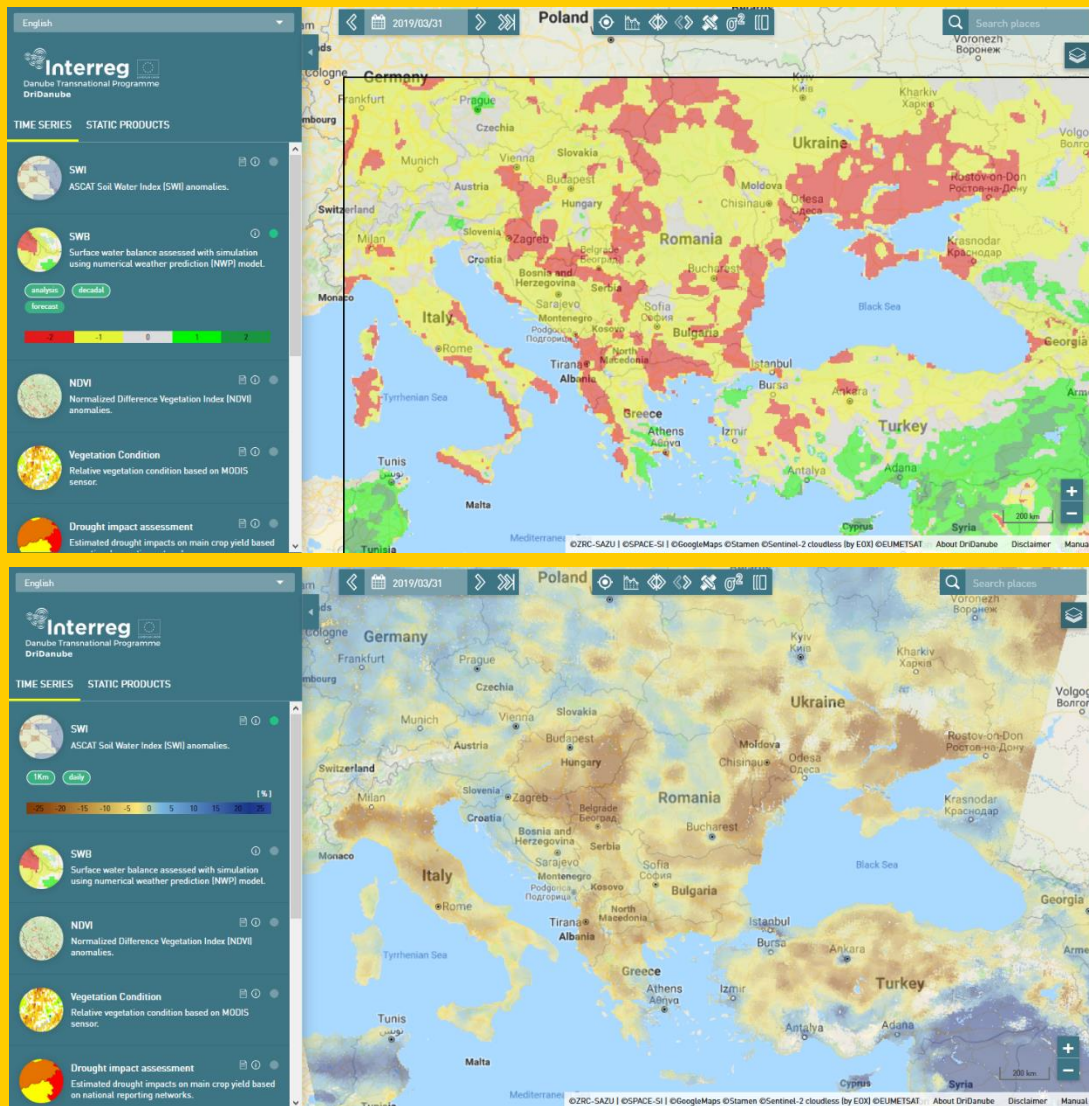


DROUGHT MONITORING BULLETIN

13th June 2019

HOT SPOT



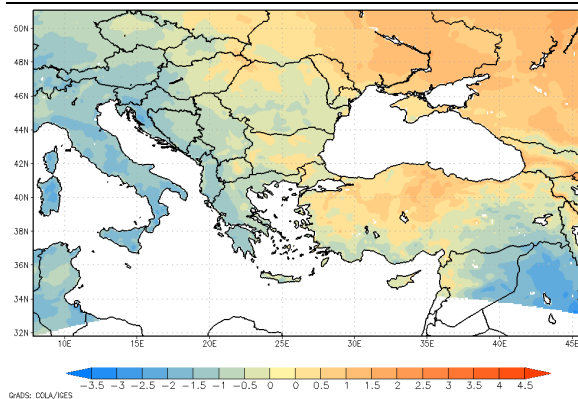
With a new open-source tool **DroughtWatch** it is possible to monitor dry conditions across Southeastern Europe **in near-real time**. Drought indices, which currently focus on state of soil moisture and vegetation, are updated daily, weekly or 10-daily and allow analyzing also past values. Access DroughtWatch: www.droughtwatch.eu. Read more: www.dmcsee.org/en/dridanube/.

First picture above shows **60-day accumulated surface water balance on 31 March 2019** as seen in DroughtWatch. It indicates that with exception of southeastern Turkey and Aegean Sea area, the region entered vegetation season with a noticeable water balance deficit. In DroughtWatch, anomalies of soil moisture conditions can be observed also on a daily scale using **Soil Water Index** – second picture above presents SWI situation **on 31 March 2019**.

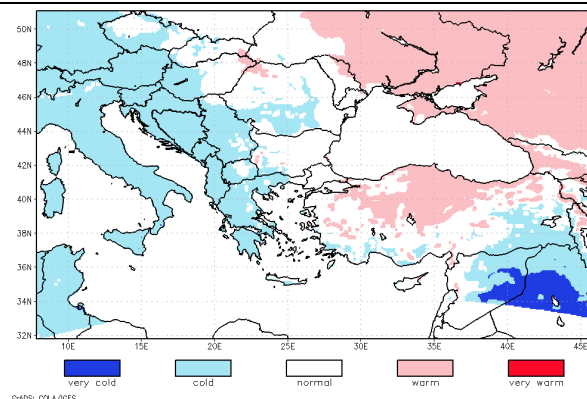
AIR TEMPERATURES AND SURFACE WATER BALANCE

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 **1st April to 30th May 2019**.

AVERAGE AIR TEMPERATURE
ANOMALY (°C)
1st APRIL - 30th MAY 2019



AVERAGE AIR TEMPERATURE
PERCENTILE CLASSES
1st APRIL - 30th MAY 2019



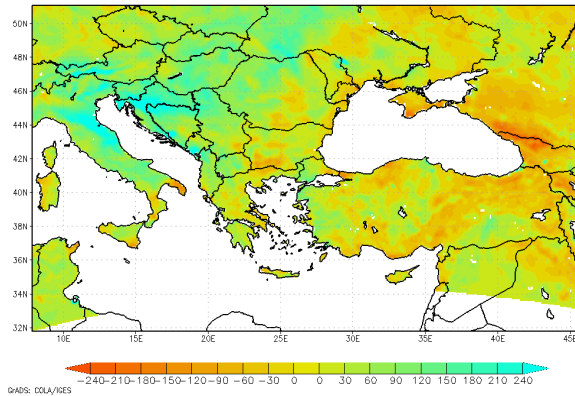
Beginning of **April** was on one hand unusually warm for that time of year over central and northern Balkan Peninsula where mean air temperature exceeded the average from 3–5 °C, but was on the other hand for up to 2 °C colder than usual across Greece, areas along western part of Black Sea and southern half of Turkey. By mid-April, mean air temperatures dropped noticeably across all region, standing mainly 1–2 °C below the average over Balkan Peninsula and between 2–4 °C below the average over Turkey. Southeastern part of Turkey remained colder than usual until the end of the month while across the rest of the region air temperatures rose again and resulted in end of April being 1–2 °C warmer than usual.

May brought air temperatures much colder than normally to entire western half of Balkan Peninsula including Hungary, eastern Romania, Serbia and western Greece: in first three weeks of May, mean air temperature stood 2–4 °C below the average, over Slovenia and parts of Croatia even up to 5 °C lower. In last 10 days of May, warmer air temperatures came to that part of the region although anomalies remained negative, of up to 2 °C below the average. Eastern parts of Balkan Peninsula, Aegean Sea area and Turkey experienced the opposite change throughout May: while air temperatures for up to 2 °C colder than usual prevailed in its first 10 days, the rest of the month was up to 2 °C warmer than normally, in northern and central Turkey even up to 4 °C.

On monthly mean, April was up to 2 °C warmer over Pannonian Basin and between 1–3 °C colder over southeastern half of Turkey; the area in between experienced about-average monthly air temperatures. Mean May temperature was between 1–3 °C higher than usual across most of Turkey while monthly anomalies from the average across Balkan Peninsula gradually declined from up to 1 °C over Black Sea coastal area down to -4 °C over Slovenia and along northern Adriatic coastline. High negative anomalies over southeastern Turkey in April and western half of Balkan Peninsula in May resulted in 60-day mean air temperature for up to 1.5 °C lower than normally, as seen on figures above, while across the rest of the area 60-day mean temperature ranged about near-average values. Most noticeable positive anomaly prevailed over northern Turkey, exceeding the average for up to 1.5 °C.

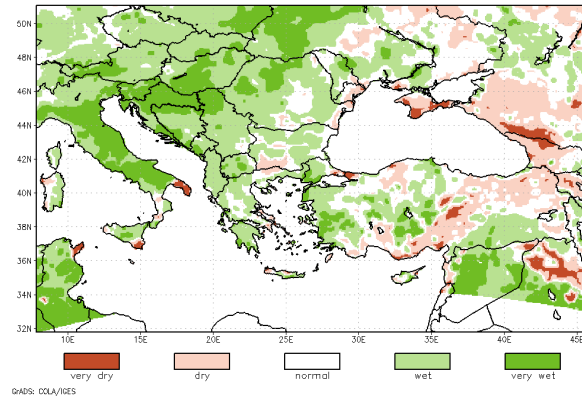
ACCUMULATED WATER BALANCE
ANOMALY (mm)

1st APRIL - 30th MAY 2019



ACCUMULATED WATER BALANCE
PERCENTILE CLASSES

1st APRIL - 30th MAY 2019



In terms of accumulated surface water balance, April was about-average or slightly wetter than usual across most of the region as values ranged mostly between -25 mm up to 50 mm. Noticeable surplus of 75–125 mm was detected only across Croatia and northern Bosnia and Herzegovina, southern Greece and southeastern Turkey. On the other hand, May was significantly dry all across southeastern half of Turkey and over coastal Greece with deficit of up to -75 mm, locally up to -125 mm, while northwestern half of Balkan Peninsula experienced very wet conditions. There, water balance surplus ranged mostly between 75–125 mm but exceeded the usual May conditions for up to 200 mm over Slovenia, Croatia, Montenegro and northern Romania, classifying them among the wettest 5 % of local historic values. Due to higher May anomalies in both extremes, also 60-day accumulations reflect similar division: water balance deficit between -60 and -120 mm present across central and northeastern Turkey, also southern Bulgaria, but high surplus of up to 175 mm present across wider northern part of the region. Its north-west and along the Adriatic Sea experienced surplus of more than 200 mm.

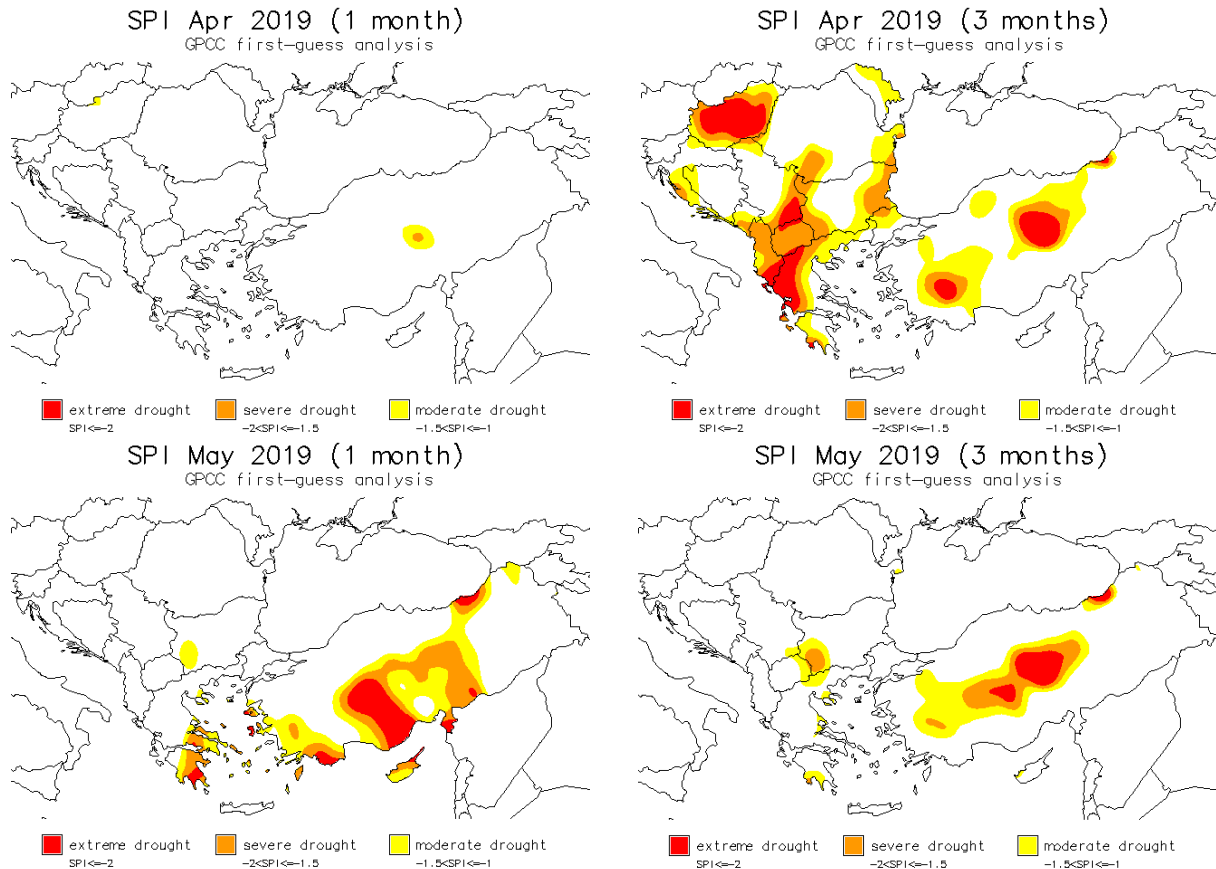
STANDARDIZED PRECIPITATION INDEX

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 April and May is shown in figures below. SPI for one-month indicates possible drought conditions which can have impact on vegetation, while SPI for three-month period can be indicative also for surface water status.

As seen from SPI1 figures below, drought conditions in April were present only in localised area in central Turkey while in May wider southern part of the region experienced drought conditions. Extreme lack of precipitation, classified among the lowest 5 % of local records, hit southwestern Bulgaria but also southeastern part of continental Greece and its Aegean islands, and vast part of southern Turkey, including far north-east of Turkey. 3-month view of SPI February–April period shows wider extent of severe to extreme drought conditions across the region, a result of mainly extremely dry February and March. Those months, significant

precipitation deficit was present over Hungary, coastal Bulgaria, vast area stretching from southern Serbia and Albania all along western Greece, and in western and central Turkey. SPI for March–May period indicates that moderately dry conditions persisted over southern Bulgaria, southern continental Greece and across western Turkey while extreme ones were located in central Turkey and locally along its northeastern coastal area.



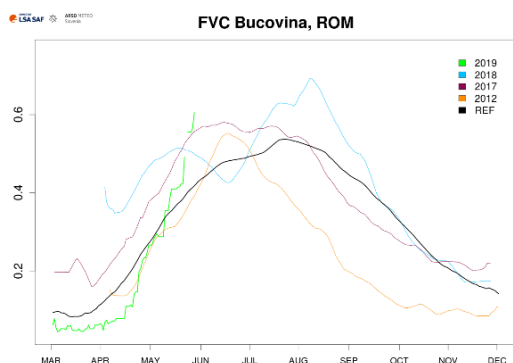
REMOTE SENSING - FRACTION OF VEGETATION COVER

Fraction of vegetation cover (FVC) is 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 of course 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 and then FVC slowly drops with vegetation senescence. Line shape depends on sort of the vegetation.

Graphs below present the **vegetation situation** as recorded on **30th May 2019** in some regions of Southeastern Europe. FVC values for year 2019 are presented as green line. Graphs also include reference line (2004–2018) in black, and lines in light blue (year 2018), magenta (year 2017, or 2013 for Slovenia) and orange (year 2012) for comparison.

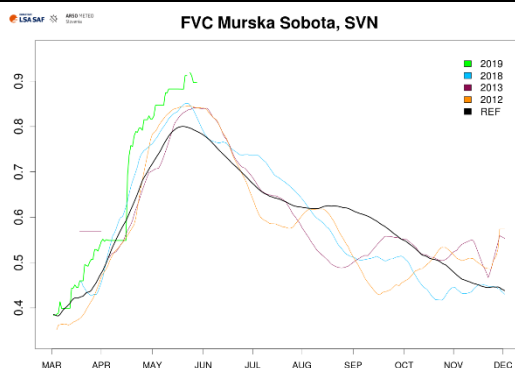
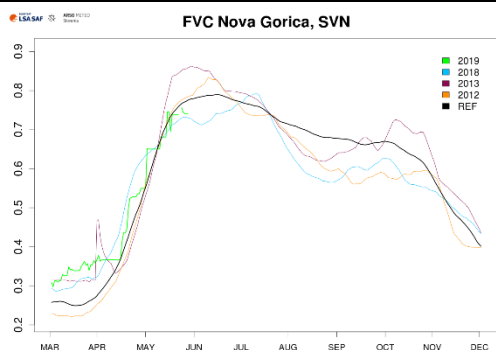
Possible missing values or sharp decline of values could be a result of a prolonged cloudy weather, extreme weather events or snow blanket.

ROMANIA



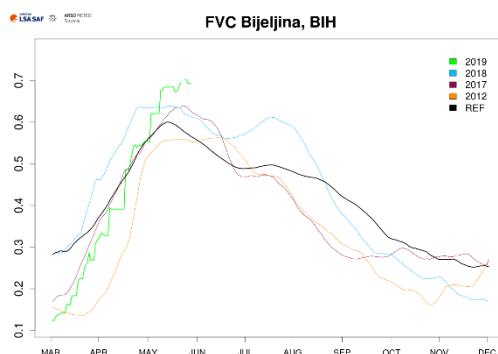
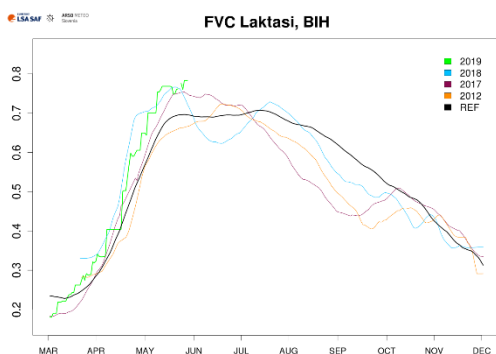
Throughout first months of spring, vegetation level in Bucovina in northernmost Romania was under-average. Although it started progressing in mid-April, approximately a month later than normally, it did not reach its average level until early May. Noticeable progress in vegetation development continued in a similar rate also throughout May and at the end of the month stood approximately 20 % above the usual state.

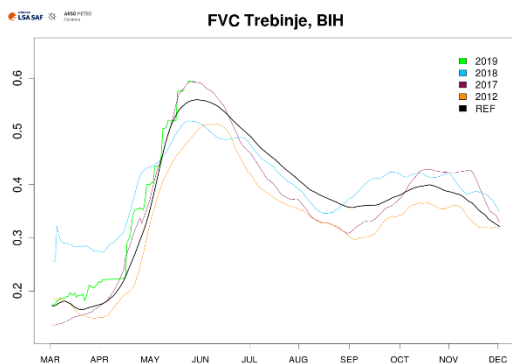
SLOVENIA



Vegetation growth in Nova Gorica in western Slovenia has in early spring reached higher level than normally, for about 10 %. Vegetation development seemed to stop progressing in first half of April, as can be seen also for Murska Sobota in northeastern Slovenia, but has since then continued to follow the usual development pattern. In Murska Sobota, FVC for the first half of spring mainly exceeded the expected values. A sudden boost of vegetation development is noticed in mid-April when FVC exceeded the usual values for almost 20 % but has since then continued progressing with a similar rate as usually.

BOSNIA AND HERZEGOVINA (REPUBLIC OF SRPSKA)

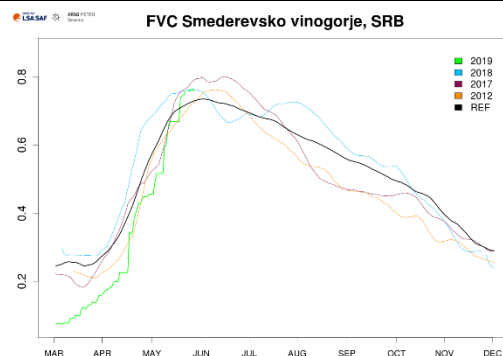
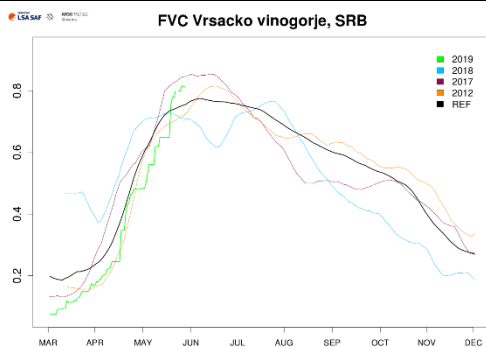




Despite initial slightly under-average FVC values for Laktaši in northern Bosnia and Herzegovina, similar as in year 2017, vegetation kept developing well and even exceeding the expected value, for almost 10 %, since the beginning of May. Also in Bijeljina in country's north-east, vegetation development followed a similar pattern as in year 2017: after a noticeable underdevelopment at the beginning on March, it progressed with a rate higher than normal and

reached its expected value by the end of April. Continuing with a high rate, vegetation development reaching its peak at the end of May with FVC values exceeding the average for approximately 15 %. There was no such early spring underdevelopment noticed in Trebinje in southern Bosnia and Herzegovina where vegetation seemed to follow the expected development throughout spring months.

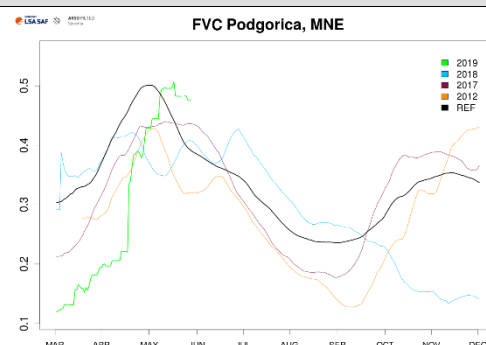
REPUBLIC OF SERBIA



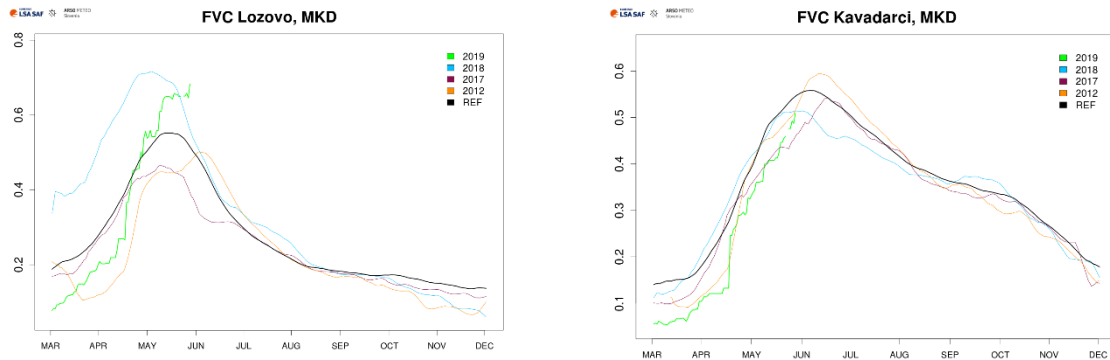
Noticeable underdevelopment in March in comparison to reference line was observed also at both locations in lowlands of northern Serbia, in Vrsacko vinogorje for over 10 % while in Smederevsko vinogorje for almost 20 %. A look at precipitation percentiles for March reveals the rainfall deficit ranked among the lowest 5–10 % of local records. Despite favourable conditions later on which boosted vegetation growth in mid-April, vegetation growth reached its usual level only in mid-May. It continued to develop well with a similar rate at both locations where FVC values at the end of May even exceeded the long-term peak.

MONTENEGRO

In Podgorica in southern Montenegro, precipitation deficit, ranked within the lowest 15th percentile, lasted over February and March which reflects also in reduced state of vegetation cover in early months of spring, for almost 20 %. After a mid-April boost, vegetation growth continued with a higher-than-normal rate, however, it reached its seasonal peak approximately 2 weeks later than normally.

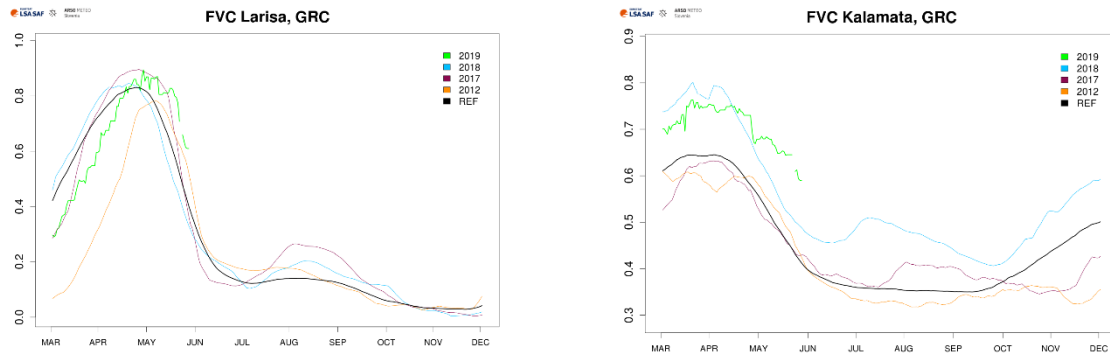


NORTH MACEDONIA



Vegetation season started late also in North Macedonia as in February and March, extreme precipitation deficit, ranked within the lowest 5th percentile, hit the entire country. It resulted in FVC values 10–15 % lower at the beginning of spring although, similarly as in other locations, mid-April brought boost in vegetation development. In Lozovo in central part of the country it resulted in vegetation growth exceeding the normal level by the end of April and continuing progressing well with FVC values approximately 10 % higher than normally at the end of May. On the other hand, despite mid-April boost, vegetation growth in Kavadarci in southern part of the country continues to progress well but approximately a week delay in reaching average values is noticed.

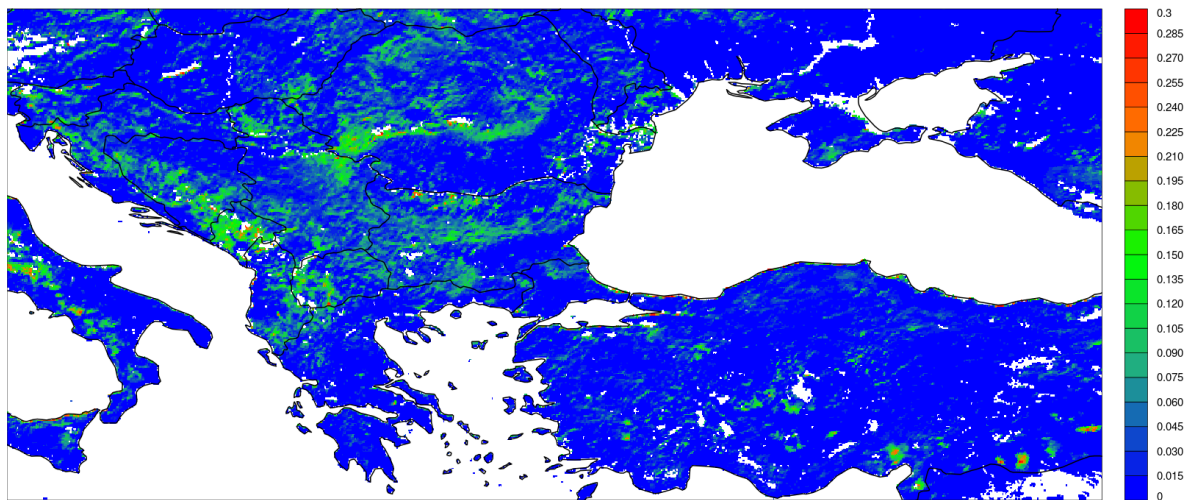
GREECE



Vegetation season started later than usually in Larisa, central-eastern Greece as well. Despite an approximate 2-week delay, according to FVC values, vegetation developed at slightly higher-than-normal rate through March and April and exceeded its peak value, which came in early May, for approximately 5 %. On the other hand, vegetation in Kalamata, southern Greece did not seem to experience any delay or under-development this spring. It followed its usual pattern of development but continuously exceeding the average for about 10 %. Despite the decline, otherwise ordinary for April and May, FVC values at the end of May stand almost 20 % higher than normally expected for this time of year.

Figure below shows negative anomaly of **accumulated 30-day FVC** as recorded on **30th May 2019** in comparison to the past 15 years (2004-2018) and are used experimentally.

Monthly FVC Anomaly (30 May 2019)



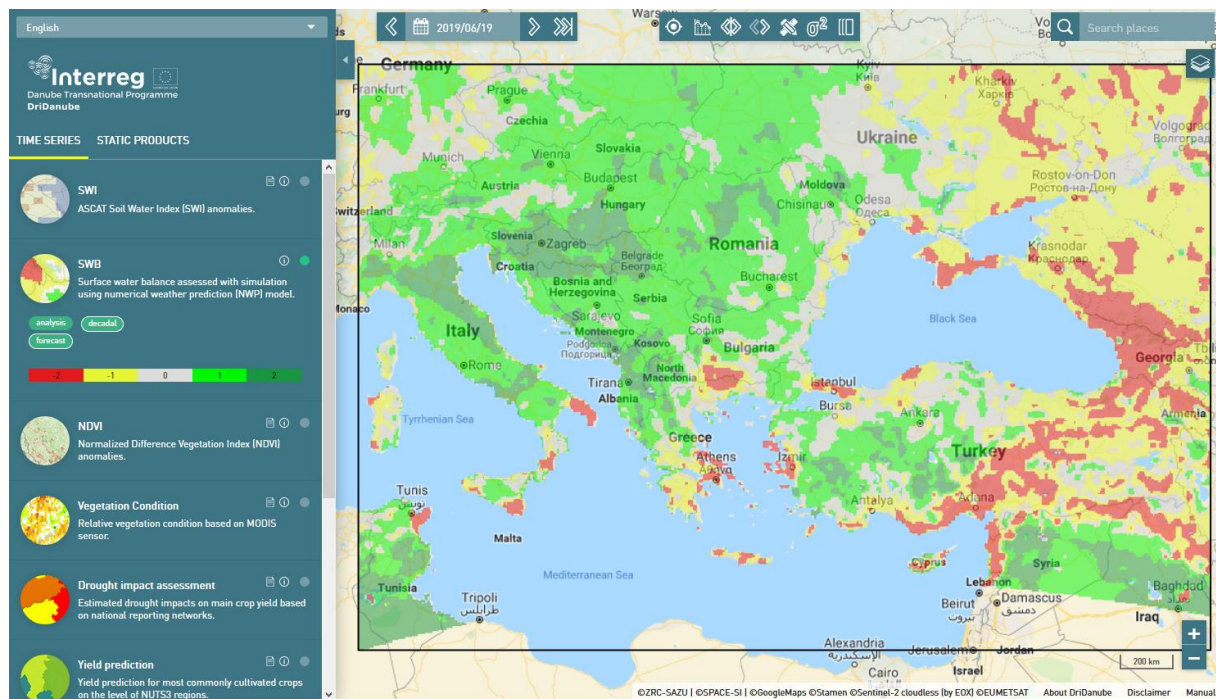
Monthly accumulations of FVC for May show wider extent of with under-average vegetation cover, for up to 18 %, especially over mountainous areas, stretching from southern Bosnia and Herzegovina and Montenegro to northernmost Greece and also across western and central Bulgaria and over the Carpathians. Noticeable negative anomalies can be seen also across lowlands of northern Serbia and northwestern Romania. Some small local areas, where FVC values stand more than 25 % below the usual values for this time of year, can be observed also scattered across coastal parts of Turkey.

IMPACT REPORTS

No drought impacts on the environment were reported across the region.

OUTLOOK

Figure below presents model simulations of the **60-day accumulated surface water balance anomaly** in historical percentile classes for the time period **from 21st April to 19th June 2019**, as seen in DroughtWatch.



In comparison to April-May period, the surface water balance situation will mostly remain unchanged across the region. Most part of Balkan Peninsula and western-central Turkey will continue to experience above-average wet conditions with local extreme surplus experienced. Noticeable water balance deficit will prevail over areas along the Black Sea, southwestern Bulgaria and mountainous part of eastern Turkey. The only major change, from surplus to noticeable deficit, is expected over southern Greece, Aegean part of Turkey and across its south-east.

Methodology

Drought monitoring bulletin is based on numerical weather prediction (NWP) model simulations over SE Europe, SPI index calculations and remote sensing. Precipitation data is provided by Global Precipitation data Centre (GPCC; gpcc.dwd.de). NWP simulations are performed with Non-hydrostatical Meso-scale Model (NMM, see: <http://www.dtcenter.org/wrf-nmm/users/>). Historical DMCSEE model climatology was computed with NMM model for time period between 1st January 1979 and 31st December 2016. European Centre for Medium Range Weather Forecast (ECMWF) ERA-Interim data set (see: <http://www.ecmwf.int/en/research/climate-reanalysis/era-interim>) was used as input for simulations. Long term averages (1979-2016), used for comparison of current weather conditions, are obtained from simulated data set. Comparison of current values to long term averages provides signal on potential ongoing drought severity.