European Commission

Drought in Europe April 2022

GDO Analytical Report

2022

Joint Research Centre

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GDO Analytical Report

Drought in Europe - April 2022

JRC Global Drought Observatory (GDO) of the Copernicus Emergency Management Service (CEMS) - 29/04/2022

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JRC Global Drought Observatory (GDO) of the Copernicus Emergency Management Service (CEMS) - 29/04/2022

Executive summary

- A severe drought has been affecting large areas of Europe, Po and Danube river basins in particular. Dry conditions are related to a persistent lack of precipitation since December 2021 in the Southern Alps region, and to a severe lack of precipitation in the first three months of 2022 in the eastern European region.
- The severe precipitation deficit has been affecting main river discharges (Po and Danube) and their tributaries. The stored water volume for energy production is very low, making difficult the optimisation of hydropower generation. Lower water availability in southern Europe makes competition for water uses harder and earlier. Winter crops in Spain and Italy are in sub-optimal conditions, and water stress has already reduced the yield potential.
- A short period of light precipitation at the beginning of April temporarily helped to limit an exacerbation of the snow deficit after the already poor snow season in the Southern Alps. On the 4th of April, the deficit compared to the 2009-2021 median conditions was -61% for the Italian Alps. The current deficit confirms extremely low accumulations. These conditions cause concerns for melting snow contribution to river discharges in late spring, increasing the likelihood of hydrological drought in the coming months.
- Drier than normal conditions are forecasted for most of southern and south-eastern Europe until June.

Standardized Precipitation Index (SPI)

The SPI[1] provides information on the intensity and duration of the precipitation deficit (or surplus). The SPI-3 (3-month accumulation period) shows a wide dry area from south-western France to south-eastern Ukraine. The dry conditions for northern Italy reported in the March 2022 GDO Analytical Report[2] have been expanding eastwards. Extremely poor precipitation in the analysed period has been observed in north-western Italy, northern Bosnia, northern

[1]SPI is used to monitor the occurrence of drought. The lower (i.e., more negative) the SPI, the more intense is the drought. SPI can be computed for different accumulation periods: the 3 months period is often used to evaluate agricultural drought and the 12-month accumulation period can be used for hydrological drought, when rivers fall dry and groundwater tables lower.

[2] https://edo.jrc.ec.europa.eu/documents/news/GDO-EDODroughtNews202203_Northern_Italy.pdf

Bulgaria, eastern Romania, Moldova and southern Ukraine (Fig. 1). Severe precipitation deficit affects the water level of most of the main tributaries of the Po River.

Considering SPI-1 (1-month accumulation period), extremely lower than normal precipitation amounts were recorded in March 2022 for large parts of Europe, except for the Iberian Peninsula, Iceland, the north-western coast of Scandinavia, and Turkey (where precipitation was higher than normal; Fig. 2). As for the Iberian Peninsula, the recent precipitation events have contributed to a partial recovery from the dry conditions experienced at the beginning of the year[3].

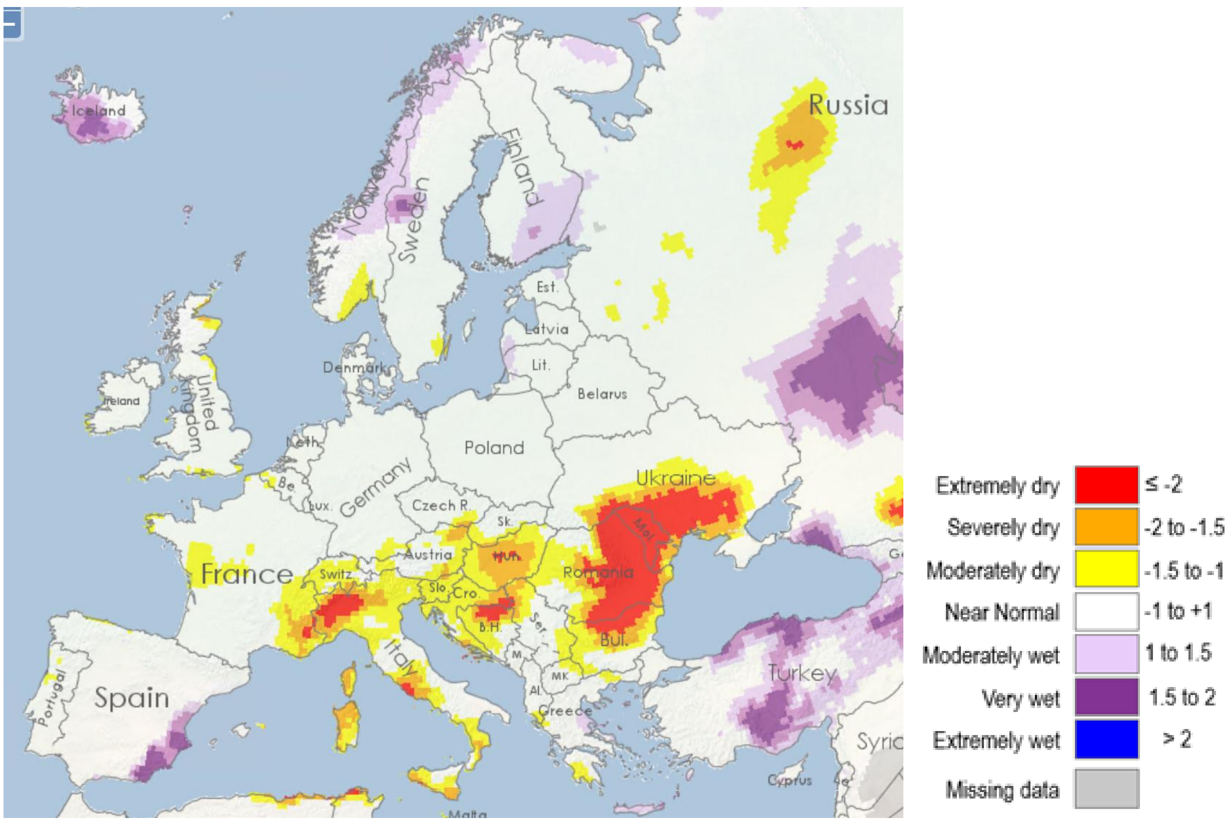


Figure 1: *Standardized Precipitation Index SPI-3 in March 2022.*

[3] https://edo.jrc.ec.europa.eu/documents/news/GDO-EDODroughtNews202202_Western_Mediterranean.pdf

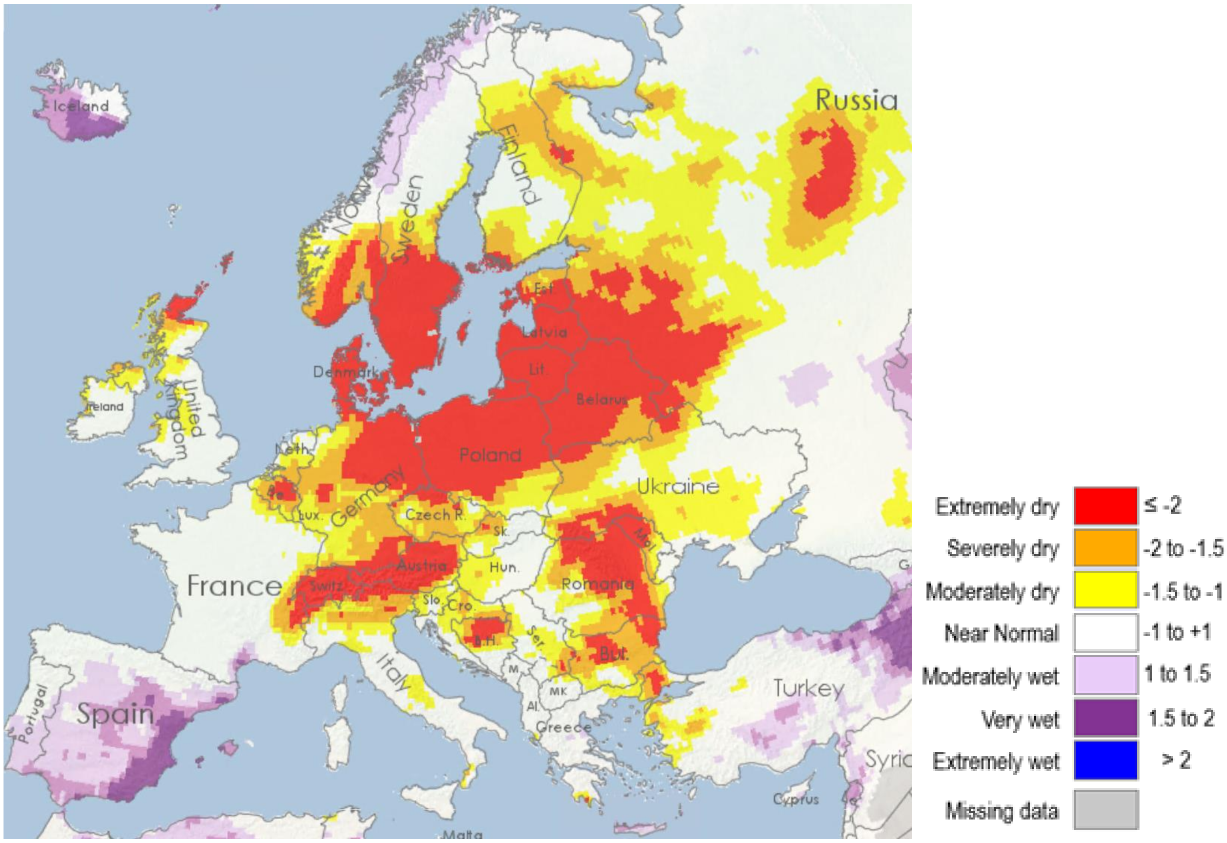


Figure 2: *Standardized Precipitation Index SPI-1 in March 2022.*

Ensemble Soil Moisture Anomaly

Lack of precipitation induces a reduction of soil water content. The aim of the Soil Moisture Anomaly index is to provide an assessment of the deviations of root zone water content from normal conditions. This a direct measure of the drought associated with the difficulty of plants in extracting water from the soil.

Drier than normal soil moisture conditions were observed at the end of March 2022 in most of northern Italy, Hungary, eastern Romania, and southern Ukraine. Soil moisture conditions coincide well with the spatial distribution of the SPI-3 (Fig. 3). In the Iberian Peninsula, the recent precipitation events helped to recover from the dry soil conditions reported in February.[4] Along the Mediterranean coastal areas of Spain, soil conditions are wetter than normal.

[4] https://edo.jrc.ec.europa.eu/documents/news/GDO-EDODroughtNews202202_Western_Mediterranean.pdf

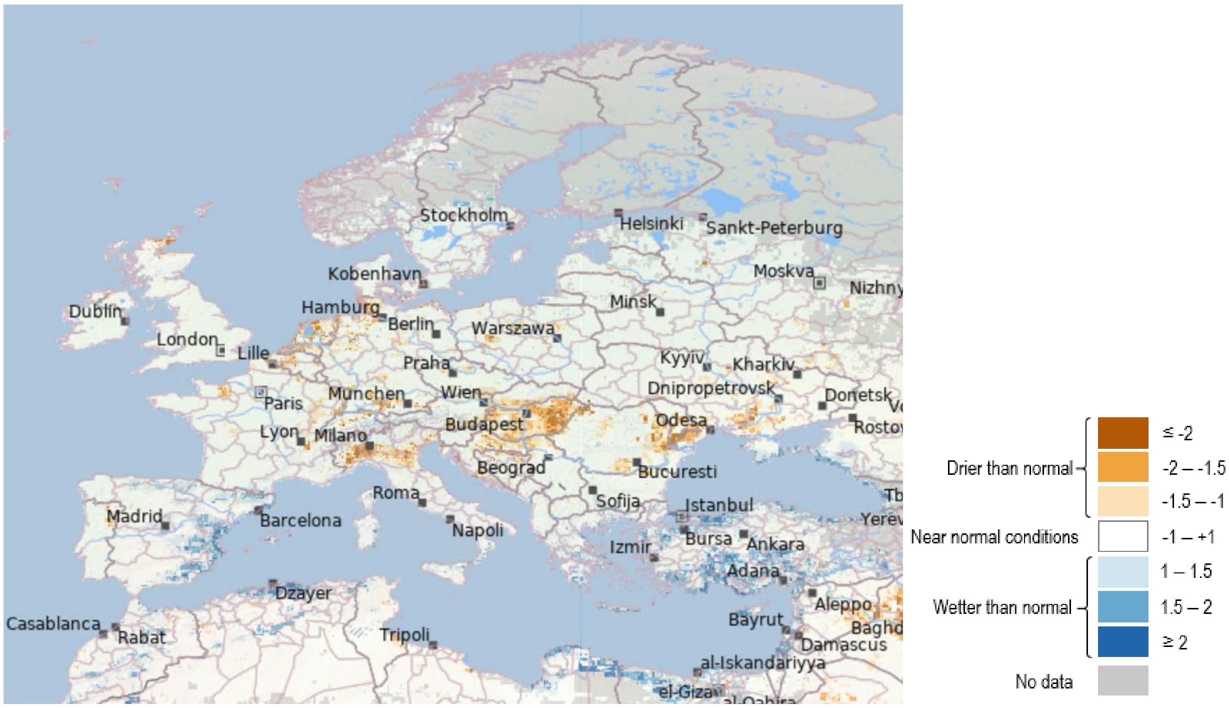


Figure 3: *Ensemble Soil Moisture Anomaly - end of March 2022.*

FAPAR anomaly

The satellite-based fraction of Absorbed Photosynthetically Active Radiation (FAPAR) monitors the fraction of solar energy absorbed by leaves. It is a measure of vegetation health and growth. FAPAR anomalies, and specifically negative deviations from the long-term average, are an indicator of possible drought impacts on vegetation.

The mild temperatures observed over most of central Europe during winter caused higher-than-normal FAPAR values (Fig. 4), pointing to an early start of the growing season. Soil moisture becomes very important for plant growing conditions - and hence FAPAR values – later during spring and summer that are key periods in terms of drought impacts in the agriculture sector. However in the Iberian Peninsula and Turkey, despite the current wetter than normal conditions, vegetation is still suffering from the preceding winter dry period (see also February GDO analytical report on drought in western Mediterranean[5]). Vegetation conditions data confirm that precipitation was not enough to achieve a full recovery. Considering the usually dry summer over the area, this deficit is of concern for impacts that may occur later in the season.

[5] https://edo.jrc.ec.europa.eu/documents/news/GDO-EDODroughtNews202202_Western_Mediterranean.pdf

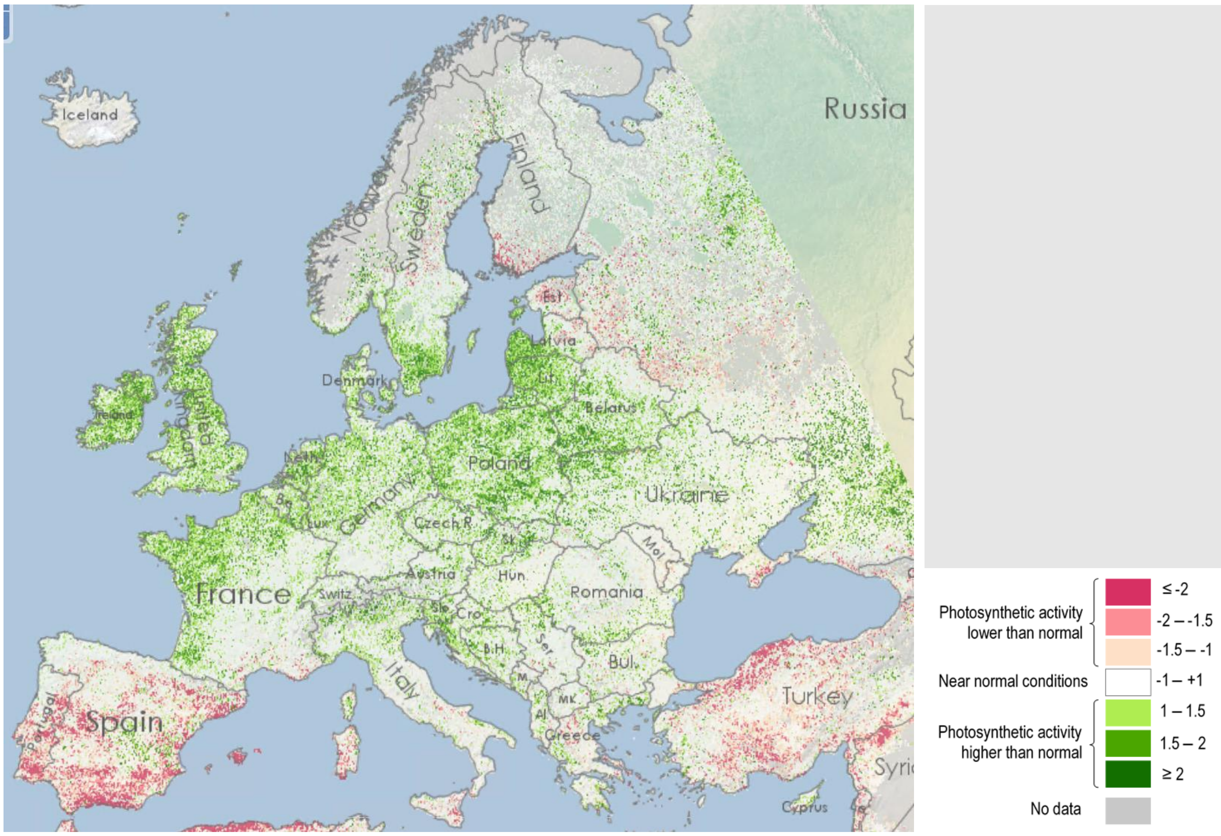


Figure 4: *FAPAR Anomaly - end of March 2022.*

Low-Flow Index

The Low-Flow Index (LFI) based on the daily river water discharge simulated by the LISFLOOD hydrological model, captures consecutive periods of unusually low streamflow. It compares the consequent water deficit during those periods with the historical climatological conditions.

At the end of March 2022, the LFI largely follows the spatial pattern of both soil moisture and SPI-3 conditions in the Po and Danube river basins (Fig. 5). There are strong deficits in the eastern part of the Po basin, and along the Danube River.

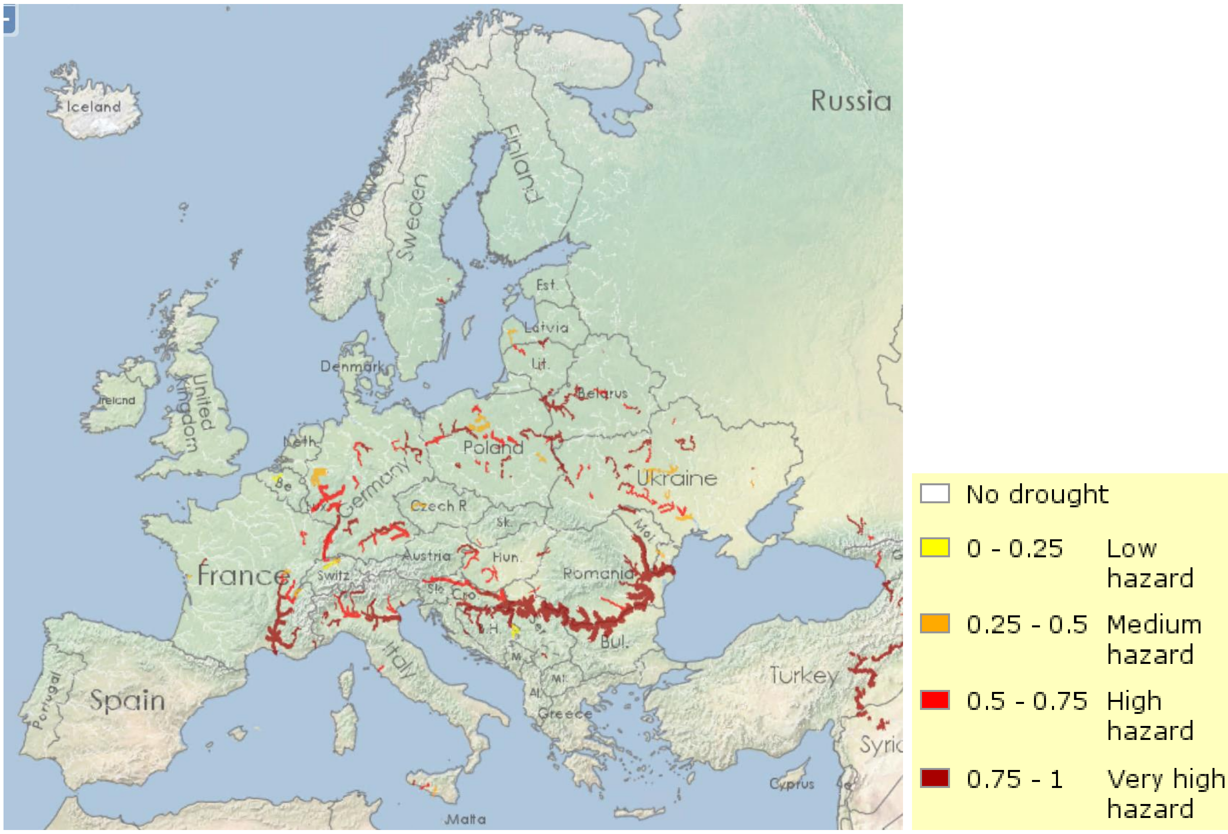


***Figure 5:** Low-Flow Index (LFI) at the end of March 2022. A Low-Flow Index of 0 corresponds to no drought and a value of 1 to the highest drought hazard.*

Most of the measured discharge data for the Danube River are just slightly above the minimum levels, indicating severe hydrological drought.[6] The water level in Budapest is shown in Figure 6, while the decreasing trend in the Romanian section of the Danube River is displayed in Figure 7.

[6] http://www.inhga.ro/diagnoza_si_prognoza_dunare; https://www.hidmet.gov.rs/eng/hidrologija/radio.php; https://www.noel.gv.at/wasserstand/#/en/Messstellen/Map/Durchfluss; https://www.hydroinfo.hu/en/hidinfo/hidinfo_graf_duna.html; https://www.doris.bmk.gv.at/en/fairway-information/water-levels/schwedenbruecke-donaukanal

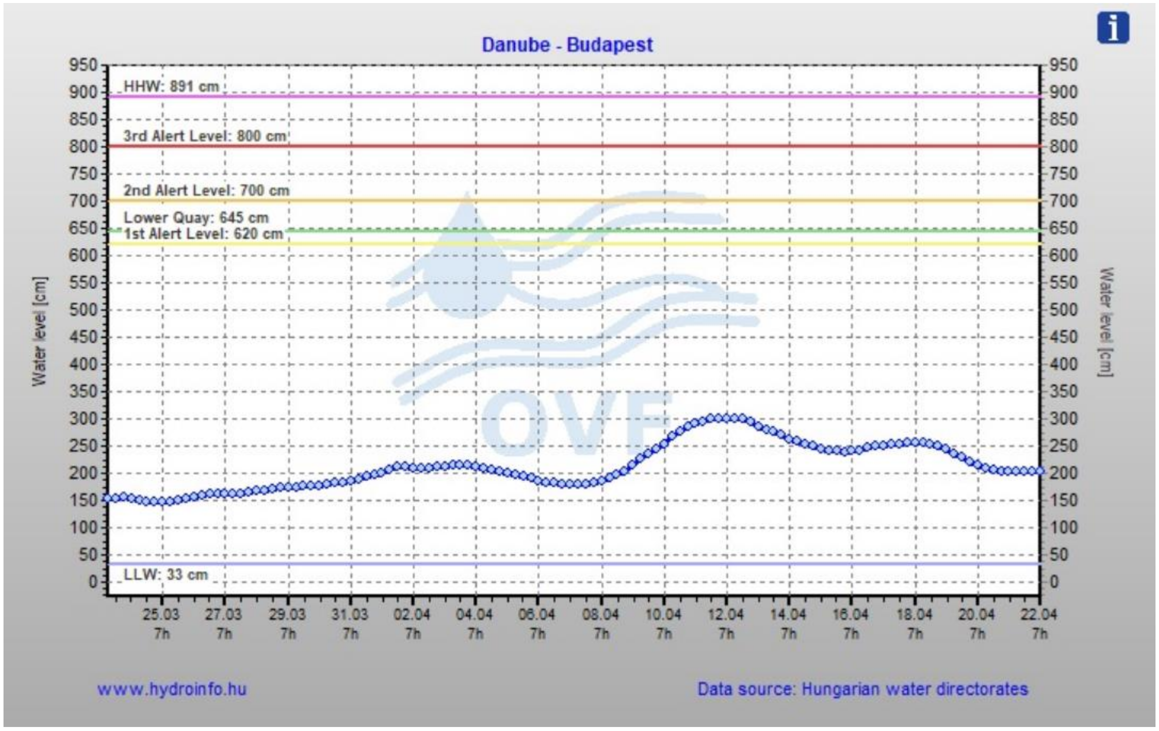


Figure 6: *Water level time-series of the Danube (Budapest) from 25th March 2022 to 22nd April 2022. Source: Hungarian Hydrological Forecasting Service (https://www.hydroinfo.hu)*

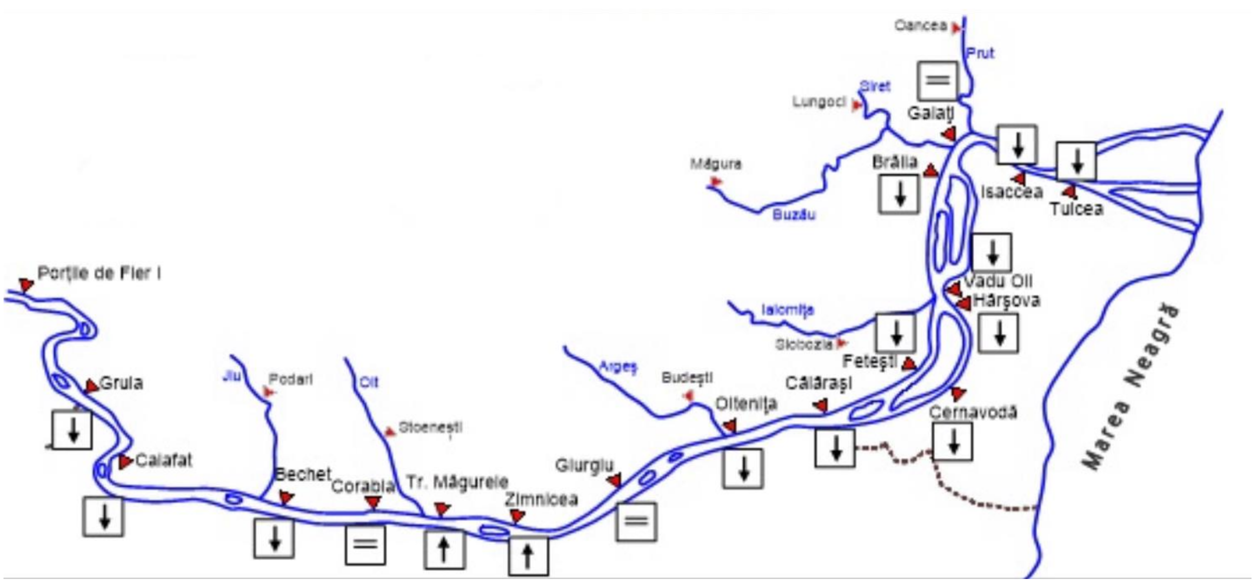


Figure 7: Water level trend of the Danube (Budapest). Source: Romanian National Institute of Hydrology and Water Management (Institutul National de Hidrologie si Gospodarire a Apelor http://www.inhga.ro)

Concerning the Po river, the hydrological drought is confirmed by the analyses performed on the observed data by the Po River District Basin Authority. The Standardized Flow Index (SFI), calculated from observations in the main sections of the Po river in March, points to: extreme hydrological drought at most of the main measurement sections (Piacenza – Fig. 8), Cremona, Boretto and Pontelagoscuro with SFI lower than –2); severe hydrological drought (SFI lower than -1.5) at Borgoforte (for details not shown here see the April Bulletin of the Permanent Observatory on water use - Po River District Basin Authority).

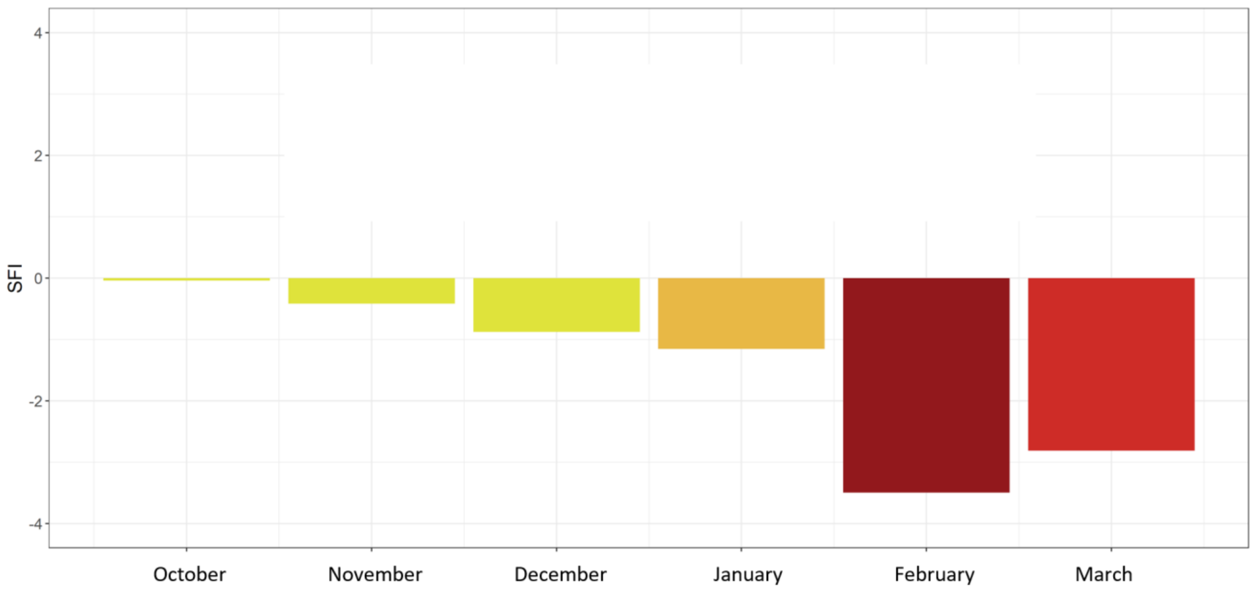


Figure 8: *Standardized Flow Index (SFI) at Piacenza section from October 2021 to March 2022. Source: Permanent Observatory on water use - Po River District Basin Authority.*

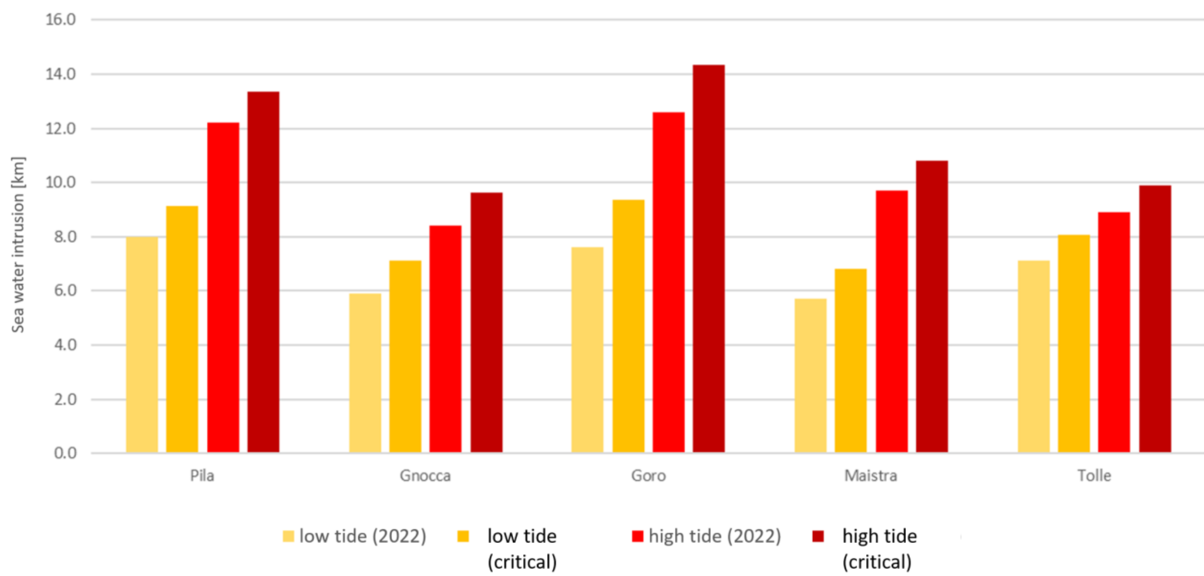
The average precipitation deficit since the beginning of the year is about 70-80% in mid-April. Local and sparse precipitation between the end of March 2022 and the beginning of April 2022 were not enough to compensate this severe deficit.

The Po river discharge is deteriorating again after a slight and brief increase, with the most critical value recorded in Piacenza (253 m^3/s discharge corresponding to 74% reduction w.r.t. the average value). Most of the tributaries have very low flows close to their minimal ecological flow for summer[7].

Sea water intrusion in the Po River Delta, which is a major cultivation zone, is extremely severe (mid-April 2022). Indicator values are comparable to the reference critical threshold

[7] https://www.adbpo.it/15093-2/

corresponding to a river discharge of 450 m³/s (Fig. 9). This critical threshold has been defined as the level when also thermo-electrical power plants have cooling systems problems for the lack of water.



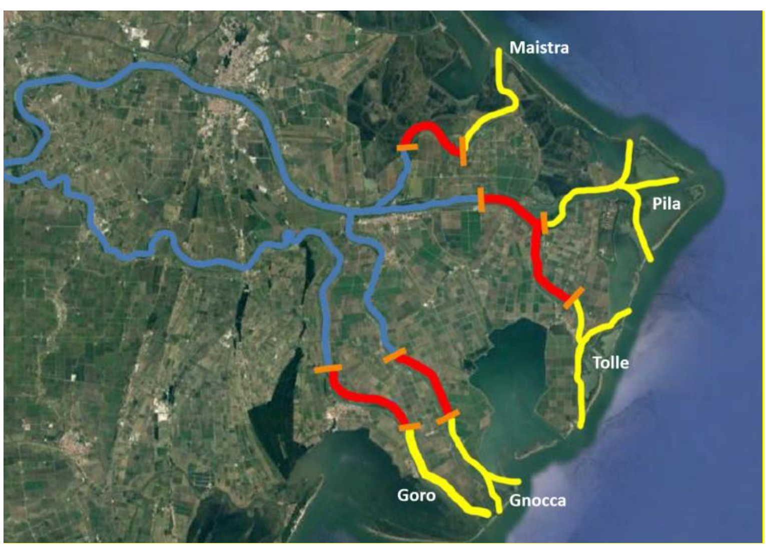


Figure 9: *Sea water intrusion distance in km at mid-April 2022 compared to the values corresponding to the reference critical threshold of 450 m³/s river discharge (upper) and location of river branches (lower). Source: Permanent Observatory on water use - Po River District Basin Authority.*

Snow Water Equivalent[8]

This section is based on data and information provided by the operational snow monitoring system for Italy (S3M-Italy) developed and maintained by CIMA (Centro Internazionale in Monitoraggio Ambientale, International Center for Environmental Monitoring) Research Foundation on behalf of the Italian Civil Protection Department (DPC). This system provides hourly snapshots of snow depth and mass content (Snow Water Equivalent, SWE) at 200 m resolution.

In the Italian Alps, the snow season started with average snow accumulation in November 2021, but a much drier period followed. Consequently, snow water resources in the Italian Alps were below the first quartile of the 2009-2021 climatology in February 2022 (Fig. 10) and continued to be so in early April. Current conditions correspond approximately to 40% of the 2009-2021 median conditions (-61% deficit, slightly lower than the -65% on the 28th of February). A short precipitation period at the beginning of April helped to reduce the SWE deficit thanks to a slight accumulation contribution and to the reduction of the just starting melting processes at the medium-low altitudes.

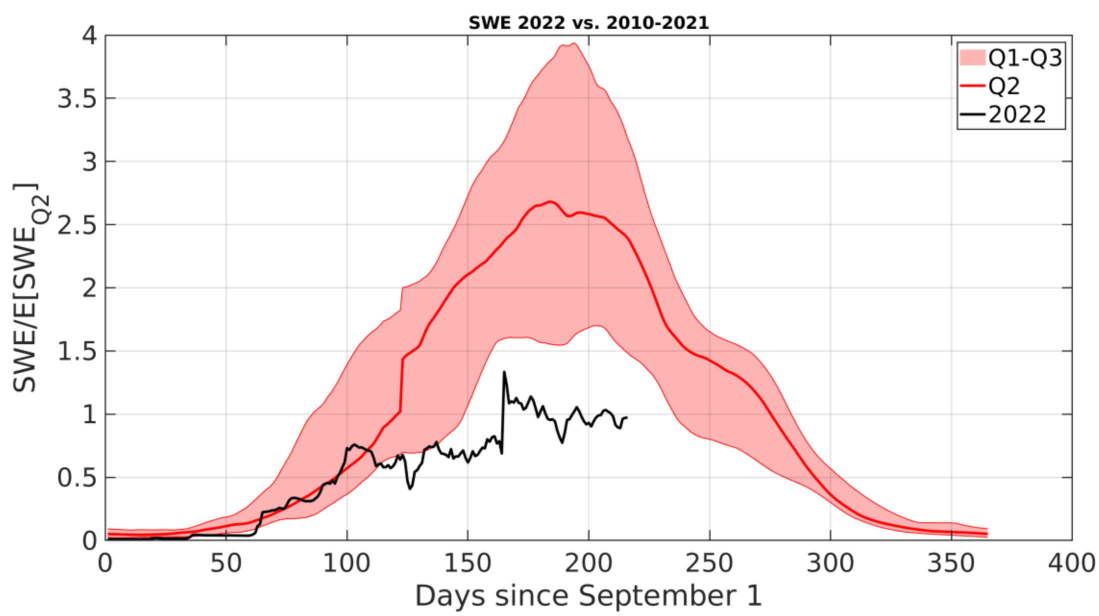


Figure 10: *Normalized Snow Water Equivalent for the 2021-22 snow season (black line) compared to the 2009-2021 climatology for all the Italian Alps. The red line represents the median (Q2), while the light red area encloses the zone between the first (Q1) and last (Q3) quartiles.*

[8] CIMA Research Foundation

Seasonal forecast

The Indicator for 'forecasting unusually wet and dry conditions' provides early risk information for Europe. The indicator is computed from forecasted SPI-1, SPI-3 and SPI-6 derived from the ECMWF seasonal forecast system SEAS5.

Severely drier than normal weather conditions are predicted over southern Europe in the period April-June 2022 (Fig. 11). These negative forecasts raise concerns for the evolution of the current drought. Monitoring its evolution in the next months is essential for risk and impact assessment and early warning.

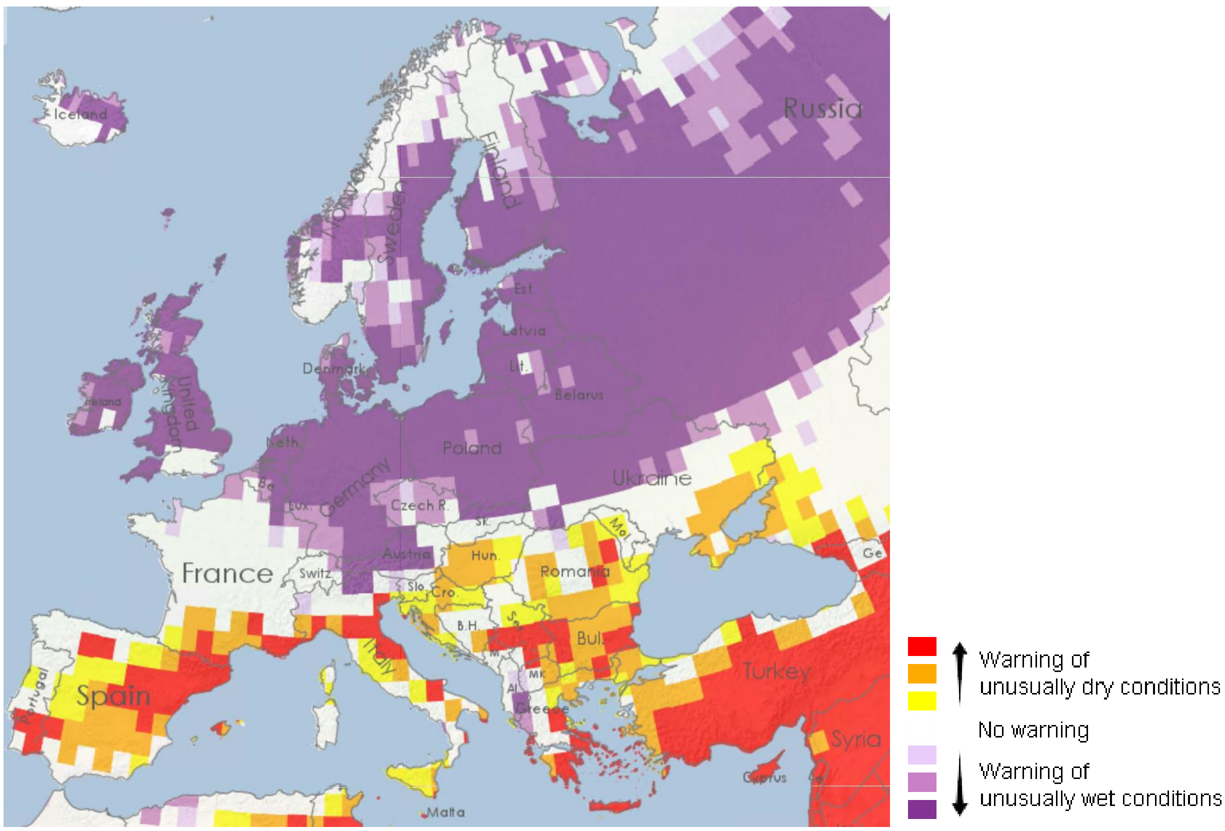


Figure 11: *Indicator for forecasting unusually cumulative wet and dry conditions for 3 months until June 2022.*

Reported impacts

Energy

The latest data from the ENTSO-E Transparency Platform (Fig. 12) shows that the generation from run-of-river plants in the weeks 1-14 (until the beginning of April) was lower than the values observed during the same period in the period 2015-2021 for many European countries, in particular for: France (-1775 GWh from the average), Italy (-1770 GWh), Portugal (-1440 GWh). A similar situation is visible for the reservoir levels. At the beginning of April the hydropower storage level for Spain, Portugal, and Italy is lower than the one in the period 2015-2021 (respectively -3040 GWh, -1050 GWh and -400 GWh). Also the Norwegian reservoirs show lower than usual level (-7550 GWh).
This suggests that the operators had difficulties in filling the storages and – at the same time – tried to maximise the use of the hydropower generation to satisfy the growing national demands considering its lower cost compared to the rest of the production assets.[9]

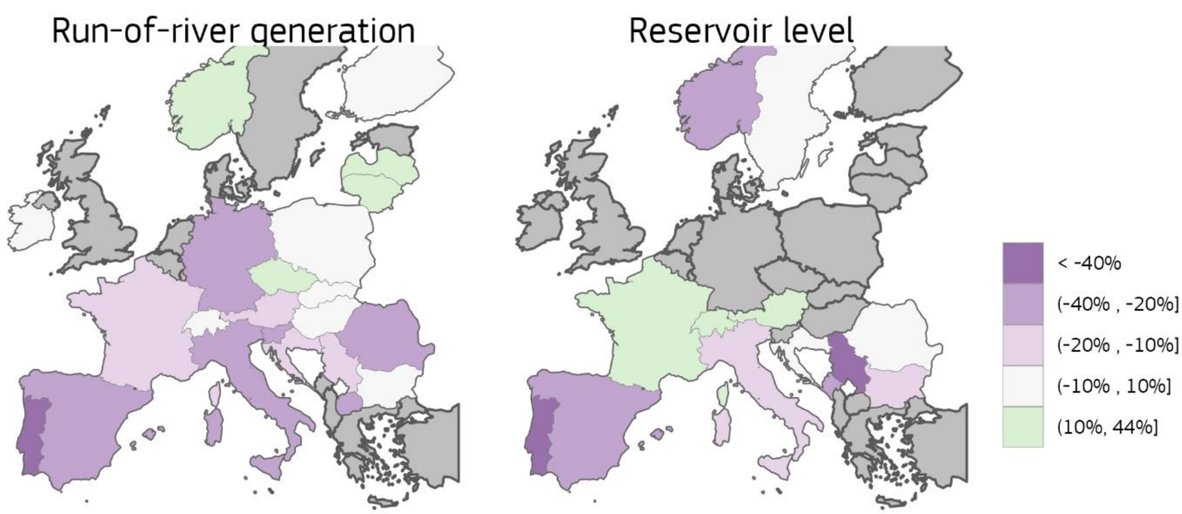


Figure 12: *Percentage difference between the cumulative hydropower run-of-river generation and storage levels for the week 14 of 2022 compared to the same week in the period 2015-2021. Data from the ENTSO-E Transparency Platform (retrieved 20/04/2022).*

Italian hydropower generation has been particularly affected by the drought, especially in the northern part of the country, where most of the installed capacity are located. The water levels

[9] European Commission Joint Research Centre Directorate C: Energy, Transport & Climate Unit C.7: Knowledge for the Energy Union

in many Italian reservoirs are below the minimum historical values (considering the period 1970-2019) since September 2021 (monthly bulletins data from Terna S.p.A[10]). At the beginning of April 2022, the stored energy value in the Italian reservoirs was 1880 GWh, i.e. 27.2% of the total storage capacity *vs* the historical (1970-2019) observed minimum of 27.5% for the same period. The Italian transmission system operator provides statistics at national level only, but the weekly level of the storages is also available at subnational level (bidding zones). Figure 13 shows the level of the hydropower reservoirs in the North bidding zone[11] for the period 2015-2022. The latest data show an amount of stored energy of 677 GWh at week 14, 22.3% less than the 8-year minimum (872 GWh in 2021).
The low level of the European hydropower reservoirs may exacerbate the current situation of the European power markets which are already experiencing record-breaking wholesale prices.[12]

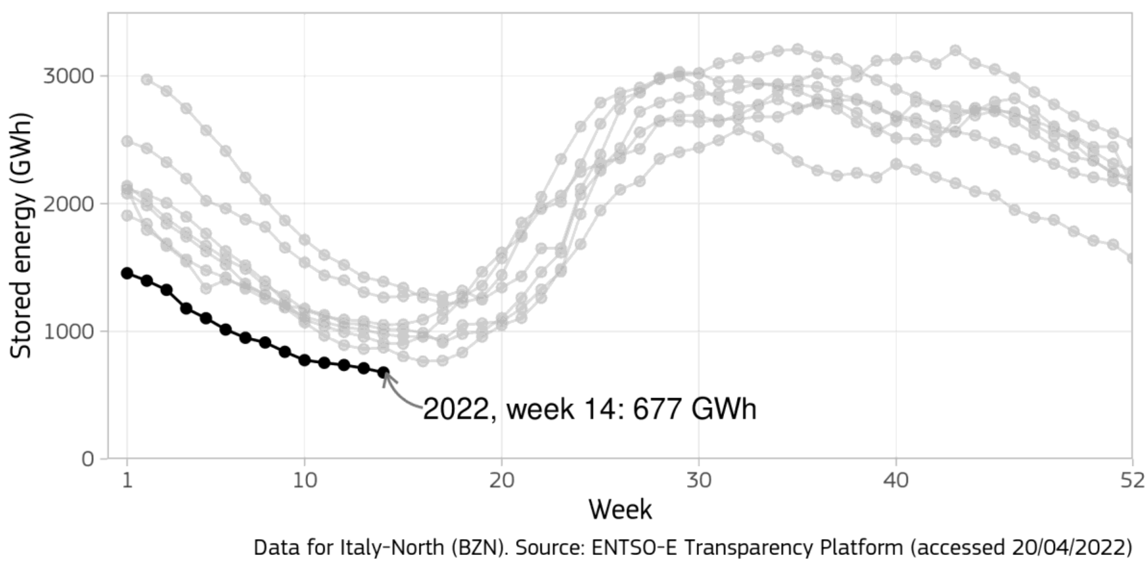


Figure 13: *Hydropower storage levels in North of Italy for the period 2015-2022. Each grey line represents a specific year. The black line is associated with 2022. Source: ENTSO-E Transparency Platform.*

More in details, the stored water volume in the artificial mountain reservoirs (including hydropower, drinking water, and agricultural uses) is below the period average (2006-2020) in

[10] https://www.terna.it/en/electric-system/publications/monthly-report
[11] The North bidding zone includes the following Italian regions: Valle d'Aosta, Piemonte, Lombardia, Veneto, Liguria, Friuli Venezia-Giulia, Trentino Alto Adige, Emilia-Romagna
[12] European Commission Joint Research Centre Directorate C: Energy, Transport & Climate Unit C.7: Knowledge for the Energy Union

almost all the sub-basins. Many values are critical and close to the historical minimum (Fig. 14). On average, the water availability in the mountain reservoirs is below the average and corresponds to 37% of the total available volume.

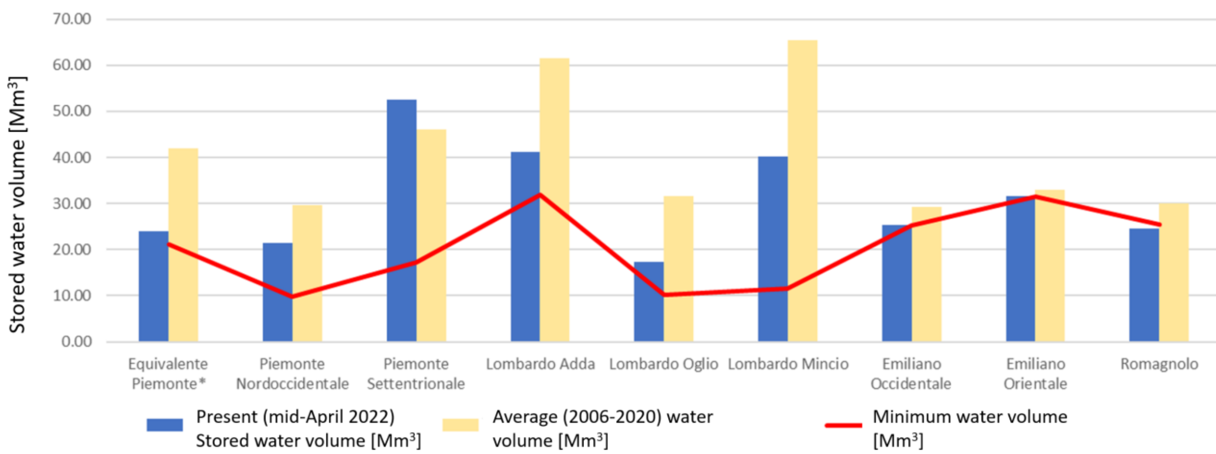


Figure 14: *Cumulative stored water volume at mid-April 2022 (blue bars), average stored water volume for the same period (2006-2020, yellow bars), and historical minimum volume (red line) for mountain reservoirs for, each sub-basin of the Po basin from west to east, source to outlet. Source: Permanent Observatory on water use – Po River District Basin Authority.*

Agriculture

According to the latest edition of the JRC MARS Bulletin on Crop Monitoring in Europe published on 26 April 2022[13], winter crops in Spain and Italy are in sub-optimal conditions, as water stress has reduced the yield potential, despite the colder-than-usual weather that reduced evapotranspiration. Notably in Italy, most regions have shown a persistently negative water balance since the beginning of winter, and rain is needed to avoid further reduction of the yield potential of winter crops and to create favourable conditions for efficient fertiliser applications and summer crop sowings.

As shown in previous sections of this report, water availability for irrigation will be lower than usual. The Po river and its main tributaries are at very low discharge levels and limited recharge is expected from snowmelt. Water use by irrigation already started, which means that competition for water will start sooner than usual with possible negative effects on the rice-

[13] https://publications.jrc.ec.europa.eu/repository/handle/JRC127960

sown area that, without significant precipitation during spring, could be reduced. The peak in water demand will occur in May because of the overlapping water demand from rice and maize producers.[14]

According to the Permanent Observatory on water use over Po River district, most of the agricultural sector has been forced to postpone the sowing by two weeks, confirming water availability for irrigation purposes at historic lows. Due to the critical situation at the Po River Delta caused by sea water intrusion, it is difficult to derivate water for irrigation during high tide. Drinking water emergency, compensated by the dispatch of tankers, concerns some Piedmont municipalities and some Lombardy areas (Varese and Brescia).[15]

[14] European Commission Joint Research Centre Food Security Unit – D5
[15] https://www.adbpo.it/15093-2/

Glossary of terms and acronyms:

ARPA	Agenzia Regionale per la Protezione dell'Ambiente
CEMS	Copernicus Emergency Management Service
CIMA	Centro Internazionale in Monitoraggio Ambientale
DPC	Dipartimento di Protezione Civile
EDO	European Drought Observatory
EC	European Commission
ECMWF	European Centre for Medium-Range Weather Forecasts
ERA5	ECMWF Reanalysis v5
ERCC	European Emergency Response Coordination Centre
FAO	Food and Agriculture Organization of the United Nations
FAPAR	Fraction of Absorbed Photosynthetically Active Radiation
GDO	Global Drought Observatory
GPCC	Global Precipitation Climatology Centre
JRC	Joint Research Centre
LFI	Low-Flow Index
MARS	Monitoring Agricultural ResourceS
RDrI-Agri	Risk of Drought Impact for Agriculture
SFI	Standardized Flow Index
SMA	Soil Moisture Index (SMI) Anomaly
SMI	Soil Moisture Index
SPI	Standardized Precipitation Index
SWE	Snow Water Equivalent

EDO indicators versioning:

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

GDO Ensemble Soil Moisture Anomaly, v.2.3.0
FAPAR (fraction of Absorbed Photosynthetically Active Radiation) Anomaly 1.3.2
Indicator for forecasting unusually wet and dry conditions 1.0.0
Precipitation (GPCC) 1.2.0
Standardized Precipitation Index SPI ERA5 (1/4-dd resolution). SPI ERA5 is a provisional dataset which replaces SPI Blended and Interpolated (v.1.2.0), unavailable in the considered period due to an issue in source data.
Low-Flow Index 2.1.0

Check https://edo.jrc.ec.europa.eu/download for more details on indicator versions.

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