European Environment Agency

8th Environment Action Programme

Water scarcity conditions in Europe (Water exploitation index plus)

8TH EAP HEADLINE INDICATOR, 2024

European Environment Agency

Water scarcity conditions in Europe

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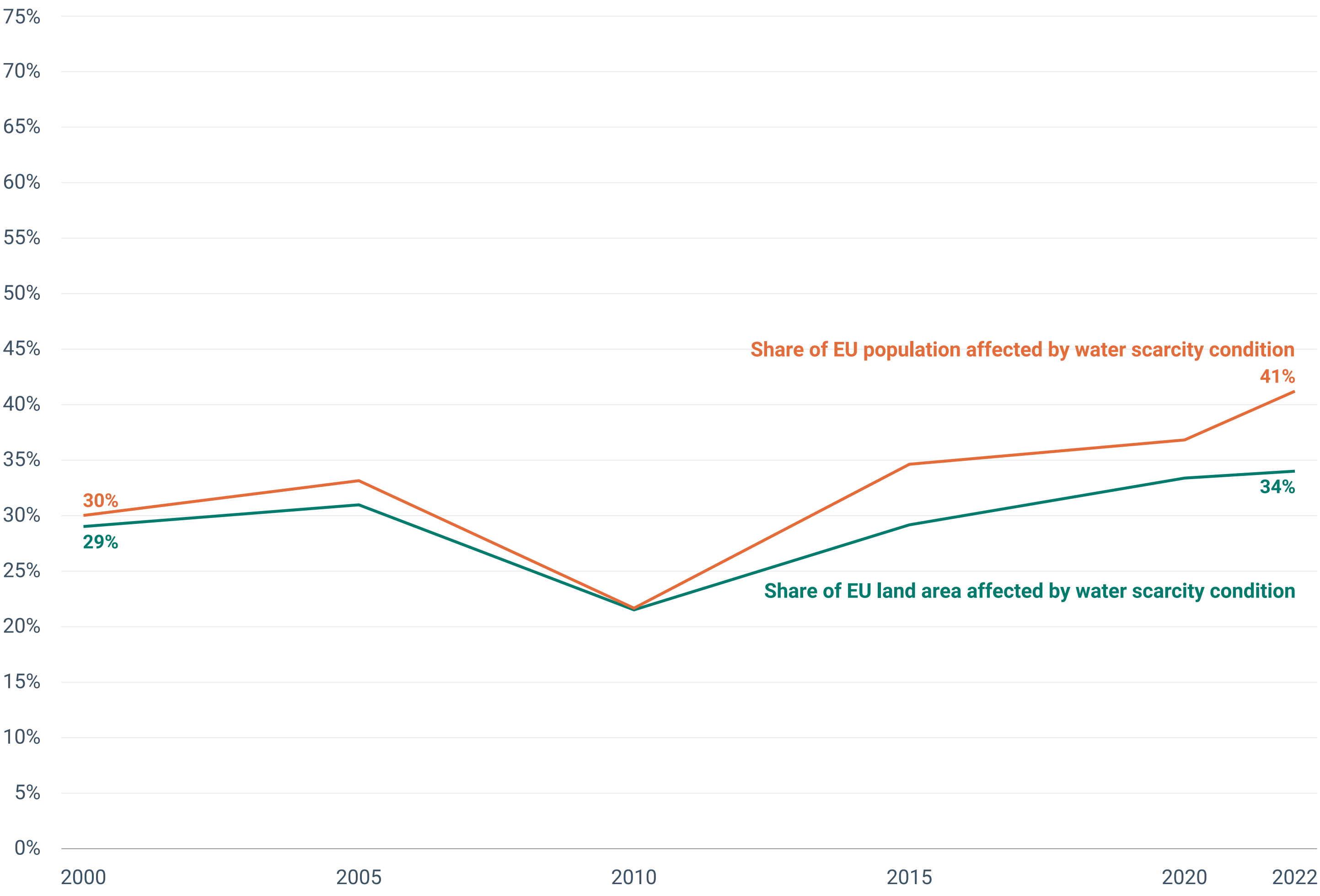
Water scarcity affected 34% of the European Union territory during at least one season in 2022. Despite water abstraction declining by 19% in the EU between 2000 and 2022, there has been no overall reduction in the area affected by water scarcity conditions. In fact, the situation has intensified since 2010. This, compounded with the fact that climate change is expected to further increase the frequency, intensity and impacts of drought events, makes it somewhat unlikely that water scarcity will reduce by 2030. Additional effort is required to ensure sustainable water use.

Figure 1. Area and population affected during at least one quarter of the year by water scarcity conditions in the EU, measured by the water exploitation index plus



Freshwater resources are essential for human health, nature and the functioning of economies and societies. However, across the EU, these **resources are threatened** by multiple pressures. To address this, the Water framework directive requires Member States to promote the sustainable use and the long-term protection of available water resources [1].

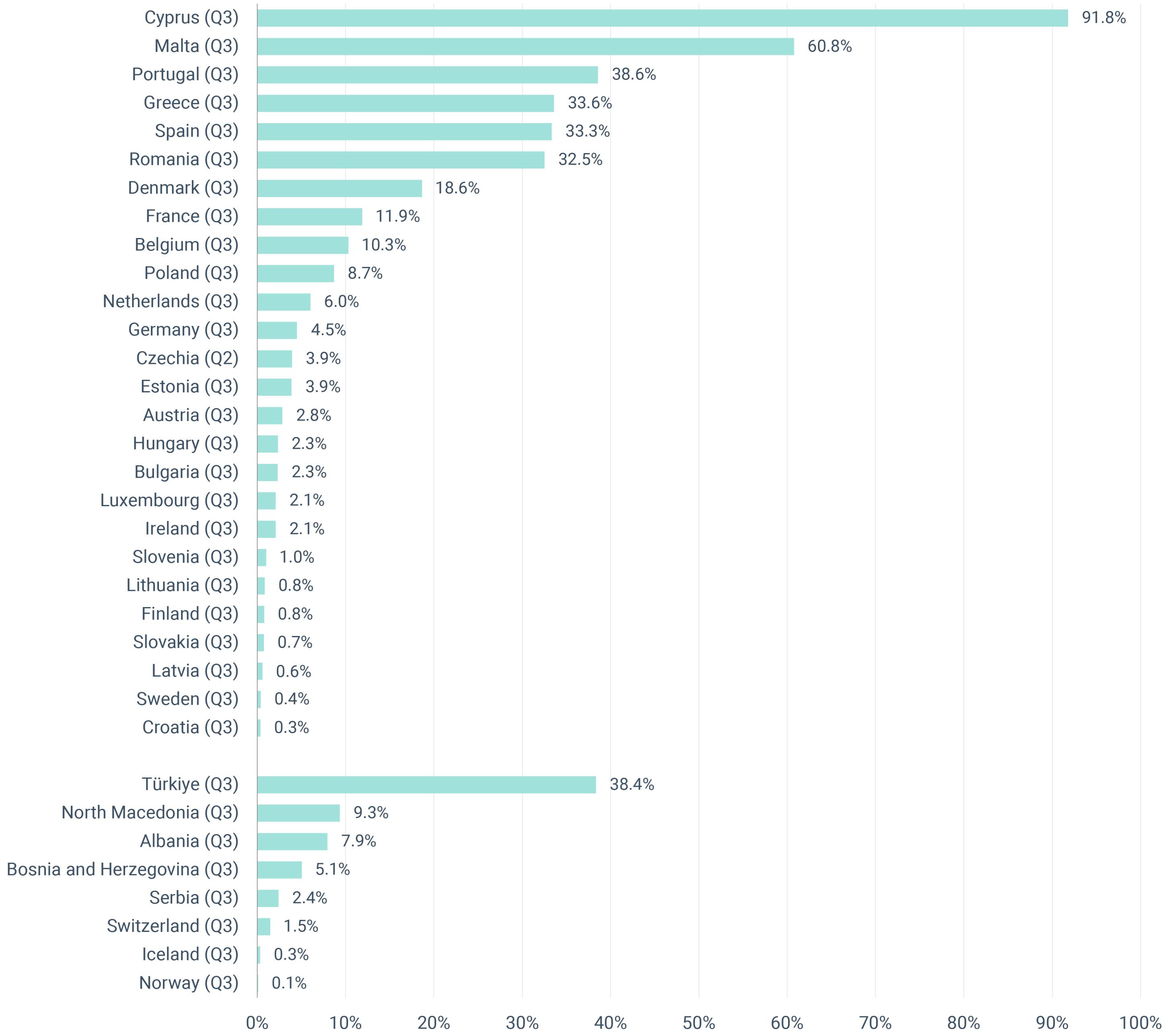
The Water exploitation index plus (WEI+) measures **water consumption** as a percentage of renewable freshwater resources at river basin or subunit levels, across each quarter of the year. This detailed approach reveals local water scarcity conditions that broader annual WEI estimates at European or country levels may not reveal. WEI+ values above 20% indicate that water resources are under stress and therefore water scarcity conditions prevail, while values above 40% signal water stress is severe, and the level of freshwater use may be unsustainable[2][3].

Figure 1 shows the percentage of EU territory and population affected in at least one of the four quarters of the year by water scarcity conditions (Seasonal WEI+ above 20%). On average, about 30% of the EU territory and 34% of the population are **affected** each year. In 2022, water scarcity conditions affected 34% of the population and 40% of the EU land area.

Water scarcity is prevalent in southern Europe, with around 30% of the population in areas with permanent water stress and up to 70% in areas with seasonal summer stress. Agriculture, public water supply, and tourism place significant pressure on freshwater resources in this region. However, water **scarcity** extends beyond southern Europe, affecting various river basins across the EU, where urban population density and water abstraction for public supply, energy, and industry are significant factors. Over the last decade, droughts have also increased in frequency and severity, impacting seasonal water availability.

Climate change is expected to intensify seasonal fluctuations of freshwater availability in Europe. Drought events are also likely to further increase in frequency, intensity, and impact[4]. Given these factors and a worsening trend since 2010, a reduction in water scarcity by 2030 appears unlikely (Figure 1).

Figure 2. Worst seasonal water scarcity conditions for European countries in 2022, measured by the water exploitation index plus (WEI+)



Cyprus and Malta faced the most significant water scarcity conditions of the EU Member States on the seasonal scale (seasonal WEI+ >40%). Greece, Portugal, Spain and Romania experienced water scarcity particularly during spring and summer. Malta is experiencing the permanent water scarcity conditions partly due to its natural hydro-climatic conditions. Among the EEA member countries, Türkiye is the most severely challenged (Figure 2).

In general, water scarcity conditions intensify between April and September in most countries. This is caused by a combination of dry weather, reduced flows and increased abstractions for irrigated agriculture, tourism and recreation, and other socio-economic activities during these periods.

Certain river sub-basins were affected by seasonal water scarcity in 2022. Belgium, Bulgaria, Cyprus, Denmark, France, Germany, Greece, Hungary, Lithuania, Malta, Netherland, Portugal, Romania, Spain and Slovakia (seasonal WEI+ >20%; see detailed information on seasonal WEI+ at Subunit scale) were all effected.

Supporting information

Definition

The WEI+ provides a measure of total water consumption as a percentage of the renewable freshwater resources available for a given territory and period. The difference between water abstractions and the water returned to the environment by economic sectors before or after use is referred to as 'water consumption'.

The WEI+ is an advanced geo-referenced version of the WEI, endorsed by the Water Directors in 2012 as part of the overall indicator set for water scarcity and drought.

Methodology

In 2011, a technical working group established under the Water Framework Directive's Common Implementation Strategy proposed the implementation of a regional 'WEI+'. This would use two different optional formulas based on the landscape conditions of river basins, i.e., no human intervention or human intervention with hydrological cycle [5].

EEA implement the formula for renewable freshwater resources in river basins with human intervention, considering that the landscape characteristics of most river basins in Europe are not pristine. Using one formula of RWR aims also to make the WEI results comparable across all European river basins (see the EEA's updated conceptual model of WEI+ computation).

The regional WEI+ is calculated according to the following formula:

WEI+=(abstractions-returns)/renewable freshwater resources.

Renewable freshwater resources are calculated as 'ExIn+P-Eta±ΔS' for natural and semi-natural areas (free of human intervention), and as 'OUTFL+(abstraction-return)±ΔS' for densely populated areas, where:

ExIn=external inflow

P=precipitation

Eta=actual evapotranspiration

ΔS=change in water storage (lakes and reservoirs)

OUTFL=outflow to downstream/sea.

Change water storage in lakes and reservoirs is computed as ΔS =(P+INFL)-(Eta+OUTFL),

where:

INFL=Inflow in lakes and reservoir from upstream area

For further clarification on the methodological implementation together with the data sources, see the WAT001_Conceptual model of WEI+ computation.pdf

The WEI+ results are classified into 10% intervals for mapping purposes, ranking between 0 and 40, with a 20% WEI threshold is used to estimate the area and population affected by water scarcity at subunit scale for the EU-27. It is important to note that there is no formally agreed-upon threshold for identifying areas experiencing water scarcity in the EU.

Following the computation and classification of the WEI values, bar and pie charts are produced, together with static and dynamic maps to illustrate the extension of the WEI values over Europe.

Climate data and streamflow data have been integrated from Waterbase — Water Quantity database, Eurostat database (env_wat_res and env_watres_rbd) with the gap filling from the Joint Research Centre (JRC) Lisflood model[6]. The JRC Lisflood data cover hydro-climatic variables for Europe in a homogeneous way for the years 2000-2022 on a monthly scale.

Once the data series are complete, changes in water storage (ΔS) and outflow are computed for each spatial scale, including WFD subunit, river basin district, country level for Eionet Member countries, and EU-27 level.

The spatial reference data is RBD and SubUnit reported under the WISE Spatial data flow. The European Catchments and Rivers Network System (Ecrins) at a 250-meter resolution is used for processing the indicator variables to fill the gaps where the data is not available. Ecrins provides topological hydrology information and hierarchical relationships between catchments, river basins, and sub-basins, which has been adapted to align with river basin districts and subunits reported by EU Member States under the WISE Spatial data flow.

The primary data source for observed variables of the WEI formula is WISE SoE Water Quantity, which are reported annually by Eionet member countries at various spatial and temporal scales. Additionally, Eurostat data on annual water resources and abstraction is included in the indicator's computation.

If data is missing at the subunit scale but available at the country level, annual country-level data is disaggregated to the catchment scale of Ecrins to ensure a homogeneous monthly baseline, while reported data on monthly resolution from the subunit or river basin scale is included directly in the computation of the WEI+.

Methodology for gap filling

The purpose of developing the WAT001 indicator is to provide a European overview of seasonal water scarcity in river basins. However, gaps in the database significantly hinder this objective, as WISE SoE and Eurostat datasets show large gaps in both temporal and spatial coverage across Europe. To address these gaps, both water abstraction and renewable water resources components are supplemented with gap-filling methods.

If the reported data is not available for renewable water resources, Copernicus data (Lisflood-JRC) is used to compute total outflow at the subunit, river basin, or country level, and to estimate changes in water storage of lakes and reservoirs.

Machine learning has recently been used to fill gaps in water abstraction data for agriculture. For industry, cooling water, and public water supply, gap filling follows the statistical method outlined in the Eurostat EDAMIS report.

In terms of water returns from the economy, if available, data from the Water Use table of the WISE SoE is integrated in the computation. However, this data is largely missing. To address these gaps, surrogate data is used, which includes sources of water supply, transfer and irrigation methods for agriculture, urban water use, and wastewater discharges from households and services. Additionally, data on fuel types, return coefficients, and the energy mix for cooling water in electricity generation are considered, along with water abstraction for other sectors. Due to data limitations, return coefficients are estimated nationally and applied uniformly across river basins and subunits within the countries.

The details of the gap filling methods per indicator variable can be seen in WAT001_Conceptual model of WEI+ computation_10 10 2024.pdf

Uncertainties

Methodology uncertainty

Monitoring data on lakes and reservoirs are incomplete. Using the modelled data may mask the actual volume of water stored in, and water flow in and out from reservoirs. Thus, the impact of the residence time, between water storage and use is unknown.

Water returns are largely based on return coefficients, which are estimated using various surrogate data. Furthermore, the return coefficients could not be estimated at finer spatial scales than the country. This creates uncertainty in the quantification and distribution of water returns from economic sectors, thus also leading to uncertainty with regard to the ‘water consumption component.

Data set uncertainty

Quantifying water exchanges between the environment and the economy is, conceptually, very complex. A complete quantification of the water flows from the environment to the economy and, at a later stage, back to the environment, requires detailed data collection and processing, which have not been done at the European level. Thus, reported data must be used in combination with modelling to obtain data that can be used to quantify such water exchanges, with the purpose of developing a good approximation of ‘ground truth’. However, the most challenging issue is related to water abstraction and water use data, as the water flow within the economy is quite difficult to monitor and assess given the current lack of data availability. Therefore, several interpolation, aggregation or disaggregation procedures have to be implemented at finer scales, with both reported and modelled data.

Due to inconsistencies in the data for OUTFL and ΔS, the change in water storage variable could not be included in the WEI+ computation for some subunits and RBDs e.g. Romania. Subunits and River Basin Districts (RBDs) where ΔS is excluded are marked as 'changeInWaterStorageNOTINCLUDED' in the final dataset.

There is a significant break in the time series of water abstraction data for Kosovo, which causes spikes in the Water Exploitation Index (WEI) values for this country.

Spatial data for subunits and river basins are not available for Türkiye and the Western Balkan countries. Therefore, the WEI+ could only be computed at the country level for these Eionet countries.

Countries may report historical data during the current reporting period to WISE SoE or Eurostat. In such cases, previously gap-filled data are replaced with the reported data, which may change the country-specific or European-level overview. As a result, some differences may appear in parts of the indicator assessment.

Rationale uncertainty

Due to the aggregation procedure used, slight differences exist in some cases between subunit, river basin district, and country levels for total renewable water resources and water use.

Policy/environmental relevance

Justification for indicator selection

The WEI+ is a water scarcity indicator that measures the pressure human activities exert on renewable water resources, helping to identify areas prone to water stress. WEI+ values for countries and annual scales align with the UN SDG indicator 6.4.2 (‘Level of water stress’), which tracks progress toward target 6.4 on water scarcity and resource efficiency (note that ecological flows are not yet included). Assessing the WEI+ at finer spatial (e.g., river basin and subunit) and temporal (e.g., seasonal) scales enhances the monitoring of water scarcity issues, as country-level annual averages may obscure significant regional differences. Calculating the proportional area affected by water scarcity, either seasonally or annually, using the WEI+ gives a better European overview than computing the WEI+ at the continental level.

Policy context and targets

Context description

The WEI is part of the set of water indicators published by several international organisations, such as the Food and Agricultural Organization of the United Nations (FAO), the Organisation for Economic Co-operation and Development (OECD), Eurostat and the Mediterranean Blue Plan. An indicator similar to WEI is also used to measure progress towards UN SDG target 6.4.2 at the global level[7]. Therefore, the WEI is an internationally accepted indicator for assessing the pressure of the economy on water resources, i.e. water scarcity.

This indicator is a headline indicator for monitoring progress towards the 8th Environment Action Programme (8th EAP)[8]. It contributes mainly to monitoring aspects of the 8th EAP Article 2.1. that requires that 'by 2050 at the latest, people live well, within the planetary boundaries in a well-being economy where nothing is wasted, growth is regenerative, climate neutrality in the Union has been achieved and inequalities have been significantly reduced. A healthy environment underpins the well-being of all people and is an environment in which biodiversity is conserved, ecosystems thrive, and nature is protected and restored, leading to increased resilience to climate change, weather- and climate-related disasters and other environmental risks. The Union sets the pace for ensuring the prosperity of present and future generations globally, guided by intergenerational responsibility'. The European Commission 8th EAP monitoring communication specifies that this indicator should monitor whether there is a reduction in water scarcity.

The purpose of the EU Water Framework Directive (2000/60/EC)[9] is — inter alia — to promote sustainable water use based on the long-term protection of available water resources. Ensuring a balance between water abstraction and recharge of groundwater, supports the aim of achieving good groundwater quantitative status. Good groundwater quantitative status also ensures that associated surface waters and dependent terrestrial ecosystems are not significantly harmed, and changes in groundwater flow do not cause salination or other types of intrusion.

The EU's new circular economy action plan explicitly addresses water stress and contains provisions for improving resource efficiency in the context of water resource management.

The new Water Reuse Regulation[10], aims at enhancing the use of reclaimed water in agriculture by setting out minimum requirements for water reuse. The replacement of freshwater abstractions with reclaimed water may decrease the pressure to surface water and groundwater.

The Common Agricultural Policy (CAP) promotes sustainable farming that ensures affordable, safe, and high-quality food, while protecting natural resources, enhancing biodiversity, and supporting rural communities. It also supports investments in water conservation, irrigation upgrades, and farmer training.

The European Green Deal aims to decouple economic growth from resource use by promoting a clean, circular economy with reduced environmental impact, while the Farm to Fork Strategy, as part of the Green Deal, targets sustainable food systems, where clean and sufficient water is an essential natural resource.

The new Climate Adaptation Strategy focuses on faster and more systemic climate adaptation and international cooperation for climate resilience. One of its main objectives is to support the reduction of water use and by promoting the wider use of drought management plans as well as sustainable soil management and land-use.

The recast Drinking Water Directive requires the assessment of the current level of leakages in water infrastructure and the implementation of measures for their reduction. The requirement covers at least water suppliers supplying more than 10 000 m^3 per day or serving more than 50 000 people.

The EU Biodiversity Strategy for 2030 aims at restoring freshwater ecosystems ("at least 25,000 km of free-flowing rivers"). In this regard, the EU Biodiversity Strategy emphasises the WFD requirement to review water abstraction and impoundment permits to implement ecological flows and achieve good status or potential of all surface waters and good status of all groundwater by 2027 at the latest.

Targets

There are no specific quantitative targets directly related to this indicator. However, the Water Framework Directive (Directive 2000/60/EC)[9] requires Member States to promote the sustainable use of water resources based on the long-term protection of available water resources, and to ensure a balance between abstraction and the recharge of groundwater, with the aim of achieving good groundwater status and good ecological status or potential for surface waters.

Regarding WEI+ thresholds, it is important that agreement is reached on how to delineate non-stressed and stressed areas. Raskin et al[2] suggested that a WEI value of more than 20% should be used to indicate water scarcity, whereas a value of more than 40% would indicate severe water scarcity. These thresholds are commonly used in scientific studies[11]. Smakhtin et al.[12] suggested that a 60% reduction in annual total run-off would cause environmental water stress. The FAO uses a water abstraction value of above 25% to indicate water stress and of above 75% to indicate serious water scarcity[13]. Since no formally agreed thresholds are available for assessing water stress conditions across Europe, in the current assessment, the 20% WEI+ threshold is considered to distinguish stressed from non-stressed areas, while a value of 40% is used as the highest threshold for mapping purposes. The previous thresholds were proposed by Raskin at al.[2]originally for the WEI which takes water abstraction into account while the WEI+ is involving the net water consumption.

Accuracy and uncertainties

Data sources and providers

- Waterbase - Water Quantity, 2023, European Environment Agency (EEA)
- Annual freshwater abstraction by source and sector, Statistical Office of the European Union (EUROSTAT)
- Population on 1 January [tps00001], Statistical Office of the European Union (EUROSTAT)
- Lisflood, Joint Research Center (JRC)

Metadata

DPSIR

Pressure

Topics

Water   # Climate change adaptation   # Extreme weather

Tags

Surface water   # 8th EAP   # Water abstraction   # Groundwater   # WAT001

Temporal coverage

2000-2022

Geographic coverage

Albania

Austria

Belgium
Bosnia and Herzegovina
Bulgaria
Croatia
Cyprus
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Italy
Kosovo (UNSCR 1244/99)
Latvia
Liechtenstein
Lithuania
Luxembourg
Malta
Netherlands
North Macedonia
Norway
Poland
Portugal
Romania
Serbia
Slovakia
Slovenia
Spain
Sweden
Switzerland
Türkiye

Typology

Descriptive indicator (Type A - What is happening to the environment and to humans?)

UN SDGs

SDG6: Clean water and sanitation

Unit of measure

WEI+ values are given as percentages, i.e. water use as a percentage of renewable water resources.

Frequency of dissemination

Once a year

References and footnotes

1. EU, 2000, Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, OJ L 327, 22.12.2000, p. 1-73. ↩

2. Raskin, P., Gleick, P. H., Kirshen, P., Pontius, R. and Strzepek, K., 1997, *Comprehensive assessment of the freshwater resources of the world — Water futures: assessment of long-range patterns and problems*, Document prepared for the fifth session of the United Nations Commission on Sustainable Development, 1997, Stockholm Environmental Institute, Stockholm. a b c

3. As there are no agreed threshold values available for the EU assessment of WEI+, we indicatively keep the same threshold values as WEI, until any new thresholds are proposed.

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4. Climate change impacts and adaptation in Europe - Publications Office of the EU, (https://op.europa.eu/en/publication-detail/-/publication/c707e646-99b7-11ea-aac4-01aa75ed71a1/language-en) accessed December 9, 2022.
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5. Feargemann, H., 2012, 'Update on water scarcity and droughts indicator development', (https://circabc.europa.eu/ui/group/9ab5926d-bed4-4322-9aa7-9964bbe8312d/library/c676bfc6-e1c3-41df-8d31-38ad6341cbf9/details) accessed December 15, 2020.
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6. Burek, P., Knijff van der, J., Roo de, A., European Commission, Joint Research Centre and Institute for the Protection and the Security of the Citizen, 2013, *Lisflood — Distributed water balance and flood simulation model: revised user manual 2013*, Publications Office of the European Union, Luxembourg.
↵

7. UN, 2021, 'Indicator 6.4.2 'Level of water stress: freshwater withdrawal as a proportion of available freshwater resources", (https://www.sdg6monitoring.org/indicator-642/) accessed May 27, 2021.
↵

8. EC, 2022, COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS on the monitoring framework for the 8th Environment Action Programme: Measuring progress towards the attainment of the Programme's 2030 and 2050 priority objectives - COM/2022/357 final
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9. EU, 2000, Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for community action in the field of water policy, OJ L 327, 22.12.2000, p. 1-73.
a

10. EU, 2020, Regulation (EU) 2020/741 of the European Parliament and of the Council of 25 May 2020 on minimum requirements for water reuse, OJ L 177, 5.6.2020, p. 32-55.
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11. Alcamo, J., Henrichs, T. and Rösch, T., 2000, *World water in 2025 — Global modelling and scenario analysis for the World Commission on Water for the 21st century*, Report, 2, Centre for Environmental Systems Research, University of Kassel, Germany.
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12. Smakhtin, V., Revenga, C. and Döll, P., 2004, *Taking into account environmental water requirement in global scale water resources assessment*, Research Report, 2, Comprehensive Assessment of Water Management in Agriculture, Colombo.
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13. FAO, 2017, 'Step-by-step monitoring methodology for indicator 6.4.2 level of water stress: freshwater withdrawal in percentage of available freshwater resources', (http://www.fao.org/elearning/course/SDG642/en/story_content/external_files/Step-by-step%20Methodology%20for%20indicator%206%204%202%20V20170719.pdf) accessed May 27, 2021.
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