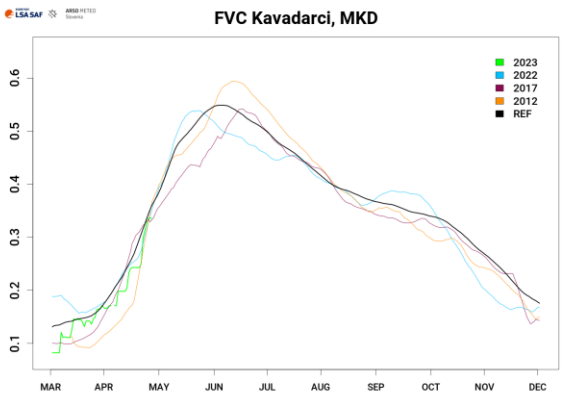
MONTENEGRO



Vegetation cover was at the beginning of March up to 10 % higher than normal in Podgorica, southern Montenegro. Growing season began as usual in second half of March although April weather conditions slightly hindered further growth, as vegetation development progressed at the lower rate than normal at that time of year. Some boost in vegetation growth can be observed at the end of April, according to FVC values, exceeding the seasonal peak level of vegetation cover.

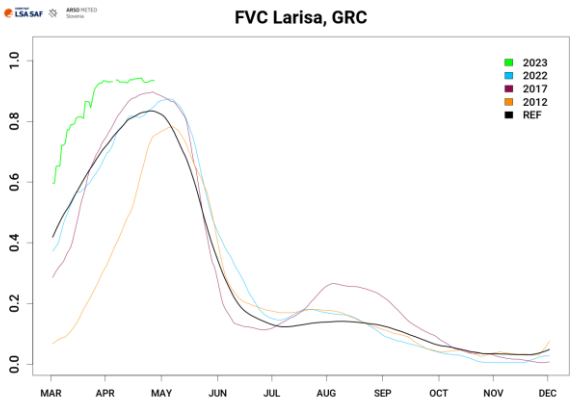
NORTH MACEDONIA

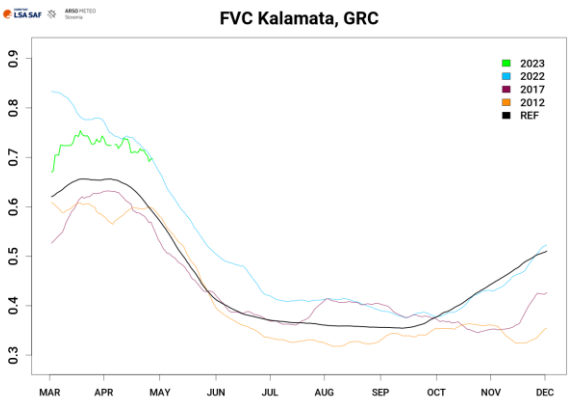




Vegetation development in Lozovo, central North Macedonia began almost a month earlier than normal this year and progressed well throughout March and April. Due to an early start as well as slightly higher than normal rate of growth, FVC were well above-average throughout spring and at the end of April values stood approximately 25 % above the normal for this time of year. In Kavadarci in southern part of the country, fraction vegetation cover at the beginning of spring was approximately half its usual for early March, but vegetation season began as usual and further vegetation development progressed at its regular rate for this time of year, resulting in just about the average FVC values throughout first months of spring.

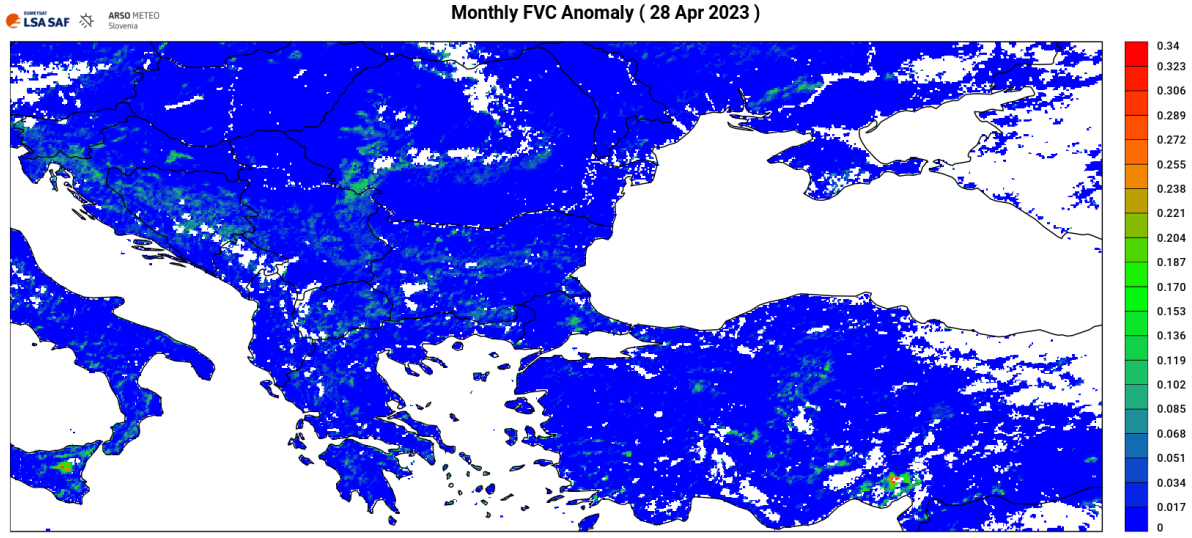
GREECE





Vegetation development in Larisa, central Greece entered March at the level much higher than normal for this time of year, FVC values exceeded the average for approximately 20 %. March weather conditions proved favourable for further vegetation growth which progressed throughout the month at the slightly higher rate than normal, covering nearly the entire unit by the early April, 20-25 % more than usual, reahced its peak almost a month earlier Values remained at such high level throughout April. In Kalamata too in southern Greece, vegetation cover in early March was above-average this season. Throughout first half of March, vegetation growth progressed at the higher than normal rate, exceeding the peak fraction of cover by at approximately 10 % by mid-March and remained at such level for another month before beginning its senescence phase in second half of April.

Figure below shows negative anomaly of **accumulated 30-day FVC values** as recorded **on 28 April 2023** in comparison to the past 19 years (2004-2022), and is used experimentally.



Monthly accumulated negative anomalies of FVC show no great deviation from the average vegetation cover across the lowlands in the region this April. Some deviations can be observed only in the higher altitudes of mountainous areas across the region, including western Carpathians, along the Dinaric Alps, the Balkans and in central Turkey where green vegetation would normally cover up to 15 % greater fraction of unit than currently observed.

DROUGHT IMPACT REPORTS

TURKEY

Due to the lack of precipitations throughout winter season, drought problems arose across vast part of the country. According to the data of the General Directorate of Meteorology, Turkey experienced the driest January in the last 22 years [1, 2]. Such conditions at this time of year caused **hydrological drought**, as water levels in rivers, dams and ponds dropped drastically, and less **snow cover** was present in the mountainous area. Much reduced or even absent was snow cover in Mount Nemrut in Adiyaman, southeastern Turkey, as well as Spil Mountain in Manisa, western Turkey, both of which are popular tourist destinations [3]. In December 2022 already, Bayramic Dam in far western Turkey, which has a water capacity of 96.5 million cubic meters, had only about 10 million cubic meters of water left due to drought. With decreased water level of the dam, the ruins emerged of a 1,500-year-old bath and church belonging to the ancient city of Skepsis [4].

In January, islets appeared in Turkey's **longest river** Kizilirmak near Yahsihan, central Turkey [5]. Drought also hit Lake Iznik in the country's north-west, one of the country's **largest fresh water resources**. Water receeded 400 meters from its original shore and the pier remained well on land, reaching alarming proportions due to winter drought [6]. As a result of lack of rainfall and absence of snowfall, also in Sapanca Lake, northwestern Turkey water level dropped significantly and receeded from its original shore line for about 40 meters. It rose

concerns over the drinking water supply as water from this lake normally meets 90 % of Sakarya's drinking water needs and 15 % of Kocaeli's water needs [7]. Severe concers arose in January over **drinking water supply also for Istanbul**, Turkey's most populous city, as the average of the occupancy rates of the dams supplying Istanbul steadily declined every month from nearly 90 % in March 2022 down to 30.3 % at the end of January 2023, the lowest there has been in the last 10 years. Of the dams supplying Istanbul, the worst istuation was at Pabucdere Dam and Kazandere Dam with water levels at less than 5 % their full capacity. According to the University Geographic Information Systems and Remote Sensing Center director, this meant that Istanbul residents had 15 cubic meters of water left per person, or enough to meet Istanbul's water needs for only two more months [8, 9, 10, 11]. In the Black Sea region, which is known for regular precipitations, the decrease in precipitation triggered concerns also over **groundwater** levels [11].

In February, low water levels in dams triggered **drinking water supply** concerns also across wider north-western and wester part of the country, especially those supplying **Bursa, Odrin and Izmir** cities. Of the two dams supplying Bursa, Nilufer Dam with its annual capacity of 60 million cubic meters and stretching over 1.47 square kilometres completely dried up and the occupancy rate of Dogancı Dam positioned in the lower basin from Nilufer Dam stood at 24 %, the lowest level since its establishment in 1983 [12, 13, 14]. Similar situation was seen in Odrin region, northwestern Turkey, where much reduced occupancy rate of the Kadikoy Dam, which meets most of the water needs of Kesan district, could meet water needs of Kesan for a maximum of 3-4 month [15]. By the end of February, water level in Kozan Dam in southern Turkey also dropped to 28 % and islets formed on its banks. **No dam irrigation** was allowed, posing great concern to farmers whose planting season already began. Warmer than normal weather as well as dry soil affected root growth in wheat and barley, indicating potential for decreased yield, similarly as reported also from Trakya Seeds Association, northwestern Turkey [16, 17, 18].

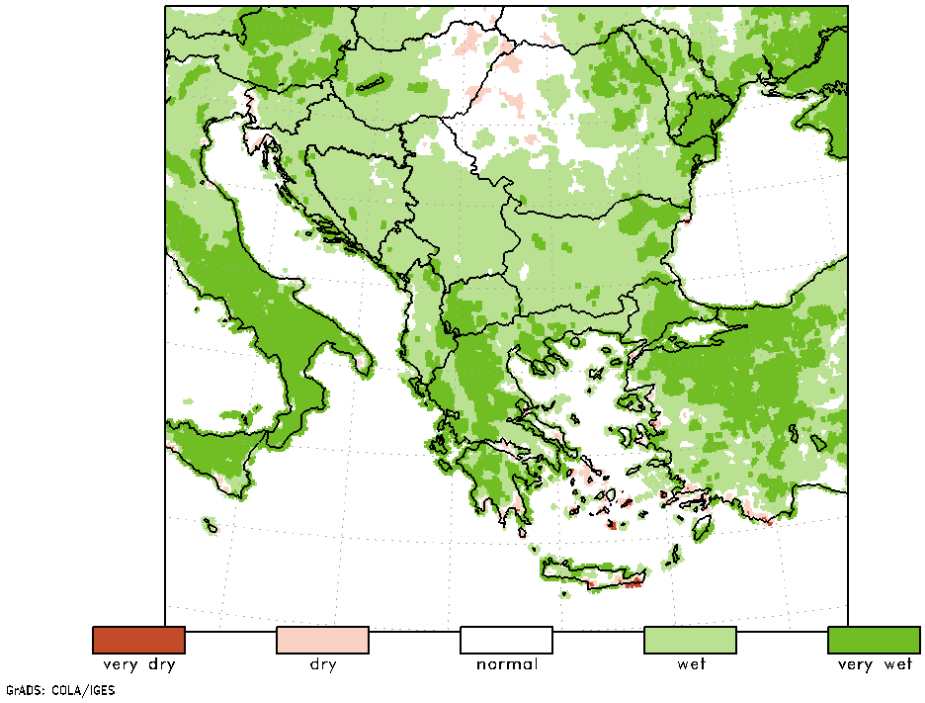
Hydrological drought upon the driest winter season of recent years continued to cause problems also in March. The occupancy rate of the Cekerek Dam, central Turkey, which normally irrigates 66,165 hectares of land in Yozgat, Corum, Amasya and Tokat, decreased to mere 10.6 %. **Water shortages** were reported also in Mersin, Mediterranean Turkey where water level in Berdan Dam, which supplies the city with water for both drinking and agricultural irrigation purposes, droped to 15 %. With water level at such critical state, it was no longer allowed to be used for **agricultural irrigation** [1, 19]. In Buyukcekmece Lake, northwestern Turkey, water was visibly withdrawn, the lake partially completely dried up and islets were formed at some parts of the lake. According to the fishermen, water level which at certain plances used to stand at 5-6 meters, in early March stood at 2-2.5 meters, and pointed out the situation was critical also for **fish community** [20]. By mid-March, water level of many dams across Turkey fell to the lowest level in recent years due to drought. According to the Canakkale Municipality, western Turkey, water level in Atikhisar Dam which meets the drinking use and agricultural irrigation needs of the city, decreased by more than half. **Water restrictions** and bans put in place were directed at both household use as well as its use in industry and services, introducting maximum limit of water consumption per month and prepaid electronic meters to be installed in workplaces with high water consumption, such as car and carpet washing, Turkish bath and toilet. It became obligatory for places using groundwater to install mechanical meters for determining groundwater use, and use of water for agricultural purposes were limited to urgent irrigation only [21, 22]. Pointed out by the University Maritime Faculty Dean, there was increased risk of **mucilage in Marmara Sea** as a result of drought reducing the inflow of fresh water from the inland, but also due to increased

sea surface temperature, which in late March was measured 4 °C higher than in March of previous year [23].

[1] https://www.hurriyet.com.tr/gundem/kurak-havalar-sonrasi-su-alarmi-barajlardaki-seviye-azaldi-42227294
[2] https://www.aksam.com.tr/guncel/istanbulda-barajlarkritik-seviyede-son-22-yilin-enkurak-ocak-ayi/haber-1345763
[3] https://www.posta.com.tr/gundem/kis-kurakligi-daglari-asti-2604688
[4] https://www.aksam.com.tr/guncel/baraj-sulari-cekilince-ortaya-cikti-tarihi-bin-500lu-yillara-dayaniyor/haber-1324530
[5] https://www.turkiyegazetesi.com.tr/fotogaleri/korkutan-manzara-su-yuzeyinde-ortaya-cikti-32403?p=5
[6] https://www.turkiyegazetesi.com.tr/fotogaleri/iskele-var-su-yok-kurakligin-en-net-fotografi-iznikte-cekildi-gol-400-metre-cekildi-32597?p=6
[7] https://www.aksam.com.tr/guncel/sapanca-golu-alarm-veriyor/haber-1336871
[8] https://www.posta.com.tr/gundem/barajlar-alarm-veriyor-iste-istanbuldaki-baraj-doluluk-oranlari-2603579
[9] https://www.posta.com.tr/video-havuzu/kurak-bir-kis-geciren-megakent-istanbulda-barajlarin-doluluk-orani-yuzde-30un-altina-dustu-2604551
[10] https://www.hurriyet.com.tr/video/istanbulda-2-aylik-su-kaldi-42210028
[11] https://www.hurriyet.com.tr/gundem/kuraklik-hic-olmadigi-kadar-tehlikeli-can-cekisen-barajlari-besleyecek-yagislar-ne-zaman-gelecek-icecek-suda-kisitlamaya-gitmek-durumunda-bile-kalabiliriz-42209961
[12] https://www.hurriyet.com.tr/video/bursada-doganci-baraji-40-yildan-bu-yana-en-dusuk-seviyede-42224897
[13] https://www.turkiyegazetesi.com.tr/gundem/-951730
[14] https://www.posta.com.tr/video-havuzu/bursanin-20-gunluk-suyu-kaldi-nilufer-baraji-su-anda-bombos-2613841
[15] https://www.hurriyet.com.tr/video/kesanin-3-aylik-suyu-kaldi-42223399
[16] https://www.posta.com.tr/galeri/adanada-kuraklik-endisesi-2613358/2
[17] https://www.hurriyet.com.tr/gundem/adanada-deprem-sonrasi-kuraklik-endisesi-42225620
[18] https://www.milliyet.com.tr/ekonomi/trakyada-kuraklik-bugday-ve-arpada-kok-gelisimini-cok-etkiledi-6915246
[19] https://www.posta.com.tr/gundem/son-yillarin-en-kurak-kis-mevsimi-prof-dr-yilmaz-ilkbahar-yagislarina-muhtaciz-2615879
[20] https://www.hurriyet.com.tr/video/buyukcekmece-golunde-doluluk-orani-gecen-yila-gore-yuzde-94lerden-yuzde-30lara-dustu-42231446
[21] https://www.turkiyegazetesi.com.tr/fotogaleri/canakkalede-kuraklik-alarmi-su-kullanimi-yasaklandi-hali-kilim-ve-hortumla-otomobil-yikamak-yasaklandi-33251?p=3
[22] https://www.posta.com.tr/galeri/kuraklik-alarm-veriyor-bir-kentte-ilk-yasaklamalar-basladi-2614436/2
[23] https://www.milliyet.com.tr/gundem/musilaj-endisesi-korkunc-bir-kuraklik-yasiyoruz-6925829

OUTLOOK

Figure below shows model simulations of the **60-day accumulated surface water balance anomaly** in historical percentile classes for the time period **from 1 April to 30 May 2023**.



The modelled 60-day surface water balance in the next 10 days is projected to be wetter than normal for this time of year across vast majority of the region, especially over its southern

parts, mostly Greece, western Turkey and parts of North Macedonia, and eastern parts, mostly Moldova, eastern Romania and eastern Bulgaria where surface water balance of the April-May period is expected to be among the wettest 5 % of local records. At the same time, parts of eastern Hungary and northwestern quarter of Romania are expected to end the April-May period with a noticeable surface water balance deficit indicating dry conditions.

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-hydrostatical 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.