AGRIWATER

SUMMARY REPORT | 2021

THE STATE OF THE ART OF CURRENT ADAPTATION STRATEGIES AND WATER MANAGEMENT SYSTEMS

Funded by
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AGRIWATER, 2021

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INTRODUCTION

Agriculture plays a crucial role in people's lives. It is vital to all humans no matter the nationality, race, gender, ethnicity, religion and so on. Even though people depend on agriculture to survive, they forget that in order to provide sufficient crop and animal production, we need to make sure that our ways of farming are sustainable and enable us to farm in the long-term future. In the same spirit, people have to make sure to adapt to climate changes in order to keep the quality and number of productions.

It is a fact that the European countries experience an increasing number of drought periods causing prolonged shortages in the water supply. Drought is a recurrent feature of the European climate that affects considerable fractions of the European population each year. The frequency and severity of meteorological and hydrological droughts have increased in most parts of Europe. Different drought indices agree that the increase is greatest in southern Europe. Available studies project further increases in the frequency, duration and severity of meteorological and hydrological droughts for most of Europe during the 21st century, except for parts of central-eastern and north-eastern Europe. The greatest increase in drought conditions is projected for southern Europe where it will increase competition between different water users, such as agriculture, industry, tourism and households.

The EU is aware of the intensification of drought and socio-economic problems which they cause, however, the measures taken are rather of a reactive form than a preventative one, explains WWF. Moreover, droughts are often worsened by overexploitation of agricultural land and poor water management of huge agricultural corporations. The main share of water usage per year accounts for agriculture, with a total of 40%. According to Eurostat, approximately 40% of land in Europe is used for agricultural purposes.

This summary report is based on a comparison of national state-of-art analysis of current adaptation strategies and water management systems implemented in partner countries – in Belgium, in the Czech Republic, in Cyprus, in Germany, in Italy, and in Spain. Also, this report tackles the current legislative frameworks in the area of implementing water systems in the agricultural landscape in implemented countries as well as programmes and state initiatives.

The main sources of information for this report were carried out desk researches and interviews with the experts on water management, agriculture, drought, state initiatives for the environment etc.

KEY INFORMATION ABOUT DROUGHT IN PARTNERSHIP COUNTRIES

HISTORICAL EVOLUTION OF DROUGHT

Drought has always been a subject of interest and has been recorded in earlier times. Monitoring was carried out by various methods, in recent centuries according to scientific data, tree samples, and other methods.

In Europe, drought does not only affect semi-arid areas such as the Mediterranean region. Extended drought events have repeatedly affected also Western and Central Europe, the British Islands, Scandinavia and Eastern Europe.

MAIN MILESTONES OF CLIMATE CHANGE IN THE LAST 50 YEARS

- Drought is a recurrent feature of the European climate that affects considerable fractions of the EU population each year. While the exact numbers and patterns depend on the specific drought index used, there is general agreement that the Mediterranean is a drought hotspot (for an overview of drought indicators and indices, see a recent WMO publication).
- Over the majority of the European continent the simulations indicate limited statistically significant variations of soil water content until the middle of the century. Under 2°C warming, Mediterranean regions will experience the strongest reduction in soil moisture, which may occur equally over the full year. On the other hand, North and East Europe show a future increase in soil water availability, which is mostly larger during the wet season. The projected patterns of change in soil drought hazard are a continuation of the drying and wetting trends observed across Europe over the past 50 years: more droughts in the west of the Mediterranean region and fewer droughts in Central and Eastern Europe. Hence, future variations across the continent are driving a further polarization of both soil moisture availability and soil drought severity. Areas of particular concern are Andalucía, Extremadura and Algarve, because the soil moisture variations will be characterized by both a reduction of the annual average and an increase of annual amplitude, depicting deeper annual minimum values in the soil moisture curves. In the present climate, these areas are already characterized by dry or semi-arid conditions and are prone to drought events.
- There was a noticeable increase in air temperature at the beginning of the 20th century. The significance of recent European droughts is mainly described in the context of the hydroclimatic conditions of the second half of the 20th century. It is, therefore, possible that recent European drought events are less (or more) extreme than estimated. The longest sequences of years with dry episodes in each year were 1778–1784, 1988–1994, and 2003–2009. For this reason, recent droughts have received considerable attention.
- At the same time, we have recently been seeing longer and more intense dry episodes. In recent decades, we have observed dry episodes even in years when the amount of annual precipitation was normal. The reason is not that we have less precipitation, but the problem is the air temperature. The output of water by evaporation is greater than its intake, which is a major milestone in climate change. This situation has changed the hydrological balance and we get into negative values.

OVERVIEW OF DRY PERIODS IN PARTNERSHIP COUNTRIES SINCE 20TH CENTURY

Dry periods in Belgium
1921, 1949, 1976, 1953 and 1956

Dry periods in Germany
1959, 1976, 2003, 2018

Dry periods in Cyprus
1990 – 1991, 1996 – 2000, 2006 – 2009, 2012 – 2016

Dry periods in Italy
1942 – 1950, 1988 – 1992, 1997 – 2001, 2003, 2007, 2012, 2017

Dry periods since in the Czech Republic
1904, 1911, 1917, 1921, 1947, 1953 (1954), 1959, 1992, 2000, 2003, 2007

Dry periods in Spain
1909 – 1914, 1938 – 1939, 1941 – 1945, 1963 – 1964, 1979 – 1984, 1990 – 1995, 2005 – 2009, 2012 and 2017

EFFECTS OF CLIMATE CHANGE ON AGRICULTURE

Climate change can be characterized, in particular:

- by changes in air temperature,
- increased evaporation and evapotranspiration,
- distribution of precipitation during the year,
- increased precipitation extremes,
- reduced snowfall in winter,
- and thus, a reduction of water supply in the soil after winter.

The effects of climate change have a greater impact on agriculture. The rising temperatures, decrease in precipitation and its greater irregularity, the increase in evapotranspiration, the lengthening of dry and very dry periods (longer summers), the temporary decrease in available water reserves and the proliferation of new pests and other phenomena closely related to climate change, they will have negative effects on agriculture and livestock farming in the coming years.

Due to several factors, water in the soil is less accessible for many crops during the growing season. For example, other spatiotemporal distribution of precipitation, related to soil moisture or increased evapotranspiration.

The development of precipitation extremes - storms and hails are a big problem that directly affects agriculture (can be derived from the data of insurance companies that pay compensation for damage caused by hail).

The growing season, its length, and onset change. Invasive diseases and pests move to higher altitudes and reproduce more generations. In recent years, there are periods when even steppe crops (cereals) face water shortages, so it is not just a matter of fruit-growing.

MAIN PROBLEMS CAUSED BY DROUGHT

Drought has historically caused famines and massive migratory movements and has been the reason for severe economic, social and political crises. In fact, the impacts of drought are considered to be greater than those of any other natural disaster. They mainly affect agriculture, forestry, transport, recreation, tourism and energy sectors, and create a range of social impacts.

WILHITE, (ED.), 2005 LISTS THE FOLLOWING FOUR TYPES OF DROUGHTS AND THEIR CONSEQUENCES:

- **Meteorological** - negative deviation of precipitation from normal during a certain period of time. The dry air associated with a decrease in humidity together with higher air temperature has a negative effect on humans, fauna, and flora):
    1. Negatively affects the psyche of people during a long period of drought.
    2. The vitality of vegetation decreases.
    3. There is a lack of water and food for wildlife.

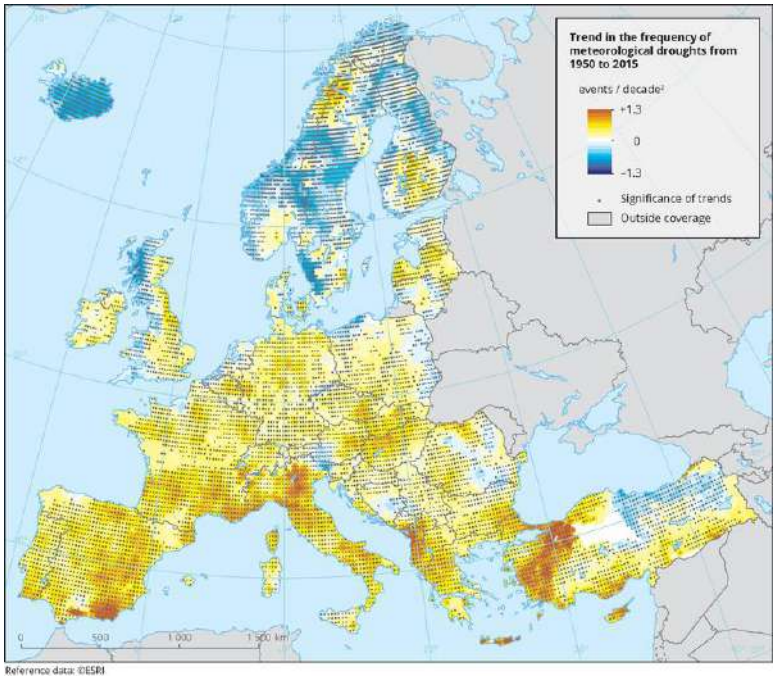
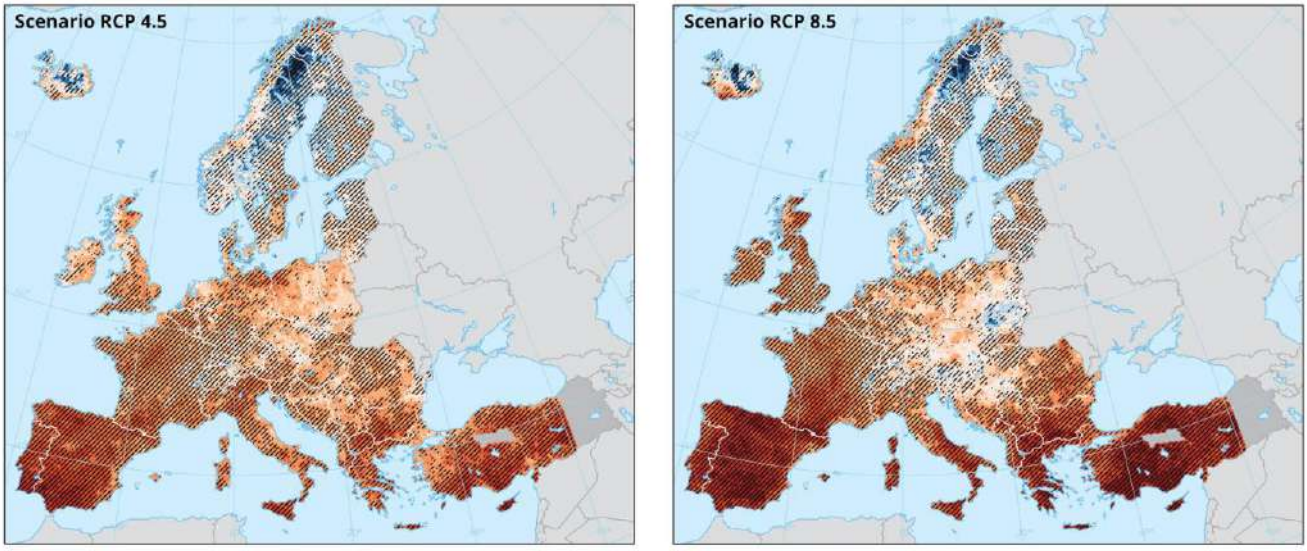


Image n. 1 *Trend in the frequency of meteorological droughts in Europe from 1950 to 2015*

- **Agricultural** – soil drought, lack of moisture for crops:
    1. Revenues are decreasing.
    2. The operating costs of agricultural holdings are rising.
    3. There is a greater need to ensure sufficient water for livestock.
- **Hydrological** – significant reduction of watercourse levels, the sinking of groundwater levels:
    1. There is a lack of water to supply the population with drinking water.
    2. There is a lack of water for flora and fauna in river systems.
    3. Water-free dry parts of streams are formed.
    4. There is a decrease in groundwater levels in the area.
    5. There is a reduction in recreation and sports.
- **Socioeconomic** – effects of drought on quality of life:
    1. Anthropological problems, which mainly concern a human itself, e.g., population development.
    2. Social problems that focus mainly on the interaction of a human and society, such as settlement due to water scarcity.
    3. Economic problems, e.g., localization problems of industry, agriculture, services, tourism, municipalities.

The problems caused by drought and climate change, in general, are linked to the vitality of agricultural crops and the increasing need for additional irrigation. It has many different aspects from sources of irrigation water, suitable methods of irrigation to the suitable and efficient distribution of water.

There is no use of intermediate crops - low-volume feed, often out of fear that the drought will cause a subsequent crop failure of major crops. The problem is, of course, the lack of water for cattle or poor harvests, when the rain does not come at the time when it is most needed.



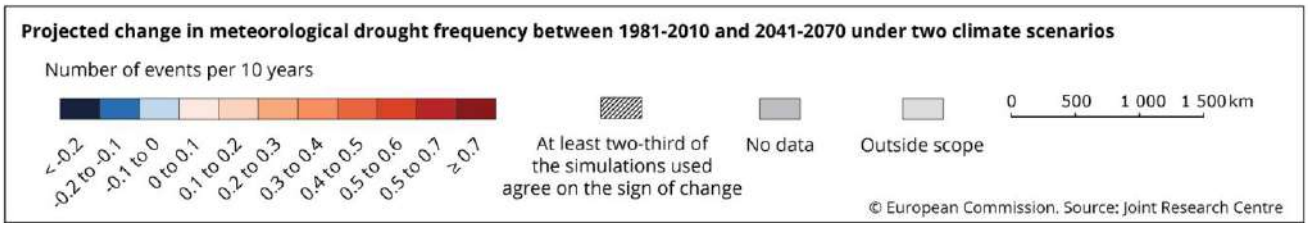


Image n. 2 (from previous page) Projected change in meteorological drought frequency between the present (1981–2010) and the mid-century 21st century (2041–2070) in Europe, under two emissions scenarios.
Comment: Image n. 2 shows projected changes in the frequency of meteorological droughts by the mid-21st century (2041–2070 compared with 1981–2010) for two emissions scenarios: RCP4.5 (left) and RCP8.5 (right). These projections show increases in meteorological droughts across most of Europe, in particular southern Europe, whereas decreases in droughts are only projected for limited parts of northern Europe. The changes are most pronounced for the high emissions scenario (RCP8.5) and slightly lower for the moderate scenario (RCP4.5).
Projections using drought indices that also consider potential evapotranspiration show substantially greater increases in the areas affected by drought than those based on the precipitation-based SPI alone, because increasing temperatures lead to increasing evapotranspiration.

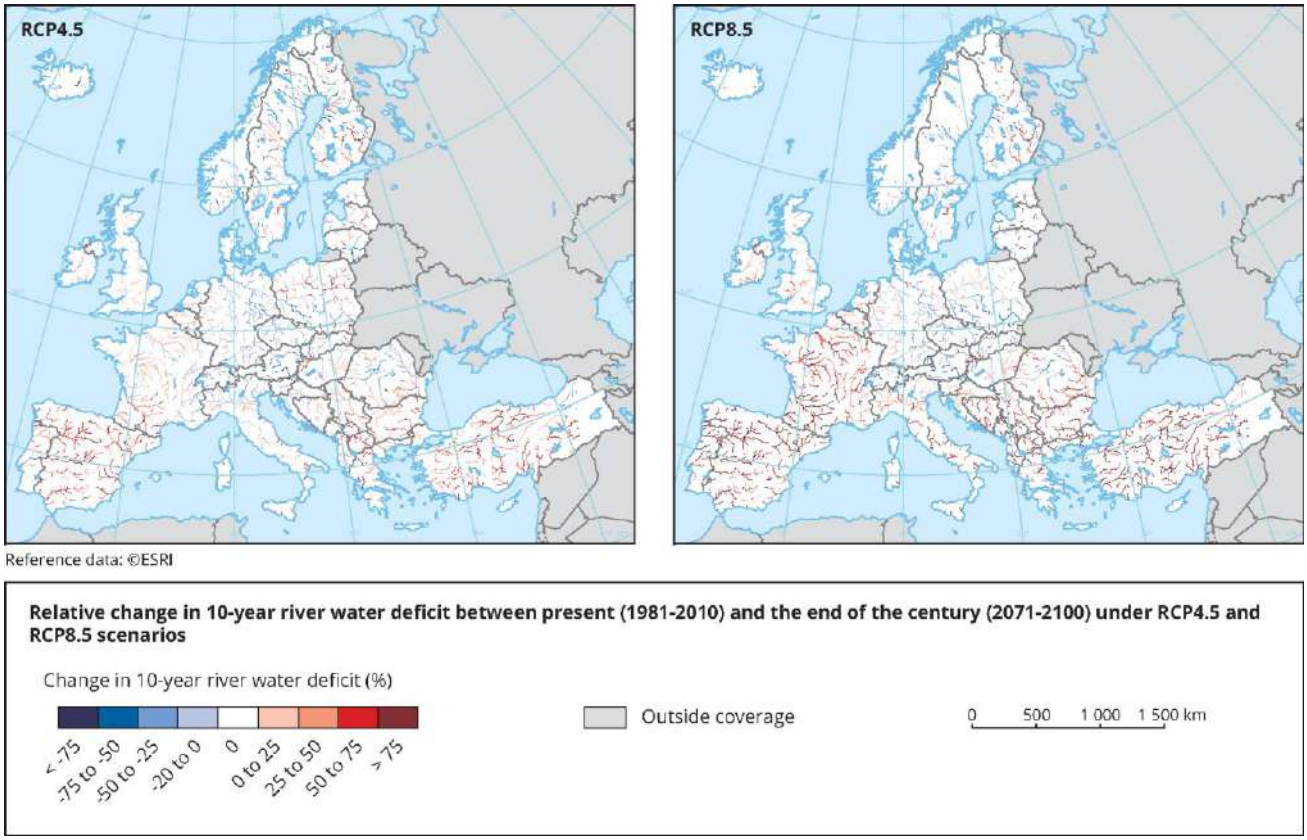


Image n. 3 Projected change in 10-year river water deficit between the present (1981–2010) and the end of the 21st century (2071–2100) in Europe, under two emissions scenarios.
Comment: Image n. 3 shows projections of extreme river water deficit for the same emissions scenarios as above. Increasingly severe river flow droughts are projected for most European regions, except for central-eastern and north-eastern Europe. The greatest increase in drought risk is projected for southern Europe, where it will increase competition between different water users, such as agriculture, households, tourism and industry, in particular under high emissions scenarios.

DROUGHT EFFECTS ON AGRICULTURE

Agriculture is not just about growing field crops, but the effects of the drought are also on other related sectors, such as livestock production. In recent years, there has been a great shortage of feed (fodder). The feed is more expensive if it is at all and there is not enough water for farm animals.

Climate change is currently occurring and of course, there is an impact on agriculture and the existing farming systems. As farming is based on soil, water and sun, changes in these factors affect farmers. All three factors

are changing not only on average but as well they are more and more volatile with even more regional differences than already before.

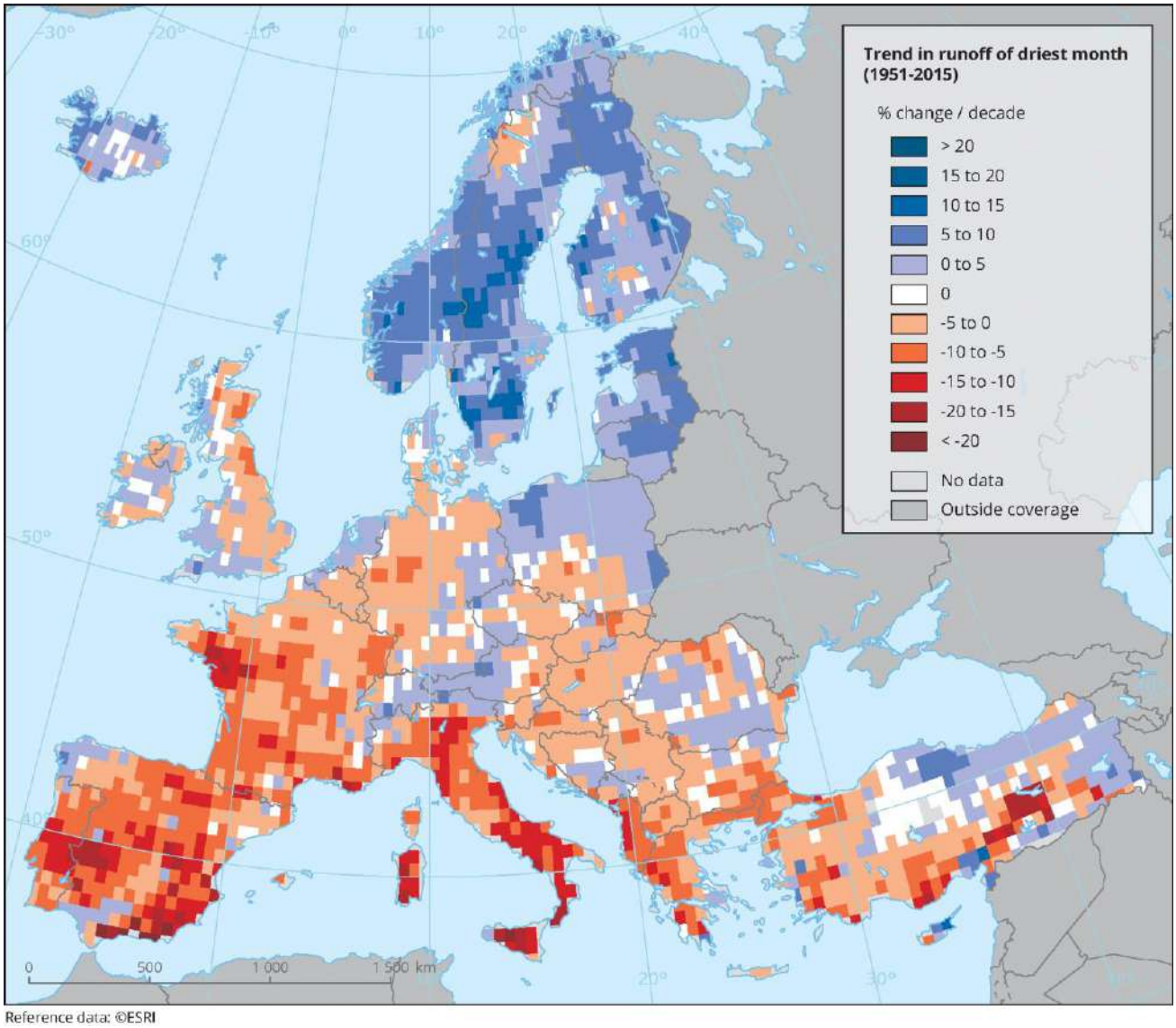


Image n. 4 Trend in runoff of driest month in Europe from 1951 to 2015
Comment: "Driest month" refers to the month with the lowest river flow in each year.

THE FOLLOWING ADDITIONAL IMPACTS CAN BE MENTIONED:

- Loss of profit: a serious impact on agriculture is mainly the loss of production, smaller and lower quality raw materials-crops, fruits, tubers;
- increased costs: with prolonged drought, there are also increased fuel costs due to the compaction of the soil with less soil moisture. At the same time, there is faster wear of work tools during tillage;
- economy: concluded contracts for the supply of products do not have to be fulfilled and producers may be sanctioned;
- economy: increased costs of production insurance;
- economy: increased costs for expanding storage capacity for hay, or the cost of importing more expensive hay from more climate-friendly areas.

MAIN INDICATORS, STUDIES AND STATISTICS IN PARTNERSHIP COUNTRIES

DROUGHT OBSERVATORIES IN PARTNERSHIP COUNTRIES

The main observatory monitoring drought are:

In *Belgium* due to the multitude of governmental levels, there is no one singular organization that is responsible for droughts on a national level, rather this responsibility falls onto the shoulders of the many provinces, regions, and municipalities within the country. Therefore, there are many publics as well as private observatories that study droughts, including the **Flemish Drought Commission**, the **Coordination Committee on Integrated Water Policy (CIW)**, and the **Flemish Environment Agency (VMM)**. CIW is responsible for the coordination of the integrated water policy on the level of the Flemish Region.

In *Cyprus* are two Departments that observe the situation of droughts, namely the **Water Development Department (WDD)** and the **Department of Meteorology**. The WDD does not "monitor" or "study" the situation regarding droughts, i.e., it is not an "observer", but deals with the management of the effects of the drought. In other words, it is called upon to manage the results from the drought phenomena, in terms of the management and distribution of the available water resources. This work is done using the Drought Management Plan as well as other relevant water management information.

In *the Czech Republic* is the **Czech Hydrometeorological Institute, v.v.i.**, which measures air temperatures, precipitation, evaporation, and other meteorological parameters in its network of meteorological stations, distributed throughout the Czech Republic. Another Czech observatory is the Institute for **Global Change Research of the AV ČR, v.v.i. - CzechGlobe**, which is engaged in basic research on ongoing global climate change.

In *Germany* **Federal Environment Agency (Umweltbundesamt: UBA)** is collecting data on the state of the environment, researching interrelationships, making forecasts for the future and using this knowledge to advise the federal government. In addition, UBA enforces environmental laws. UBA's tasks are defined in the Act on the Establishment of a Federal Environment Agency. Another institution The **Helmholtz Centre for Environmental Research (UFZ)** for Drought Monitor provides daily area-wide information on soil moisture conditions in Germany. The **German Weather Service (DWD)** is responsible for meeting the meteorological needs of all economic and social sectors in Germany. Its tasks are based on statutory information and research mandate, the Law on the German Meteorological Service.

In *Italy* exists **Drought Observatory CNR IBE Climate of the National Research Council – Institute of Bioeconomy (CNR-IBE)**. It provides operational services for decision makers, water management authorities and stakeholders. **The Higher Institute for Environmental Protection and Research (ISPRA)** is an Italian public research body and subject to the supervision of the Ministry of ecological transition. It publishes report and bulletin on drought conditions in Italy. Also, there are other three organizations that are dealing with drought: **River Basin District Authorities**, the **Reclamation Consortium** and **Euro-Mediterranean Centre for Climate Change**.

In *Spain* is **National Drought Observatory (ONS)** which aims is to bring together all the Spanish water administrations with competencies in water matters, to constitute a centre for knowledge, anticipation and monitoring of the effects of drought in the country and to mitigate its consequences in the environmental, social and economic fields. The Observatory has a Committee of Experts on Drought, which evaluates the water scarcity situation and advises the Ministry on the actions to be taken to manage the drought.

STUDIES/PERIODIC REPORTS THAT ANALYSE DROUGHT

Belgium

- There is no study or periodic report that encompasses all of Belgium. There are studies that have been done for specific regions.

Cyprus

- **Drought Management Plans** make a decisive contribution to effective, efficient, and sustainable water management and are therefore an integral part of the Water Policy. In the case of Cyprus, a country plagued by frequent and prolonged droughts, policy to address and effectively manage drought is the most important part of Water Policy (Water Development Department, Drought indices). Drought Management Plans aim at the quantification and timely diagnosis of drought as well as the effective management and reduction of its adverse effects.

The Czech Republic

- The CzechGlobe organization on the INTERSUCHO website deals with most aspects of drought and regular monitoring of the development of drought in the growing season in individual years and also in connection with individual years. Regular annual reports, the so-called **Blue Report**, are available on the website of the Ministry of Agriculture (eAGri), which contains data and information on water management in the Czech Republic. There are regularly published reports on the website of the Ministry of the Environment - Environmental Reports of the Czech Republic. There are available data on the state of the climate in a given year, the occurrence of drought, the climate system in the global system, or greenhouse gas emissions. Regular annual reports are published by all public research institutions (v.v.i.) and there can be found all projects dealing with drought, the results achieved, and new findings.

Germany

- In Germany, The Helmholtz Centre for Environmental Research (UFZ) for Drought Monitor provides daily area-wide information on soil moisture conditions in Germany. It is based on simulations with the mesoscale hydrological model mHM (www.ufz.de/mhm) developed at the UFZ.

Italy

- The Higher Institute for Environmental Protection and Research publishes **Drought bulletin** which provides monthly-updated maps of SPI, computed for 3-, 6-, 12- and 24-month timescales over four areas: Italy, Europe, Mediterranean basin and EU CADSES area. The SPI calculation is based on daily precipitation data from the NCEP/DOE Reanalysis 1 project, which are freely-available only from 1948 to the present.

Spain

- The State Meteorological Agency (AEMET) has been preparing an **annual report** on the state of the climate in Spain since 2020. The document collects data on meteorological drought (annual precipitation) and standardized precipitation index (SPI) by large river basins and on soil moisture by provinces. AEMET also has historical series of annual rainfall and temperature records at least since 1961.
- The Ministry for Ecological Transition and Demographic Challenge (METDC) periodically monitors a range of drought related parameters:
    - The National Drought Observatory publishes a **monthly summary report** and a map on the situation of prolonged drought and relevant scarcity in all the inter-community river basin districts.
    - The Hydrological Information Area publishes the weekly **Hydrological Bulletin** with data from the Hydrographical Confederations, the intra-community hydraulic Administrations, the State Meteorological Agency and Red Eléctrica de España.

ANNUAL PRECIPITATION AND TEMPERATURES IN EUROPE

- There is no clear trend in annual precipitation for Europe, and 2019 values were close to average.
- The number of precipitation days was up to 30 more than average in the north, west and south, whereas central and eastern Europe saw below-average values.
- In winter, spring and summer, precipitation was below average in the southwest, however, through autumn to December, large parts of this region changed to seeing much-above-average precipitation.
- Soil moisture shows a downward trend, with values for 2019 being the second lowest since at least 1979.
- Most of continental Europe saw below-average soil moisture throughout the year, especially in central Europe during summer and in the southeast during autumn.

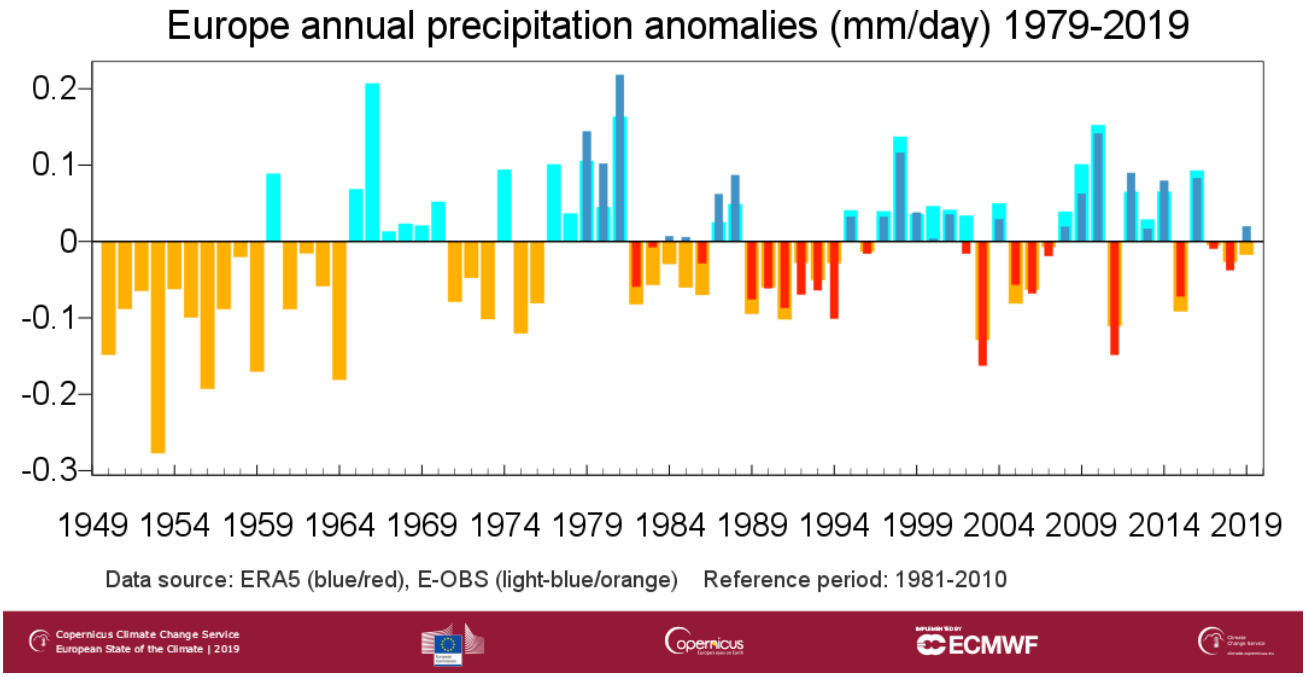


Image n. 5 Europe annual precipitation anomalies (mm/day) 1979-2019

Precipitation over Europe as a whole does not show a significant trend, neither for annual nor for seasonal values. There is spatial variation in trends across Europe, though this is not explored further here.

- The European average temperature in 2018 was one of the three highest on record.
- Summer was the warmest on record - more than 1.3°C than usual.
- All seasons were warmer than usual, with late spring, summer and autumn all seeing temperatures more than 1°C above average.
- There were high maximum temperatures from spring onwards, especially in the north.
- There were much above average minimum temperatures in the southeast.

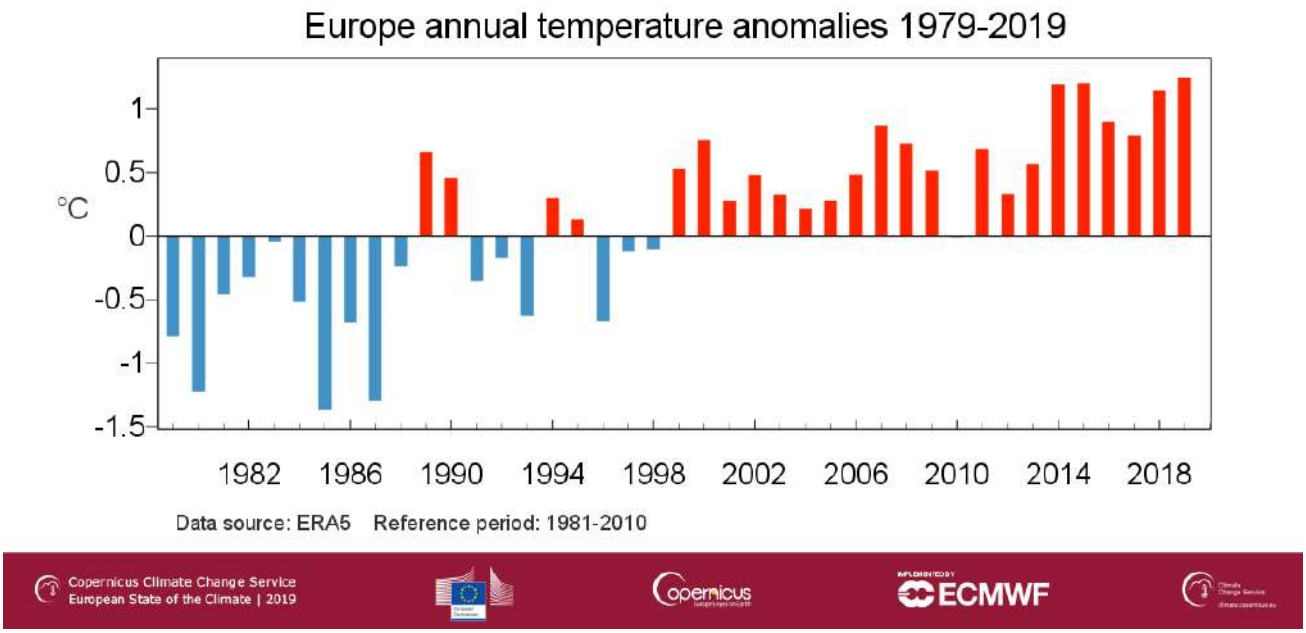


Image n. 6 Europe annual temperature anomalies 1979-2019

Temperatures over Europe show long-term warming trends since 1979 for both the annual and seasonal averages, though the rate of change and the time at which a clear trend emerges differ for the different time periods. The annual mean temperature shows that 2019 was the warmest on record for the ERA5 dataset, at over 1.2°C above average, but closely followed by 2014, 2015 and 2018. According to ERA5, 11 of the 12 warmest years in Europe have occurred since 2000.

Belgium

- The historical record shows a slow, yet statistically significant and steady increase in annual precipitation (Brouwers et al., 2015) at a rate of 0.5 mm per year. In 2017 the annual rainfall was 92 mm higher than when measurements started in 1833.
- High-resolution climate scenarios indicate a seasonal dependence: winter (December, January and February) precipitation is expected to increase by about 18% by the end of the century. On the other hand, for summer (June, August) a decrease of 10% is expected (De Ridder et al., 2020).

Cyprus

- Water scarcity in Cyprus is already aggravated by the impact of climate change. The effect started to be felt as early as the 1970s, with increasing rainfall variability and frequency of droughts. Statistical analysis shows a 20 percent drop in the mean annual precipitation since the early 1970s, compared to precipitation records over the past 100 years. While the mean annual precipitation over a 30-year period of the last century (1901–30) amounts to 559 mm, it has dropped down to only 463 mm during the past 30-year period (1971–2000). This reduction in rainfall has been accompanied by a parallel increase in average temperature, with a parallel negative impact on evapotranspiration in agriculture (with higher crops consumption).

The Czech Republic

- The data show an increase in average precipitation totals in the Czech Republic since 1961.
- In addition, the individual periods did not develop in the same way. In contrast to later increases in values, their steady-state (for example, average annual temperatures) or even a decrease (for example, April

temperatures) was often observed until about 1980, or until 1990 (average temperatures in November). The change in precipitation totals probably occurred around 1995 - since that year, higher precipitation totals have occurred relatively often outside the winter period. These conclusions are consistent with the observed climate periodization at some climatological stations, which have been evaluated so far.

Italy

- The Mediterranean area is considered a hotspot for climate change. An increasing trend in temperatures started to be observed in Italy since the 80's considering the annual averages, but even more when considering only the summer season, which extended its duration with increased heat waves spanning from May to October. The analysis of historical precipitation trends shows a higher variability, typical of areas with a complex orography like Italy, but overall, no significant trends are clearly observed (ISPRA, 2013; Toreti et al., 2009).

Spain

- Over the last 50 years the average annual precipitation shows a moderate decrease.
- As in the case of rainfall, temperatures also show a very uneven distribution. Heatwaves and cold spells are usual.
- Periods of meteorological drought are recurrent in Spain due to the irregularity of precipitations and temperatures. The rainfall pattern is directly influenced by the North Atlantic Oscillation (variation between the high pressure of the Azores anticyclone and the low pressure of the Iceland Low): from time to time, the Azores anticyclone blocks the passage of squalls towards Spain, which suffers droughts of 3-5 years.

DROUGHT AND AGRICULTURE

WATER USE IN AGRICULTURE

Water plays a crucial role in food production and agriculture in general. The major reason for water uses in the agricultural sector is crop irrigation. Based on the annual average, agriculture accounts for 59% of total water use in Europe, most of which is used in the southern basins where precipitation and soil moisture are not sufficient to satisfy crop water needs and production of some crop types would not be possible without irrigation. Irrigation is also used to increase crop yields. In general, vegetables and other crops that generate high gross value added are also very water demanding.

Around 7-8% of the total agricultural area in Europe is irrigated, reaching 15% in southern Europe (source: Eurostat). Although only a small proportion of agricultural land is irrigated, around 40-45% of total water use in Europe is allocated to crop irrigation annually. Crop irrigation is particularly intensive (80% of total water use in southern Europe) between April and August, when crops grow, precipitation decreases and evapotranspiration increases.

Southern Europe uses around 95% of the total volume of irrigation water at the European level (including Turkey and the Western Balkans).

The agricultural sector generated more gross value added (20%) in 2017 than in 1995. However, there is still room for improvement in irrigation efficiency. In many cases, water is abstracted off-stream and conveyed over long distances, via open channels, ditches or pipes, to supply water for irrigation. During this transportation, a portion of the water is lost via evaporation or leakages in the conveyance systems (resulting in a decrease in irrigation efficiency). No comprehensive data are available to undertake a review of European irrigation efficiency although some literature suggests that irrigation efficiency is between 50 and 70% (Clemente at al., 2013; Baldock et al., 2000; Brouwer at al., 1989).

Crop patterns also determine the amount of water needed for irrigation. Favouring crop types with higher gross value added, but which are also more water-demanding, such as citrus fruits and energy crops, puts pressure on water resources. In the coming years, a slight increase in the water requirement for irrigation (EEA, 2014a), associated with a decrease in precipitation in southern Europe (EEA, 2015b) and the lengthening of the thermal growing season, may be expected.

Belgium

Year	1990	1995	2005
Groundwater abstractions for agriculture (million m³)	10.181	13.761	34.792

Cyprus

The massive development of nonconventional water resources – namely desalination (with an installed capacity in 2016 of 80 million cubic meters) and wastewater reuse (21 million cubic meters in 2015) – in order to substitute for overexploited groundwater is obviously of crucial importance and impact. However, additional measures are needed to control abstraction from private boreholes, which for irrigation alone was estimated at 74 million cubic meters (year without restriction).

The Czech Republic

Year	1998	2000	2005	2010	2015	2019
Groundwater abstractions for agriculture (million m³)	4.55	5.22	11	11.5	14	15.3

Germany

Farmers are very dependent on the weather in their business. In principle, this is not a problem, because fluctuations in yields due to weather conditions usually even out over the years. However, due to the extreme structural change in agriculture, the globalization of markets and the related intense price war, many farms have been working at the very limits of profitability for many years.

Italy

The agricultural sector is responsible for more than the 50% of the total water consumption (ISTAT, 2019). In 2016, the 42.9% of farms (572,000) were equipped with irrigation facilities, for a total area of 4.1 million hectares. Compared to 1982, it increased by 4.2%. The 85.8% of the farms equipped with irrigation facilities effectively practiced irrigation in 2016, for a total area of 2.5 million hectares. In Italy, the 20.3% of agricultural land is irrigated, being one of the highest percentages among EU countries (ISTAT, 2019). In 2010, the total volume of irrigation water amounted to 11,618 million of m^3, that is equal to an average of 4,666 m^3 for each irrigated hectare (ISTAT, 2014).

Spain

According to the Survey on Crop Areas and Yields of the Ministry of Agriculture, Fisheries and Food (MAPA) in 2018, irrigated area reached 3,774,286 hectares, 399,654 more than ten years earlier. This increase has gone hand in hand with a decreasing trend in water consumption. Between 2008 and 2012, the volume consumed by farmers was close to or exceeded 16,000 cubic hectometres, while now it is below 15,000 hectometres, according to information from the National Institute of Statistics. The Ministry of Agriculture points in the same direction. In 2002, the agricultural sector accounted for 80% of the total water consumed in Spain. Today, this figure has fallen to approximately 65%.

DIFFICULTIES AND CHALLENGES FOR FARMERS (GENERAL CHALLENGES)

Agriculture is the sector that will be most negatively affected by climate change. Besides increased temperatures and decreased rainfall, another significant negative impact is related to rainfall events that will occur with increased intensity, causing direct damages to infrastructures and crops and erosion of the most fertile soil layers.

The rise in temperatures will increase evapotranspiration and consequently crop water requirements, which in many cases can be satisfied only by practicing irrigation.

- It is impossible to separate water scarcity in general (in municipalities and cities) from water scarcity in agriculture. The farmer should manage to retain water in the landscape, no one but the foresters can do this. So, water management must be learned and implemented.
- Due to increased evaporation and surface and subsurface runoff of water during heavy precipitation, there is often a long period of drying out of streams and rivers, death of fish, etc.
- Farming sector needs to improve product marketing processes, competitive defence of prices, reduction of production costs with greater mechanization of the sector and above all to enhance product quality and differentiation for the consumer to appreciate their characteristics.
- It is necessary to increase technical knowledge and increase professionalism among farmers in order to make farms and cooperatives more competitive. Many do not acquire this professional profile as their income does not depend exclusively on agricultural production.
- The high average age of farmers limits change, and there is excessive conservatism. Succession processes need to be defined to facilitate generational relay, allowing opportunities for young farmers.
- Agriculture has to respond to consumer demand for healthier products, maintaining forms of management and handling that respect the environment and the landscape.
- The future of the countryside will be linked to climate change, so it is important to adapt farms to future limitations. In Spain, improvements in irrigation systems will be fundamental, with important financing needs.
- The agricultural sector is starting to undergo a revolution, the level of complexity in the future is going to be very high, so a change of mentality is required. It will be necessary to increase the professional profile with more training, development of new skills, but allowing advice on technical, bureaucratic and financial aspects.
- The sustainability of agriculture and the sustainability of the rural world as we know it today will depend on how these challenges are met.

STATE SUPPORT IN PARTNERSHIP COUNTRIES

MINISTRIES FOCUSED ON THE PROBLEM OF DROUGHT IN PARTNERSHIP COUNTRIES

Country	
Belgium	❑ Ministry of Environment ❑ Ministry of Agriculture and Fisheries
Cyprus	❑ Ministry of Agriculture, Rural Development and Agriculture
The Czech Republic	❑ Ministry of Agriculture ❑ Ministry of the Environment
Germany	❑ Federal Ministry of Environment ❑ Federal Ministry of Nutrition and Agriculture, Rural Development and Agriculture
Italy	❑ The Ministry of Ecological Transition ❑ Ministry of Agricultural, Food and Forestry Policies
Spain	❑ Ministry for Ecological Transition and Demographic Challenge

PROGRAMMES OR INITIATIVES IMPLEMENTED BY MINISTRIES IN PARTNERSHIP COUNTRIES

Country	Programme/Programmes
Belgium	❑ Blue deal is an initiative of the Flemish government and Flemish ministries
Cyprus	❑ Rural Development Programme 2014-2020
The Czech Republic	❑ Ministry of Agriculture, Grant programme 129 420 “Support for the purchase and consolidation of water supply and sewerage infrastructure” ❑ Ministry of Agriculture, Grant programme 129 390 “Support for measures on small water streams and small water reservoirs - 2nd stage” ❑ O Ministry of the Environment, Challenge to municipalities: “Prepare projects against drought”
Germany	❑ As water/irrigation is regulated at Länder level subsidies for public support directly related to water/water management are based more on Länder level. End of 2020 in Bavaria, the Ministry of the Environment’s funding programme for innovative environmentally sound and large-scale irrigation concepts in agriculture was entering the next round: the Bavarian-wide application process for up to three pilot projects, whose implementation will be financially supported by the ministry
Italy	❑ European Agricultural Fund for Rural Development (FEASR)

Country	Programme/Programmes
Spain	❑ The National Plan for Adaptation to Climate Change (PNACC) 2021-2030 ❑ Spain's Water Governance System ❑ The Green Paper on Water Governance ❑ The National Hydrological Plan ❑ The Special Drought Plans ❑ The National Action Programme to Combat Desertification (PAND)

SUPPORT OR SUBSIDY AVAILABLE FOR FARMERS WITH GOOD WATER MANAGEMENT

In some of the partnership's countries are already prepared programmes that support the projects and initiatives focused on good water management. But we can say these programmes are quite unusual and hopefully in the future we will see more of this kind of "motivating" programmes.

Belgium

- The Vlaamse Landmaatschappij (VLM) has a programme called „Beheersovereenkomsten", which is mainly dedicated to water quality and nature conservation. On top of this, there is also a project that gives financial compensation for measures by farmers to keep water on their land by stowage, but it is not widely used.

Cyprus

- The Good Agricultural and Environmental Conditions is a set of measures under Cross Compliance of the RDP, through which farmers receive direct payments if comply with these conditions.

The Czech Republic

- In the fight against drought, it is not only subsidies that help, but also support for new agrotechnological or anti-erosion procedures that help in the fight against drought, such as the Call for projects for the activities of Demonstration Farms in 2021.
- In the last 10-15 years, a program to support the reconstruction or revitalization of drainage systems existed, but was not much used. At that time (before 2015), the need was not yet perceived by farmers or water managers as fundamental, except for selected localities (e.g. South Moravia); even though experts pointed this out at least 10 years before the problem arose.

Italy

- National and Regional governments invested to encourage the utilization of more advanced and efficient high pressures irrigation practices among farmers, and to improve the infrastructures to deliver water on-farm for irrigation, strengthening the role of irrigation consortia.
- Farmers can access special Solidarity and Recovery Funds made available by the Ministry of Agriculture, in order to economically restore them after the occurrence of extreme events like floods, hailstorms and also droughts.
- PSR are divided into several measures; some of them have a direct impact on water management. Measure 2 regards consultancy services; measure 4 investments in infrastructures; measure 5 prevention of catastrophic events and losses restoration; measure 12 compensations for protected areas. In addition, measure 10 consists of agro-climate-environmental payments.

Spain

- Direct aids are divided into two components: “basic payment” and “greening”, which aims to reward respect for good environmental practices in relation to pastures, rotations and areas of ecological interest.
- There are aid programmes in the national, regional and provincial framework for legally constituted Irrigation Communities. These aids are related to works and installations of reform or major repairs, including machinery, project drafting expenses, project management and consultancy.

LEGISLATION, BACKGROUND

An overview of the basic and most important legal acts and regulations concerning water management as well as national strategies in partner countries can be found below. We can conclude that the majority of partnership countries already have implemented strategies supporting keeping water in the landscape and these strategies are the starting point for the further steps.

Belgium

The heavily fragmented nature of the Belgian policy sphere has resulted in a complex, interconnected and dynamic network of policies and legislation. For this reason, there is no one policy/legislation that looks after drought and water management. Every jurisdictional level implements policies based on their own discretion and their own interests.

National adaptation strategy

The National adaptation strategy was adopted by the National Climate Commission in December 2010. It describes the main impacts of climate change in Belgium and the existing adaptation measures. It pursues 3 main objectives:

- Improve the consistency between adaptation activities existing in Belgium;
- Improve communication at national, European and international levels;
- Develop a National Adaptation Plan.

National adaptation plan

To do this, the Strategy sets out a roadmap for the development of this National plan for the end of 2012. Given that all the information necessary for its drafting (impact analyses, draft regional and federal adaptation plans) was not available in 2012, its finalization was postponed, which also made it possible to take better account of the European Adaptation Strategy.

The National Adaptation Plan, drawn up by the “adaptation” working group of the National Climate Commission, was adopted on April 19, 2017 by the National Climate Commission.

In accordance with the decision of the National Climate Commission of June 27, 2013, this plan aims to:

- Provide clear and synthetic information on adaptation policies and their implementation in Belgium;
- Identify measures of national scope to strengthen cooperation and develop synergies between the various governments (federal, regions) in matters of adaptation;
- A final assessment was carried out in 2020, which confirmed the positive trend: two measures were dropped (but one of them is expected to be launched in 2021); all the others have been launched (sometimes with a slight delay). Only one measure which had progressed well during the mid-term evaluation had to be stopped due, in particular, to the health crisis.

Cyprus

Water Management related legislation is quite wide in Cyprus:

- The Water Integrated Management Law 71(I)/2010 and relevant Regulations. National Law.
- The Water Protection and Management Law 13(I)/2004 and relevant Regulations. The EU Water Framework Directive 2000/60/EC and National Law.

- The Water Quality for Human Consumption (Monitoring and Control) Law. EU Drinking Water Directive 2015/1787/EC and National Law.
- Water Saving legislation. National Law.
- Legislation for the operation of the Water Supply Organizations (Water Boards, Municipalities and Communities).
- The Irrigation Divisions and Irrigation Associations Law. National Law.
- Legislation on the Assessment and Management of Flood Risks. The EU Floods Directive 2007/60/EC.
- Legislation on the Control of Water and Soil Pollution. Relevant EU Directives and National Law.

Drought Management Plans aim at the quantification and timely diagnosis of drought as well as the effective management and reduction of its adverse effects. Drought quantification concerns:

- its “imprint” on the rainfall and runoff time series,
- its intensity, and
- its duration.

The Czech Republic

Legislative background in the Czech Republic relating to water:

- In 2020 was finally approved that an amendment to the Water Act No. 254/2001 Coll., which allows the authorities greater regulation of water consumption in times of drought.
- The operational management system during a drought has been set up similarly as it is currently in flood situations. The new part of the Water Act, Title X, entitled “Drought and water scarcity management”, paragraphs 87a) to 87m), defines the framework for drought monitoring, responsibilities of competent authorities, taking measures to manage drought and water scarcity, and control mechanisms.

In 2015, the government adopted the so-called National Action Plan with Fight Against Drought Combat/Adaptation Measures. This material seems to have moved from a general list to more specific topics, steps and activities. The topic is interdepartmental, dozens of experts and institutions comment on the issue and submit proposals, so activities are moving forward at the pace that can be expected in the Czech Republic.

Germany

In Germany, the most important legislative acts are:

- The "Law on the Prevention and Control of Infectious Diseases in Humans” - the Infection Protection Act (Infektionsschutzgesetz: IfSG) for short - is the legal basis for ensuring and monitoring the quality of drinking water.
- The quality of drinking water is defined in terms of human health (Section 37(1) IfSG): ”Water for human consumption must be of such a quality that its consumption or use is not likely to cause harm to human health, in particular through pathogens.”

There is no specific national strategy in Germany, but it is more or less prominently included in the monitoring of the annual climate protection reports.

Italy

The most important legislative acts regulating water are following:

- Water Framework Directive Dir. 2000/60/EC: Art. 1 of Directive 2000/60/EC asks member states to facilitate sustainable water use based on the long-term protection of available water resources.
- The environmental flow for ensuring the maintenance of ecosystem services is considered by the L. 221/2015 (Art. 70, f), which promotes the payment for ecosystem services for farmers, in order to comply with the objectives of the cited Dir. 2000/60/EC and of the Dir. “Habitat” 92/43/CEE and Dir. “Birds” 2009/147/CE.

Unfortunately, it can be affirmed that the management of drought in Italy has been based mostly as an emergency rather than on prevention. One of the first legislative instruments has been the DPCM n. 4 March 1996, followed by the Document the Prime Minister Romano Prodi circulated on the 13th of March 2007, in order to address the issue of drought in Italy and adopt subsequent measures. Another important step has been the establishment of a National Committee to fight against Drought and Desertification, fostered by the Ministry of Environment in 1999 under the auspices of the UNCCD, with relative Action Plans. Two other important documents are the Communication from the Commission to the European Parliament and the Council of July 18, 2007 and the Resolution of the European Parliament of October 9, 2008 on addressing the challenge of water scarcity and droughts in the EU. Recently the Ministry of Agriculture has been involved in an International Program launched by FAO, the WASAG Program, aimed at addressing the issue of Water Scarcity on Agriculture.

The Ministry for Environment, Land and Sea Protection (MATTM) started two initiatives to tackle drought:

- National strategy of adaptation to climate change (2014)
- National plan of adaptation to climate change (2018)

The Ministry of Agricultural, Food and Forestry Policies (MIPAAF) in (2020) announced the implementation of a National strategy for water saving and hydrogeological instability.

The Ministry of Infrastructure and Transport (MIT) adopted in 2019 the National Plan of Interventions in the Water Sector – "Reservoirs".

Spain

Spain was a pioneer in water regulation (Water Law from 1879, Hydrographical Confederations from 1926).

The main current water legislation in Spain:

- Consolidated Text of Water Law, approved by Royal Decree-Law 1/2001 (basic law for surface water and groundwater).
- Law 10/2001, National Hydrological Plan: it establishes the bases for planned management of droughts and the elaboration of special action plans for alert situations and drought (art. 27.2) and foresees emergency plans for urban water supply to populations of +20,000 inhabitants in drought events (art. 27.3).
- Order MAM/698/2007 (special action plans in situations of alert and possible drought in inter-community basins).
- Order TEC/1399/2018 (revision of the special plans from 2007).
- Specific rules for some hydrographical confederations to combat droughts.

The national plans and programmes related to climate change and drought develop several functionalities. They range from the consultative sphere for evaluation and planning to the existence of national framework plans.

1. The National Plan for Adaptation to Climate Change (PNACC) 2021–2030
2. Spain's Water Governance System
3. The Green Paper on Water Governance
4. The National Hydrological Plan
5. The Special Drought Plans
6. The National Action Programme to Combat Desertification (PAND)

EDUCATION, TRAINING

TRAINING NEEDS FOR A BETTER WATER MANAGEMENT

Each of the partner countries differs greatly in the level of water management programs offered. Some of the partner countries already offer a system of programmes and subjects dealing with this issue, while other countries are at the beginning and do not include water management in their curricula. other countries are at the beginning and water management issues in the curriculum we cannot find.

Belgium

- There are no official training courses or education programmes in water management. They may be a part of University courses.

Cyprus

- The Water Development Department, in collaboration with the Ministry of Education and Culture has started in 2007, an information campaign on the Water issue in Cyprus, on a planned basis. The objective is the development of a water conscience from a young age.
- The Ministry of Education and Culture included Environmental Education on Sustainable Development in the Curriculum, which is part of a special unit on Water in Elementary Education. Some examples of events/activities relevant to water include:
    - The World Water Day
    - Educational excursions in Dams with Primary Schools
    - The WDD, together with the Cyprus Symphony Orchestra Foundation organized a concert inspired by water, using sounds from real drops, as well as percussion instruments played in the water. The special performances took place in Nicosia, Limassol and Paphos.
    - Lectures in schools (Kindergartens, Primary Schools, Gymnasiums, Lyceums and the Cyprus School of Guides) and festivals (Annual Ecological Festival of Lakatamia). In addition, the WDD took part in relevant Exhibitions and other organized events.

Apart from the above, the Department of Agriculture (DoA) and other departments of the Ministry of Agriculture, Rural Development and Environment organise educational lectures for farmers, related to water management and water saving. An example is the participation of farmers in Schemes 6.1 ”Support for the first establishment of young farmers“ and 4.1 ”Investments that improve the overall performance and viability of farms“ of the Rural Development Program 2014–2020. The DoA is obliged to train farmers who have been approved in these schemes.

The Czech Republic

- A sophisticated system of education of farmers in water management is lacking, farmers are after 40 years of totalitarianism and 30 years of “subsidy capitalism” used to not having to worry about water management.
- Previously, two state organizations operated in this field: The State Land Improvement Administration, The Agricultural Water Management Administration, but both were abolished without compensation.
- After 70 years of “state dirigisme” in the organization, construction, and maintenance of waterworks and measures, farmers do not know much about the water regime of the landscape and are not interested in it, as long as crop production and profit are not endangered.
- The “weather instability” in the Czech Republic also contributes to this, when floods and shorter and longer periods of drought occur during the year and decades.

- Training and courses are organized (unsystematically) by many organizations:
    - Vltava River Basin, state enterprise - protection of water resources, reduction of surface runoff in the catchment area of the Švihov on Želivce water reservoir;
    - Research Institute of Land Reclamation - modernization of drainage systems and runoff regulation;
    - Research and Breeding Institute of Fruit Growing Holovousy s.r.o. - workshop on the issue of drought in fruit trees;
    - Wetland building courses are also organized by many non-profit organizations, supported by various grant sources.
- Instead of supporting the farmers' initiative to intensively and systematically address the optimization of the water regime of the landscape and water management issues on the land more independently, the state decided to support the "dependence of farmers" on the state and strengthen the role of the State Land Office in the field of complex landscaping, where this office wants to deal with agronomic and hydrological drought.
- The state administration also did not support the change of legislation regarding the creation of conditions for the operation of "Water Cooperatives" - releasing the initiative of landowners and land users to address drought, soil, and water protection, as in the Czech Republic is the average acreage is 0.39 ha, so it is difficult to plan and implement anything.

Germany

- Water is a topic in dual education as well as in further education. It is dealt with from a technical-operational point of view, as well as from an economic point of view with regard to investment calculations.
- The "Bavarian Irrigation Forum" is a platform for comprehensive information on environmentally friendly and efficient irrigation in agriculture, horticulture and viticulture.
- The project is part of the Bavarian State Government's "Irrigation Action Plan" and is funded in equal parts by the Ministry of Agriculture and the Ministry of the Environment.
- The aim is to optimize irrigation in agriculture on a technically sound basis and in a balanced manner. At the same time, special attention is paid to environmental and social compatibility.
- The Network Irrigation of the ALB Bavaria is a neutral network of experts, concepts and contents oriented towards agricultural practice with concrete decision-making aids for environmentally compatible water harvesting and efficient, low-loss irrigation adapted to the needs of the plants.

Italy

- Education and training at Higher Education Level is provided by all Italian Universities. At this level, specific courses on Water Management, Agricultural Water Management, Agricultural Hydraulics and Irrigation are present in all courses in Agricultural Sciences, Forestry, but also in Civil and in Environmental Engineering, being mandatory for the qualification of each BSc/MSc course in the Italian Academic regulation.
- Besides Universities, specific training for professionals is provided also by national federations of farmers, such as CIA - Conferderazione Italiana Agricoltori and Coldiretti, often by the means of specific training agencies (like the network of CIPA-AT agencies hosted by CIA).
- Lastly, specific training on irrigation and water resources management is provided within the Italian Agricultural Technical Institutes.
- Some entities involved in the education sector of farmers:
    - CIA Italian Confederation of Farmers. The organization has an internal training institution organizing lifelong education programmes for farmers. About 1,400,000 the number of people who make use of the services offered by Cia-Agricoltori Italiani during the year, through the advice and assistance of its professionals.

- CIPA-AT Grosseto is the sector of the CIA Grosseto to offer Professional Training services, it develops and manages projects for the Valorization of the Territory and for the Companies of the Tuscan Maremma.

Spain

- The training offer is aimed at developing technical aspects of water use and management. This training must be complemented with plans to raise awareness of the responsibility that farmers must exercise over water, in order to gradually work towards more efficient use of it.
- Training must combine a technical nature and good practices. Some training needs and subjects for more efficient use of water are:

1. General knowledge about water in nature.
2. Water scarcity. Awareness of the problem.
3. Legislation. Legal use of water.
4. Sustainable water use by crops:
   a) Soil water balances;
   b) Determination of crop needs;
   c) Irrigation efficiency.
5. Irrigation water quality:
   a) Parameters;
   b) Influence of irrigation systems; soil and crops.
6. Irrigation technologies and management
   a) Precision agriculture (sensors);
   b) Types of irrigation (infrastructure and automation);
   c) Management strategies.
7. Fertiliser and chemical product supply via irrigation.
8. Irrigation characteristics.
9. Irrigation strategies for crops: olive groves, citrus fruits, sugar beet, cotton, rice, fruit trees, cereals, forage crops, etc.
10. Controlled deficit irrigation (RDC).

CURRENT STUDIES/RESEARCH AND/OR ACADEMIC REVIEWS

Belgium

Due to Belgium's heavily divided and fragmented jurisdictions, there are no specific national level studies that examine the effects of droughts across the entire country. However, on more provincial, regional, and municipal levels, there are studies that examine droughts. Indeed, the region of Flanders is currently developing such a plan, as well as the province of Limburg has already produced a drought-specific study for its area. (Meuris, 2020)

Such studies are either performed by the jurisdictional body (municipality, province, or region) on behalf of institutes, or they hire private companies to perform such studies for more accurate policy action. Indeed, water and waste-water companies perform their own studies in regards to water management and how it is affected by previous, ongoing, and future droughts.

On top of this, federal departments in Belgium work on this issue as well, most notably the Department of Environment, which publishes their annual environmental report, which is seeing an increase in drought-related and water management content.

Finally, there are multiple NGOs that also work alongside these governmental bodies on drought-related studies, either through receiving financial aid or working alongside governmental experts. (Meuris, 2020).

Cyprus

The research work of Natural Resources and Environment section of ARI (Natural Recourses and Environment section, n.d.) over time, concerned irrigation and fertilization of crops, soil fertility, the application of new technologies in greenhouses, the use of treated wastewater for irrigation and the use of renewable energy in agriculture. Methods and techniques that have already promoted to farmers in the field of irrigation/fertilization are the most widely applied. The results of limited irrigation are especially useful in periods of drought when irrigation must be restricted. Noteworthy, the long-term research data of the section enabled the acceptance of treated wastewater reuse for irrigation, while also formed the basis for the legislative framework.

An important part of the research work is being carried out within the framework of competitive programmes (partners or lead partner) from various funding agencies, such as the European Union, and the Research and Innovation Foundation of Cyprus.

The ARI has developed an online tool for the calculation of monthly water needs (m^3/decare) per location and crop in Cyprus (Natural Resources and Environment section, n.d.). The open access ARI tool facilitates the sustainable use of water by farmers via making sound decisions on irrigation scheduling. In this sense, drought stress and reduced crop productivity impacts of climate changes on study crops can be mitigated.

The Czech Republic

Solved research projects focusing on the issue of drought can be found on the specialized website https://www.isvavai.cz/cep after entering the keyword “drought”. On the list we can found 86 supported projects dealing with issue water, water management and drought. Here is a selection of interesting ones:

- Intersucho: launched in 2012 (before the biggest drought period in the Czech Republic in the near past since 2015).
- RainPRAGUE: proposes a system of interconnected measures in the landscape and built-up areas.
- Water – Drought: water retention in the landscape.
- Drought in the landscape: strategies for protection against the negative effects of drought in the Czech Republic.
- XEROS, Extreme European Drought: a multi-model synthesis of past, present, and future events.
- Stories of Drought: a research project of the Charles University is a multidisciplinary project combining natural and social sciences (anthropology, sociology, landscape ecology, bioclimatology, geography), -which aims to understand how Czech society responds to changes in the natural environment due to drought.
- SIM4NEXUS, Landscape restoration to mitigate and adapt to climate change: this project aims to assess long-term society-wide impacts of resource use and policies in the Czech Republic, Slovakia, and Eastern Germany.
- Smart Regions: Buildings and Settlements Information Modelling, Technology and Infrastructure for Sustainable Development. The main objective of the project is to establish and operate a competence centre for the Smart Regions solution, which will be able to effectively create an information system for strategic decision-making, define the energy potential of the region.

Germany

Six organizations from climate research and science-based climate communication - German Climate Consortium, German Meteorological Society, German Weather Service, Extreme Weather Congress Hamburg, Helmholtz Climate Initiative, klimafakten.de - have thus summarised the most important scientific findings on climate change. The fact paper with four chapters proves that the current global warming of about 1 degree compared to pre-industrial times is a fact and human activity is the main reason.

Despite 30 years of international climate policy, more and more greenhouse gases continue to accumulate in the atmosphere and intensify climate change - even the Corona Lockdown has not changed this. What is needed are lasting and profound structural changes in all areas of society - from the energy system to land use and infrastructure, as outlined in the Intergovernmental Panel on Climate Change's Special Report on 1.5 degrees Celsius Global Warming. The later these changes begin, the more difficult it will be to slow climate change and avoid irreversible changes. The massive funding that needs to be invested to address the Corona crisis is an opportunity to start these structural changes now.

Italy

Since the Italian University system is mostly based on multi-disciplinary Universities (unlike, for example, the Dutch system, with specialized Universities for each topic) researchers of the mentioned sectors are present in almost every institution across the country.

Researchers in the sector are active in different scientific associations, namely:

- The Italian Association of Agricultural Engineering (AIIA)
- The Italian Association of Agrometeorology (AIAM)
- The Italian Chapter of the International Commission for Irrigation and Drainage (ICID)
- The Italian Group of Hydraulics (GII)
- The Italian Society of Hydrology (SII)
- The Italian Group on Irrigation (GRUSI)

All the associations held national conferences where drought-related problems are considered as one of the main topics.

The main Academic conferences dealing with irrigation can be considered:

- AIIA Conferences and Mid-Term conferences GII National Conference on Hydraulics and Hydraulic Structures (Convegno Nazionale di Idraulica e Costruzioni Idrauliche).

Spain

- The National Plan for Adaptation to Climate Change (PNACC) 2021–2030 is the basic planning instrument to promote coordinated action against the effects of climate change in Spain. Its main objective is avoiding or reducing present and future damages derived from climate change and building a more resilient economy and society.
- Spain's Water Governance System is an example of the adaptation capacity to the environment through a governance system based on planning, public participation and technological development and innovation. The Green Paper on Water Governance has been drawn up, with the aim of generating proposals for improvement in collaboration with institutional actors and stakeholders.
- The National Hydrological Plan establishes the basis for the planned management of droughts through the Special Drought Plans. Thus, in order to minimize the environmental, economic and social impacts of possible drought situations, a global system of hydrological indicators is established to foresee these situations and to serve as a general reference for the basin bodies for the formal declaration of alert and possible drought situations.

EXISTING PROJECTS

Belgium

In Flanders there is a programme called Water-Land-Schap and aims to solve water problems in rural areas in close collaboration with farmers, businesses, residents and landscape managers. The intended outcome of the programme is to have stronger agriculture, a sustainable water supply, good water quality, a collection of excess water in both the built environment and natural systems and a stronger landscape in the area.

In Waasland situated in East Flanders the "Barbierbeek connects" project aims to construct buffer zones along the Barbierbeek working together with farmers and finding solutions to their water management problems.

Cyprus

MED Greenhouses: The objective was to improve eco-innovation capacities of public and private actors in the greenhouse/agriculture sector through stronger transnational cooperation, knowledge transfer and better networks between research bodies, businesses, public authorities, and civil societies.

ORGANIKO LIFE +: The project has a duration of 4 years (2015–2019). The goal of the project was to demonstrate the comparative advantages of organic versus conventional farming and products using indicators of mitigation efficiency to climate change, agronomic and environmental quality, reducing/decreasing children's exposure to pesticides in diet, and healthy food promotion for better children's health (ORGANIKO Life, 2015–2019).

Adapt2Change LIFE+: Adapt agricultural production to climate change and limited water supply. The project started in 2010 with a duration of 72 months. The main objectives were to minimize freshwater use for agricultural production and introduce water-recycling method in a close greenhouse system.

ERANETMED- CrITERIA: Aimed to assist water resources management organizations and water users on decision making when coping with water scarcity, climate change and polluted water.

SWOSOIP: Smart Watering System for Optimizing Irrigation Process. The research project, funded by the European Space Agency, concerns the creation of a smart water meter that will receive data from satellites for automatic irrigation of certain crops and will be piloted in the area of Achelia in Paphos.

The Czech Republic

Major projects which are considered that should be mentioned, but there are many more other relevant projects focusing on better water management in agriculture:

- Methodology for assessing the moisture needs of agricultural crops for irrigation purposes. This methodology describes the theoretical basis and provides practical procedures related to the determination of moisture balances and optimization of irrigation doses for agricultural crops in various conditions and concerning climate change in the Czech Republic.
- Smart landscape Amálie: the project of the Technology Agency of the Czech Republic (TA ČR) beta is sponsored by the Ministry of the Environment of the Czech Republic and carried out by the CULS).
- The General water management of the Czech landscape: the project initiated by the Agrarian Chamber (i.e., from the farmers themselves), ended in 2018. The project aimed to map the complete threat of the Czech Republic to drought (including the identification of 8% of the most endangered areas). In the second phase, cooperation was to be established with 4 agricultural cooperatives in the Czech Republic to create 4 model farms, where several adaptation measures will be planned to prevent drought (e.g. irrigation, crops, agrotechnology).

Germany

- Model Project: ”Demonstration farms for increasing the efficiency of irrigation technology and irrigation management in outdoor vegetable production“ was launched to contribute to the development of a sustainable strategy for the protection of groundwater and its use.
- Research Project: Development of an automated decision-making aid for resource-saving and efficient irrigation in horticulture and agriculture with the aim of optimizing water distribution and nitrogen utilization.

Italy

- In Italy exists projects which are focusing on the topic of water management under H2020 programme such as H2020 MOSES, H2020 SWAMP, H2020 FATIMA.
- But there are also projects focusing on water management and drought which are implemented under different programmes: WATERAGRI, IRRINET – IRRIFRAME, PON – Water4AgriFood, PRIN, HANDYWATER, H2Olivo, IRIDA, ERA-NET, JPI OPERA.
- In Emilia Romagna Region are examples of projects following: POR FESR – POSITIVE, POR FESR – S30.

Spain

- As shown in “Institutions, levels, courses which are addressing water management”, there are several running projects about water management in agriculture, such as the National Irrigation Observatory, the National Centre for Irrigation Technology (CENTER) or the Agroclimatic Information System for Irrigation (SIAR).

FUTURE FORESIGHT

CHALLENGES AND PROSPECTS FOR CHANGE IN THE FUTURE FOR FARMERS

The farmer has a far greater role than is attributed to him in the fight against drought. The main challenge for farmers is:

1. Be able to retain water on agricultural land during torrential rains. Today, this collision and its consequences are called “force majeure”, but the principle and fact are that there is a lack of small technical measures on agricultural land to retain runoff water and especially to understand water infiltration into the soil and hydrogeological structures.
2. The farmer must understand why such measures need to be taken. This rainwater, which has not yet been retained, subsequently causes problems with erosion. So far, key water-capture measures are only designed voluntarily and implemented on a small scale.
3. Be able to retain water for periods of drought using a system of storage tanks and operate and use them primarily for irrigation.
4. Learn to operate irrigation according to scientific knowledge. Supplementary irrigation means that irrigation is supplied only with regard to the amount of precipitation during the year and the vegetation stage of cultivated crops.

CONCLUSION

Farmers are faced with challenges due to climate change. There may be some positive aspects as the other side of the coin, but the problems seem to have far more weight.

Climate change brings with it the increasing risk of yield losses due to drought stress or extreme events such as storms, heavy rain, hail and floods.

More and more in the future drought might be the cause of social turmoil and political instability, if not properly addressed, besides bringing serious economic problems to rural communities, but not only to these.

Under a climate scenario of increasing temperature up to 3°C by 2100, it is estimated that drought economic losses could be five-times higher compared to the present (Cammalleri et al., 2020). Considering ecosystem services losses, difficult to be monetized, losses could increase even more.

In summary, it can be stated that a major challenge for the state and farmers will be to compare the costs and benefits of production (crop yield) and non-production landscape functions (soil quality, water, drought, floods), especially in the long-term perspective. Although the landscape must produce (raw materials, food, energy, wood…), it must also guarantee non-productive functions – biodiversity, soil protection, water protection, or drought-resistant function. At a time when one-sided pressure is only on production, the condition of the soil, vegetation, and water supply is unsustainable. However, it is not even possible to focus unilaterally only on non-productive functions, because then we will lose competitiveness in agriculture.

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