DROUGHT MONITORING BULLETIN

September 2021

HOT SPOT

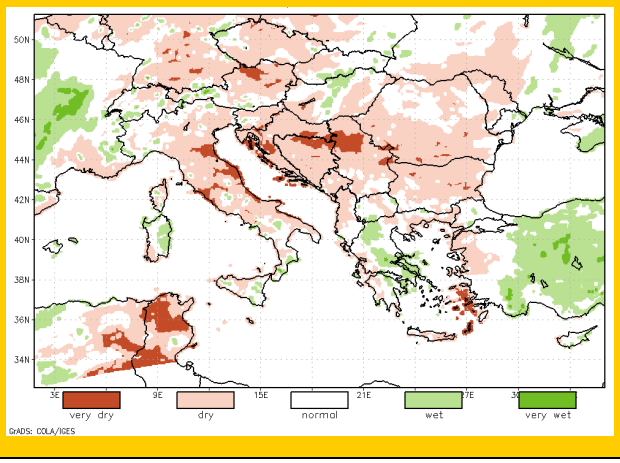
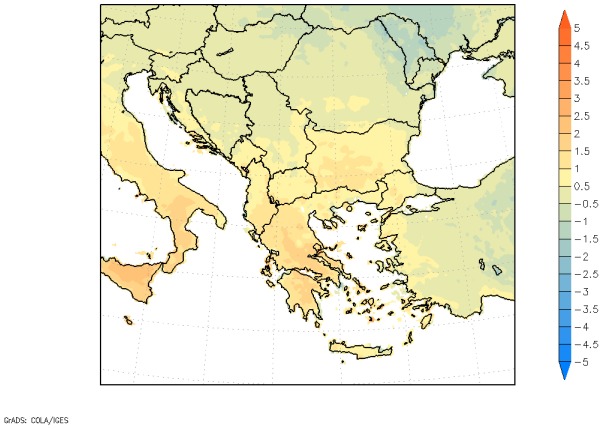


Figure on the left shows **anomaly of monthly precipitation in percentile classes for September 2021** and reveals it was a dry month across most of Balkan Peninsula. Unusually low rainfall rate for this time of year caused a rainfall deficit of mostly up to 45 mm. Lack of rain was most evident in a belt from Croatia to Serbia and along the Adriatic Sea coast where deficit of up to 75 mm, in northwestern Croatia about 100 mm, classified as one of the driest September months.

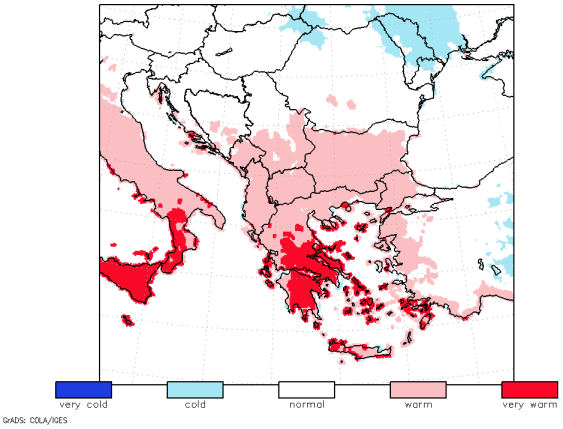
AIR TEMPERATURE AND SURFACE WATER BALANCE

*Figures in this section present anomalies of the average air temperature and accumulated surface water balance as well as classified values of the average **air temperature** and **surface water balance** in percentile classes for 60-day period **from 30 July to 27 September 2021**.*

AVERAGE AIR TEMPERATURE ANOMALY (°C)
30 JULY – 27 SEPTEMBER 2021



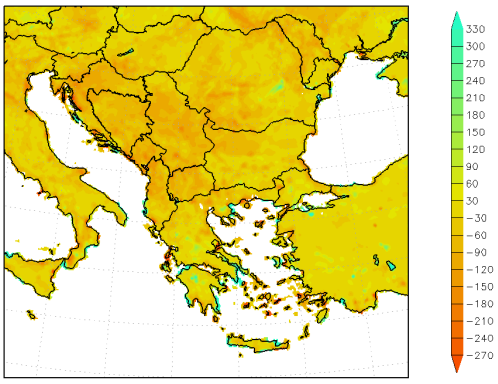
AVERAGE AIR TEMPERATURE PERCENTILE CLASSES
30 JULY – 27 SEPTEMBER 2021



Air temperature conditions in September were very diverse across the region. There was a clear west-to-east gradient of air temperature anomalies: highest anomalies of up to 1.8 °C were recorded in Slovenia, September was between 1-1.5 °C warmer than normal also across Croatia,

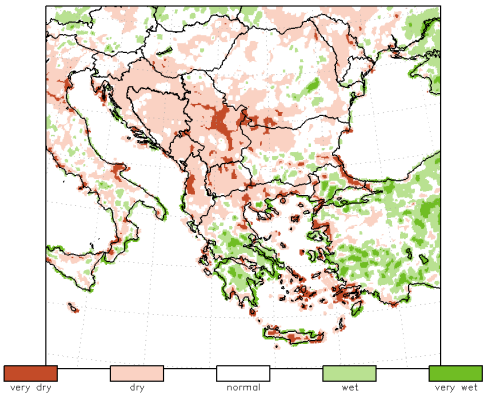
Bosnia and Herzegovina and northwestern Hungary. Over the central third of Balkan Peninsula from Hungary to Bulgaria and Greece, monthly mean ranged about the average air temperatures for September or was slightly warmer than normal. Further to the east, across eastern half of Romania and western Turkey, September was 1-2 °C colder than normal while greatest deviation into the cold was present across Moldova and central third of Turkey where September was up to 2.7 °C colder than normal. September saw changing air temperature conditions also throughout the month. Its first 10 days saw, at best, average air temperatures which were present over Slovenia, Greece and Turkey, but elsewhere they were noticeably colder than normal, between 2-3 °C, in Moldova up to 4 °C. Mid-September saw evident increase in air temperatures, nearly all Balkan Peninsula with the exception of Greece experienced air temperatures 2-3 °C above the average, in localized areas across Slovenia, Hungary and Croatia even up to 4 °C. At that time, decrease in air temperatures was present only across central Turkey, 2-3 °C below the average. While they remained colder-than normal throughout the rest of the month, the rest of the region experienced another set of changes in air temperature conditions: after an average month so far, Greece experienced up to 2 °C warmer than normal final days of the month, over its central and southern part up to 3 °C, but a spell of air temperatures 2-4 °C colder than normal returned to Moldova, Romania and eastern Hungary. Since August brought north-to-south gradient in air temperature conditions while in September a west-to-south gradient prevailed, a 60-day mean air temperature averages out across most of the region especially its central and northern third where 60-day mean ranged for up to 1 °C about the average. However, areas in the south including southern Bulgaria, southern Albania and most of Greece saw consecutive months of above-average air temperatures, meaning last August-September period was up to 2 °C warmer than normal, while areas in the north-east including Moldova, eastern Romania and northeastern Hungary experienced consecutive months of colder-than-normal air temperatures, which puts August-September mean up to 1.5 °C below the average over that part of the region.

ACCUMULATED WATER BALANCE ANOMALY (mm)
30 JULY – 27 SEPTEMBER 2021



GrADS: COLA/IGES

ACCUMULATED WATER BALANCE PERCENTILE CLASSES
30 JULY – 27 SEPTEMBER 2021



GrADS: COLA/IGES

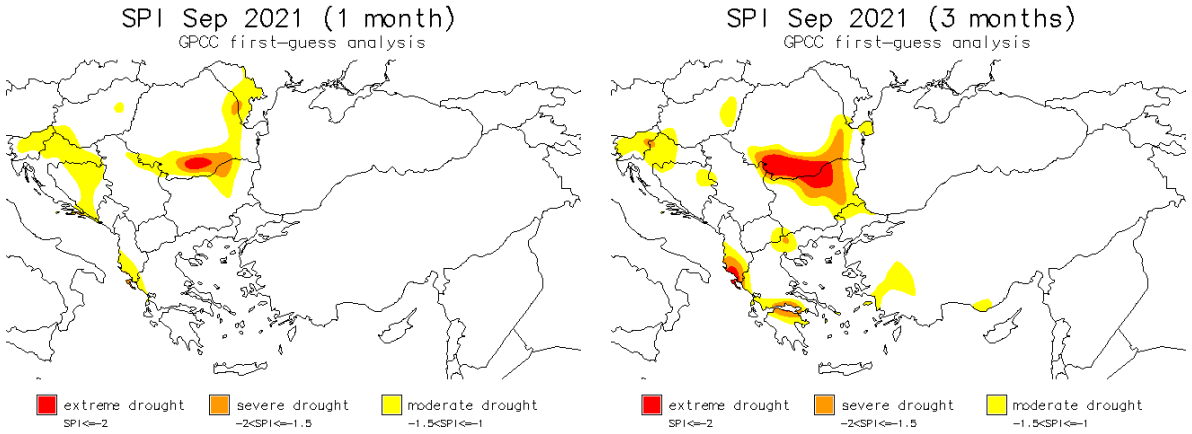
If September was warmer than normal across southern parts, mostly Greece, it was at the same time also wetter, especially over its continental part. Turkey and central Hungary too recorded wetter than normal water balance conditions in the topsoil layer, but across the rest of the region, this September water balance deficit prevailed in comparison to the long-term records. Especially dry were northern Serbia, northern Bosnia and Herzegovina and several localized areas across the Adriatic Sea and Aegean Sea. Although August brought normal to slightly wet surface water balance conditions across the region, with the exception of central part of Balkan

Peninsula where August was dry to very dry, the deficit experienced in September greatly shaped the values of 60-day accumulations: surplus of up to 90 mm prevailed over southern half of Greece and most of Turkey while elsewhere accumulated deficit ranged between 60 mm and 120 mm, especially across central part of the region and Moldova, while over Montenegro and northern Croatia, water balance deficit reached up to 150 mm, leaving August-September period as one of the unusually dry ones for this time of year.

STANDARDIZED PRECIPITATION INDEX

The drought situation with regard to the precipitation accumulation is presented by Standardized Precipitation Index (SPI). The SPI calculation is based on the distribution of precipitation over long time periods (30 years, in our case long-term average 1961-1990 was used). The SPI can be calculated at various time scales which reflect the impact of the 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 **September 2021** 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.



Low SPI values for September indicate presence of moderate drought conditions across greater part of northwestern Balkan Peninsula, from Slovenia across continental Croatia to most of Bosnia and Herzegovina, and along southern Albania. Noticeable precipitation deficit over a great part of southern and eastern Romania and Moldova, also suggest the presence of severely to extremely dry conditions this September.

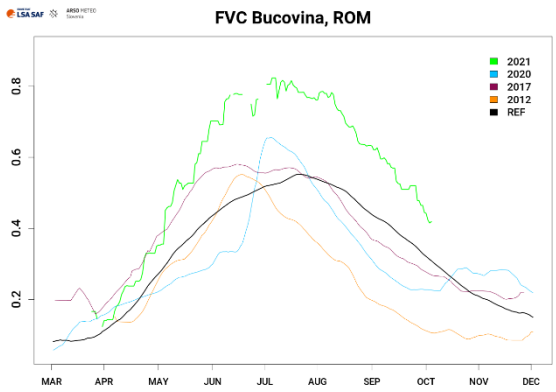
Entire southern Romania is also the one part of the region that experienced severely to extremely dry conditions throughout all past 3 months, which on the accumulated term of SPI3 also indicates extremely dry conditions over the July-September period. Similarly extreme was precipitation deficit of the July-September period over southern Albania which rarely records such low precipitation amount this time of year. Areas of moderate, locally also severe drought conditions over the past 3 months include also Slovenia and continental Croatia, mostly due to precipitation deficit in August and Septemeber, as well as central and northeastern Greece and isolated areas in southeastern Hungary, eastern Bosnia and Herzegovina and western Turkey.

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 sort of the vegetation.

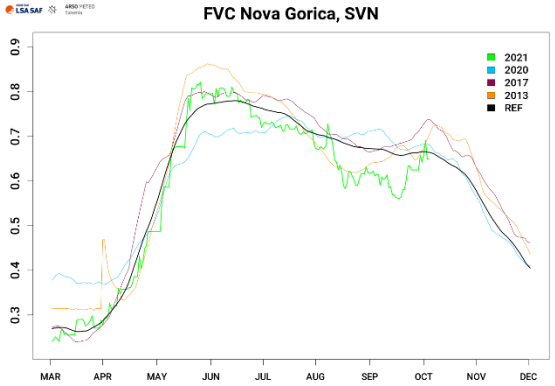
Graphs below present the **vegetation situation** as recorded **on 4 October 2021** in some regions of Southeastern Europe. FVC values for year 2021 are presented as a green line. Graphs also include reference line (2004–2020) in black, and lines in light blue (year 2020), magenta (year 2017) and orange (year 2012, or 2013 for Slovenia) for comparison. Possible missing values or sharp decline of values could be a result of prolonged cloudy weather, extreme weather events or snow blanket.

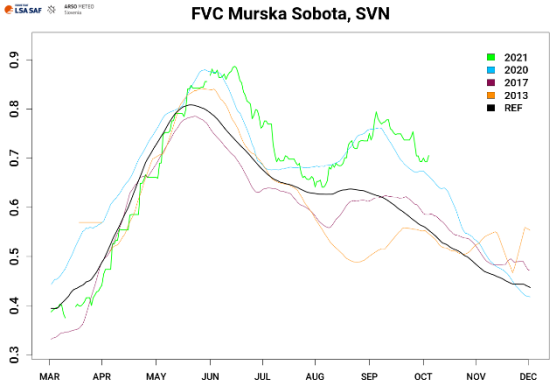
ROMANIA



First half of the season brought favourable weather conditions for vegetation growth and development to Bucovina, northern Romania, as indicated by continuously well-above-average FVC values. The much higher than normal growth rate resulted in reaching more than 20 % greater level of vegetation cover at its peak time than expected. Although weather conditions were not ideal in the second half of the season, vegetation abundance reached prior to it was enough to maintain higher than normal vegetation cover for this time of year.

SLOVENIA

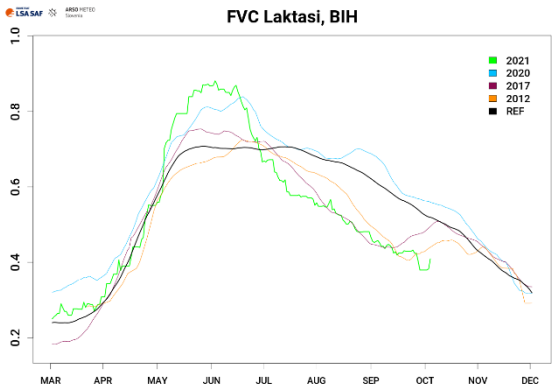


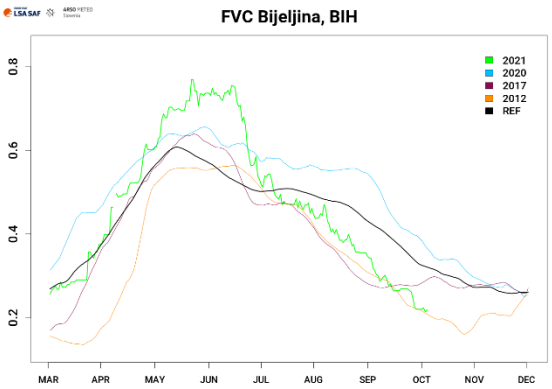


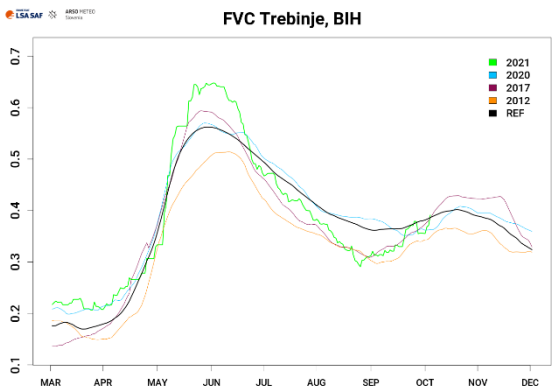
In Nova Gorica, western Slovenia, vegetation growth followed well its usual pattern of development during first half of the season. Unfavourable weather conditions that began in early summer are reflected in under-average FVC values from July onward, falling up to 15 % below the expected level of vegetation cover during August-September. Recovery from stress period can be observed in second half of September. Vegetation in Murska Sobota, northeastern Slovenia, experienced favourable conditions for its development, according to

FVC. Its regular rate of vegetation growth in spring months continued into June beyond its usual peak time, and exceeded it for approximately 10 %. Especially noticeable is the abundance of the second peak of the year, which normally is minimal during its senescence phase but this year resulted in expansion of vegetation cover for up to 15 % during August, before its senescence phase continued. As a result, FVC values at the end of September were almost 20 % higher than normal for this time of year.

BOSNIA AND HERZEGOVINA (REPUBLIC OF SRPSKA)

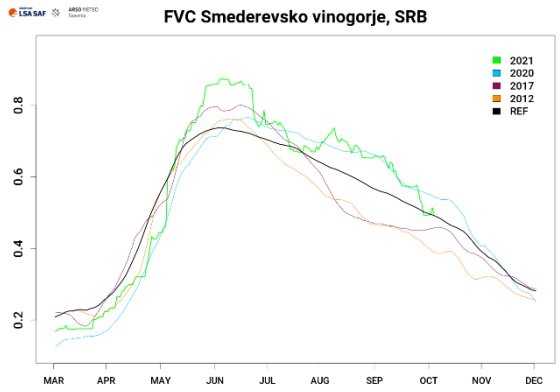


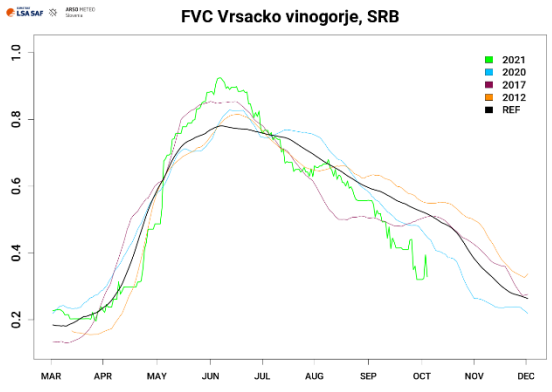




Similar pattern of vegetation development throughout this year can be observed for all three locations across Bosnia and Herzegovina. Initial growth in spring months followed well their usual rate of development and in late spring also well exceeded the level of vegetation cover at its peak time in late May, for 15-20 %. Early summer brought unfavourable weather conditions for healthy vegetation development, which is reflected in noticeable drop in the level of vegetation cover from second half of June onward. Vegetation at all three locations across the country saw exceeding coverage being lost before early days of July and with further vegetation senescence at the rate much higher than normal. September brought a relief from stress period to Trebinje, southern Bosnia and Herzegovina when vegetation began to recover and reached its regular level of the second peak of the year, while vegetation in Laktasi and Bijeljina across northern parts of the country continued its senescence period with well below-average level of vegetation cover, lasting from July onward. At the end of September, FVC values continued to be 10-15 % below the usual values.

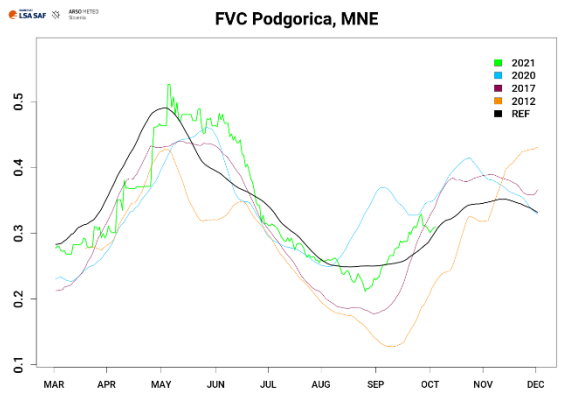
REPUBLIC OF SERBIA





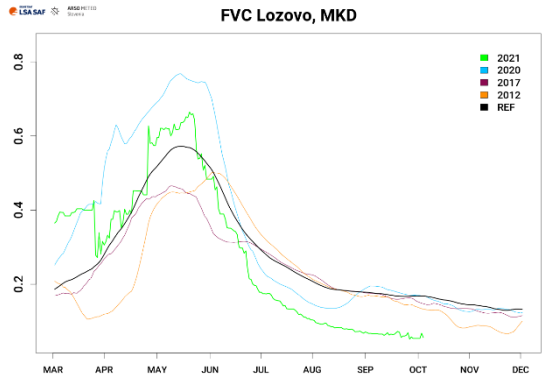
Vegetation development in Smederevsko vinogorje, central Serbia began a little later than normal but then followed well its usual pattern of growth in spring months. Favourable weather conditions in early months of vegetation season resulted in exceeding vegetation cover for up to 20 % at its peak time in early June. It was followed by a rapid decline in FVC values throughout June and most of July, after which came a slight recovery which prevented the continuation of vegetation senescence into a below-average vegetation cover for this time of year. On the other hand, vegetation in Vrsacko vinogorje, northeastern Serbia experienced a different second half of the season. After an initially good growth and development in first months of vegetation season, an above-average level of vegetation cover at its peak time, and sudden decline throughout June upon unfavourable weather conditions, a relief experienced in late July was short-lasting and insufficient to help vegetation recover. Weather conditions in August and September further accelerated the rate of vegetation senescence, resulting in an even greater decline of vegetation cover from the average at the end of September, for up to 20 %.

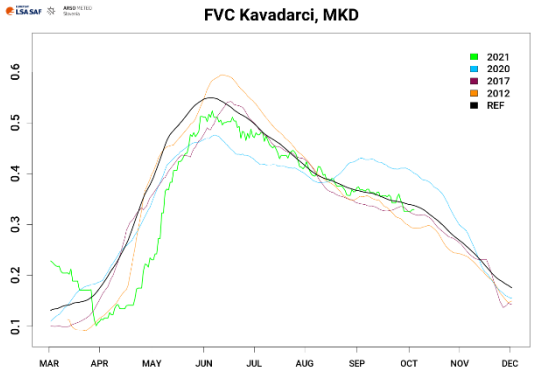
MONTENEGRO



Vegetation growth in Podgorica, southern Montenegro began later than normal this year but progressed at its usual rate throughout spring months. Favourable weather conditions at that time allowed reaching its average peak coverage although at a slightly later time than normal. Weather conditions in June soon resulted in a rapid decline of vegetation cover, which fell below the average by the end of the month. July and August weather conditions did not prove unfavourable for further vegetation development. The coverage remained more or less average and second growth in the year was boosted ahead of its usual time, in early September already.

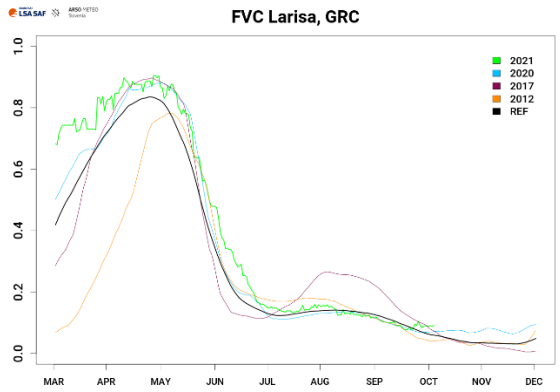
NORTH MACEDONIA

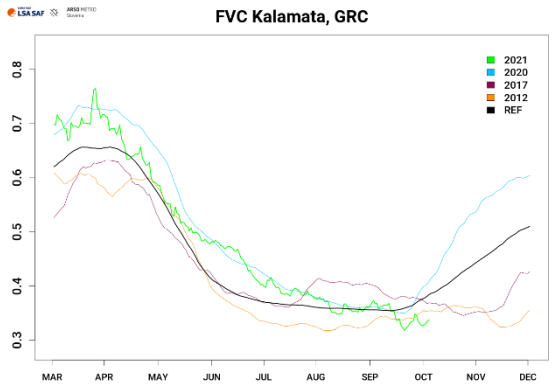




First half of vegetation season was favourable for vegetation development also in Lozovo, central North Macedonia. Unfavourable summer weather conditions changed this pattern, as the rate of vegetation senescence was continuously greater than normal throughout June and July and resulted in up to 10 % lesser-than-normal vegetation cover at the end of July. In late summer, vegetation senescence continued at its normal rate again although vegetation cover was already lesser than normal. Vegetation in Kavadarci, southern part of the country experienced more or less a regular season. Although in early spring its growth began later than normal, it followed well its regular pattern of development throughout spring, reached its seasonal peak at the slightly lower degree of vegetation cover than normal, and progressed into senescence at the average rate and level of coverage throughout the rest of the season.

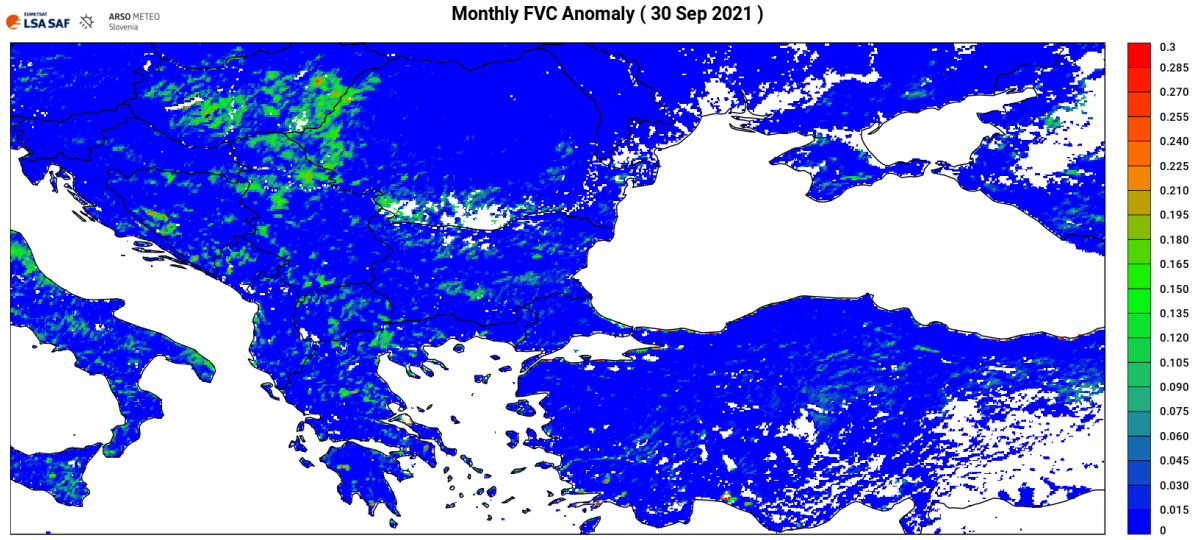
GREECE





In Larisa, central Greece vegetation experienced an undisturbed season as its growth and development followed well its regular pattern. Early months of the year brought favourable weather conditions for its development, as FVC values were above-average throughout all that time, and resulted in slightly exceeding the average level of April vegetation cover and the duration of its peak time. The senescence period continued at the average rate, and it was only from July onward that FVC values no longer exceeded the long-term average but followed the regular level nearly identical. Vegetation in Kalamata, southern Greece seemed to experience an even more favourable season for its growth and development. FVC values at its peak time were exceeded for up to 10 %, while senescence period progressed at the slower-than-normal rate throughout summer months, resulting in above-average vegetation cover during that time. In late September, FVC values continued to decline, which is unusual for this time of year.

Figure below shows negative anomaly of **accumulated 30-day FVC values** as recorded **on 30 September 2021** in comparison to the past 17 years (2004-2020), and is used experimentally.



In September, the greatest negative deviation of vegetation cover from its regular level was recorded across vast part of Hungary, far western Romania and across northern Serbia, where vegetation cover was up to 25 % lower than it normally is for this time of year. Across several other areas scattered across the Dinaric Alps, central-eastern Greece and Bulgaria, monthly accumulations of FVC indicate 10-15 % lower extend of green vegetation cover. Other areas remain unaffected or with smaller anomalies from the average for this time of year.

DROUGHT IMPACT REPORTS

SLOVENIA

Lake Cerknica was completely drained for the first time in 18 years due to a prolonged hydrological drought. Slovenian largest intermittent lake was supposed to be present again at that time of year but its water level lied as low as 22 meters below the surface of the lake, as explained by officials from the Notranjska Regional Park [1]. Due to critical hydrological conditions, the management board of Fishing Family Cerknica in early September announced temporal prohibition of sport fishing in Lake Cerknica and in Rakov Skocjan. The prohibition was lifted in last week of September [2, 3].

[1] https://sta.si/2944552/cerknisko-jezero-izsuseno-do-22-metrov-pod-povrsjem?q=su%C5%A1
[2] https://rdcerknica.si/novice/obvestilo-18/
[3] https://rdcerknica.si/novice/ribolov-spet-mozen/

CROATIA

In September, a precipitation deficit was recorded across almost entire Croatia. In most areas, the drought that began in the summer, in certain places even in spring, continued into September.

Drought in Continental Croatia

Međimurje County: The area recorded only a sixth of usual September rainfall amount. The plants ended up burnt and even irrigation did not improve the situation, leaving a great damage on field crops and vegetables. Corn crops, cabbage and potato suffered the greatest damage, with potato yield lower by up to 70 % due to drought and high temperatures. A state of natural disaster due to drought and high air temperatures was declared in eight municipalities and cities.
Varaždin County: Damage in agriculture was caused by high temperatures and the absence of precipitation in July, August and September. A state of natural disaster due to drought was declared in one municipality.
Koprivnica-Križevci County: Great damage in agriculture was caused by this year drought, which lasted approximately from mid-May to mid-September. A state of natural disaster due to drought has been declared in seven municipalities.
Bjelovar-Bilogora County: During drought conditions, the price of water for irrigation kept rising, and so were the food prices in green markets. Some parts of the country declared the state of natural disaster due to drought.
Slavonia: The state of natural disaster due to drought was declared in six municipalities.

Drought in Dalmatia
Zadar County: The drought damaged vineyards and so below-average yields are expected, although not catastrophically bad since a small amount of rain fell on several occasions throughout the month.
Dubrovnik-Neretva County: the area recorded less than 10 mm of rain throughout the summer months. Olives fell off the branches and some plants withered. According to the olive growers, this year has been the worst they encountered. Prices of fruit and vegetable at green markets kept rising.

Extracted from:
https://meteo.hr/klima.php?section=klima_pracenje&param=spi&el=prspi
https://meteo.hr/klima.php?section=klima_pracenje&param=ocjena
https://meteo.hr/proizvodi.php?section=publikacije&param=publikacije_publikacije_dhmz&el=bilteni (preliminary report; publication is in preparation)
https://meteo.hr/klima.php?section=klima_pracenje&param=spi&el=karte_suse&Week=210805

BOSNIA AND HERZEGOVINA

The drought that hit Bosnia and Herzegovina this year had a negative impact mostly on sunflower cultivation. The yield is expected to be about 50 % lower than last year, according to the Regional Association of Farmers of Semberija and Majevica as well as the Association of Farmers of Tuzla Canton, who also report the situation is similar across all of the country. Lower yields are likely to induce additional increase in sunflower prices oils [1, 2]. Due to the lack of precipitation and high air temperature, corn crops in Semberija, northeastern Bosnia and Herzegovina, suffered damage of 30-70 % in various localities, according to the government's Department for providing professional services in agriculture [3]. Another agricultural crop greatly affected by drought this year is soybean. With its yield nearly halved and with several plots damaged to a degree not worth entering fields with a combine harvester, purchase prices are record high [4]. As pointed out by the head of Professional Service of agricultural associations in Bosnia and Herzegovina, an increase in prices can be observed for many agricultural products. This year, spring came relatively late, followed by droughts that affected the quality and quantity of various crops. This is one of the worst years for all fruit and vegetable producers, but also milk and cheese processors and beekeepers [5].
As a result of increasing risk and impacts of drought as well as rising feed price, people across Bosnia and Herzegovina are closing farms en-masse. According to the Agency for Statistics of Bosnia and Herzegovina, in July 2021, milk production was lower by 18.2 % compared to

the same month last year. The number of slaughtered cattle increased by 49.36 %, sheep by 38.38 % and pigs by 17.31 %, compared to the same period in 2020. Overall agricultural production is decreasing, also milk production and livestock in general since farmers had no food for the winter and many animals were sent to slaughter houses [6].

[1] https://www.nezavisne.com/ekonomija/agrar/Susa-pokosila-suncokret-u-BiH-i-jos-zagrijava-cijenu-ulja/678676
[2] https://www.akta.ba/kapital/susa-pokosila-suncokret-u-bih-i-jos-zagrijava-cijenu-ulja/138811
[3] https://www.akta.ba/vijesti/uz-prepolovljene-padavine-i-steta-na-usjevima-od-30-do-70-posto/138807
[4] https://www.nezavisne.com/ekonomija/agrar/Rod-soje-duplo-manji-cijene-otkupa-rekordne/681397
[5] https://www.nezavisne.com/ekonomija/trziste/Huseinbegovic-Zbog-suse-rastu-cijene-poljoprivrednih-proizvoda/680565
[6] https://www.akta.ba/vijesti/zbog-posljedica-suse-i-rasta-cijena-stocne-hrane-ljudi-masovno-zatvaraju-farme/139915

SERBIA

Precipitation was not evenly distributed across Serbia, which left certain placed more affected by drought than others and in inevitable loss of yield. Where present, rainless periods and extremely high air temperatures of about 40 °C during the high summer months reduced the yield of almost all fruit, vegetable and field crops, except for wheat which was harvested before the dry period. Of the field crops, the greatest damage is left on soybean and corn crop, with expected yield loss of about 50 % and 30-50 % respectively. Less damage is expected on sunflower yield, up to 15 %, as sunflowers better withstood high temperatures but the prices of oilseeds on the world market remain high [1, 2, 3]. It is estimated the grain yield will be at around 5.9 tons/ha, altogether bringing approximately 2 mio tons less grain than expected which is enough for domestic use but will certainly affect the export. Also, this year's soybean yield will most likely not be sufficient for export [3]. According to the Ministry of Agriculture, certain fields had nothing to harvest, and where fields bore yield farmers encounter problems with quality in addition to quantity. Overall economical damage is estimated at least 500 million dollars [1].

The impacts resulted in rising prices for crops, i.e. corn was sold at 14-15 dinars/kg in 2020, while this year it was sold at 25-26 dinars/kg [4]. A rise in prices was observed also for vegetables, which also saw reduced yield due to summer drought. Warm and dry weather conditions prevented pollination, so the flowers fell off, and in addition the costs increased to keep the plant alive and bear some produce. The president of the association of vegetable growers from Glogonj, central Serbia, said green beans cost 300 dinars/kg, and cabbage 80 dinars/kg, which he encountered was never the case before [5]. Mitigation of drought conditions with irrigation with waters of the largest rivers flowing through the country for irrigation did not offer much relief, because Sava, Danube, Drina and Timok rivers have become international rivers and in order to use the capacities of these waters for irrigation, it became necessary to reach an agreement with countries in the region [1].

Drought affected also livestock sector. Sheep breeders from Banat, central Serbia, reported that long rainless period dried up the grass on pastures. At the same time, also fodder became more expensive, as both corn and soybean saw great increase in market price, thus ensuring sufficient livestock feed became a great challenge [6]. On Suva Planina, southeastern Serbia, a herd of 800 cows and 200 horses grazing there were reported dying of thirst, is dying of thirst after the only spring there completely dried up. Cattle breeders from the area reported the spring did not have enough water for months before it completely dried up, and the Serbian Army, the municipality of Gadzin Han and local inhabitants came together to transport water to the area [7, 8].

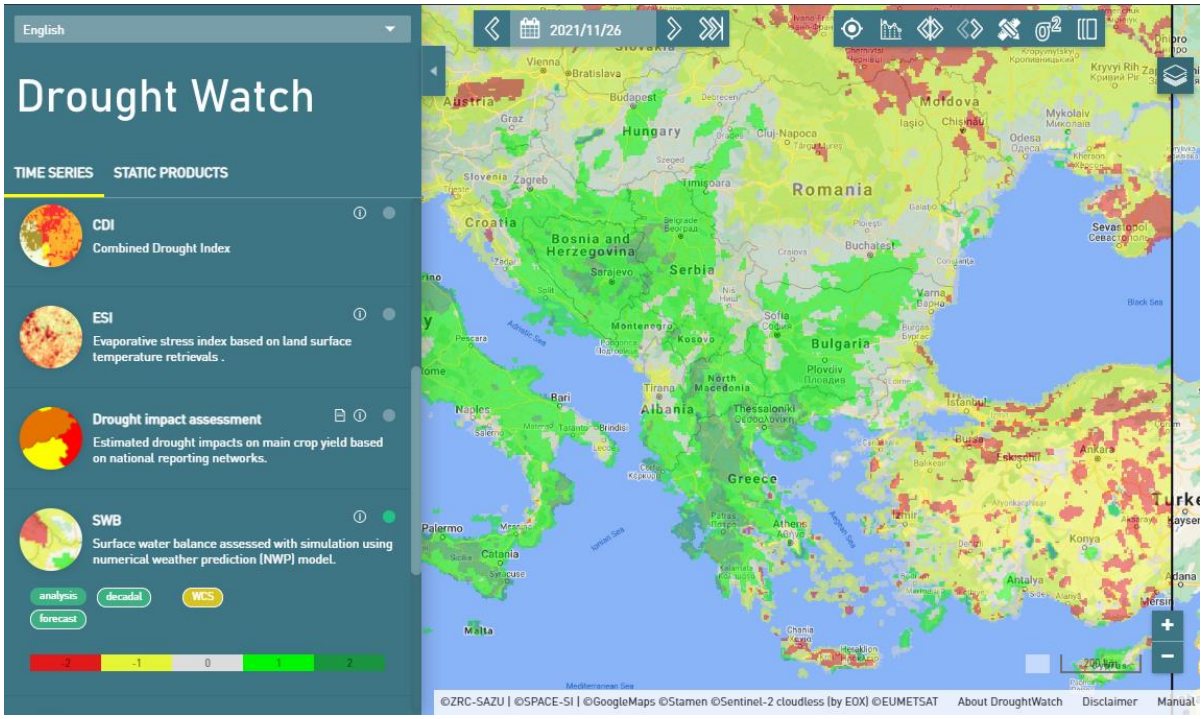
In early September, water restrictions were re-introduced over the whole territory of Bajina Basta municipality due to minimum level of springs after a prolonged drought. During that time, households saw water turned off from 11:30 pm to 5:30 am [9].

[1] https://beta.rs/ekonomija/ekonomija-srbija/151972-susa-umanjila-rod-svih-poljoprivrednih-kultura-u-srbiji-steta-najmanje-500-miliona-dolara
[2] https://nova.rs/vesti/biznis/susa-udarila-na-prinos-kukuruza-u-pomoravlju/
[3] https://www.novosti.rs/vesti/ekonomija/1034869/susa-desetkovala-zitarice-zetva-kukuruza-krece-desetak-dana-soje-suncokreta-zbog-loseg-vremena-prekinuta
[4] www.politika.rs/scc/clanak/488340/Србија-ће-ове-године-извести-око-3-1-милион-тона-кукуруза
[5] https://mondo.rs/Info/Ekonomija/a1519542/Cene-povrca-ce-zbog-suse-i-dlaje-rasti.html
[6] https://www.rts.rs/page/stories/sr/story/13/ekonomija/4520034/stocarstvo-ovcarstvo-korona-jagnjad-cena-susa.html

[7] https://www.politika.rs/sr/clanak/487638/Krdo-sa-1-000-krava-i-konja-umire-od-zedi-na-Suvoj-planini-stocari-apeluju-za-pomoc
[8] www.politika.rs/scc/clanak/487781/Стигла-вода-за-жедне-краве-и-коње
[9] http://www.rina.rs/item/8498-n-a/

OUTLOOK

Figure below presents model simulations of the **60-day accumulated surface water balance anomaly** in historical percentile classes for the time period **from 28 September to 26 November 2021**, as seen in Drought Watch tool[1].



[1] https://www.droughtwatch.eu/

Unusually wet surface water balance conditions is expected to prevail across cast part of Balkan Peninsula, especially its western and central part previously experiencing great deficit as well as its south. Dry levels of 60-day surface water balance will remain to be present over eastern parts of the region, including north-eastern quarter of Romania but also Moldova and Turkey where 60-day accumulated surface water balance will result in noticeable deficit, indicating very dry conditions for this time of year.

Methodology

DMCSEE Drought monitoring bulletin is based on numerical weather prediction (NWP) model simulations over SE Europe, SPI index calculations, remote sensing 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). NWP simulations are performed with Non-hydrostatical Mesoscale Model at ~7 km spatial resolution (NMM; http://www.dtcenter.org/wrf-nmm/users/). Historical DMCSEE model climatology is computed with NMM for time period between 1 January 1991 and 31 December 2020. European Centre for Medium Range Weather Forecast (ECMWF) ERA5 dataset (http://www.ecmwf.int/en/forecasts/datasets/reanalyses-datasets/era5) is used 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 with long-term averages provides a signal on potentially ongoing drought.