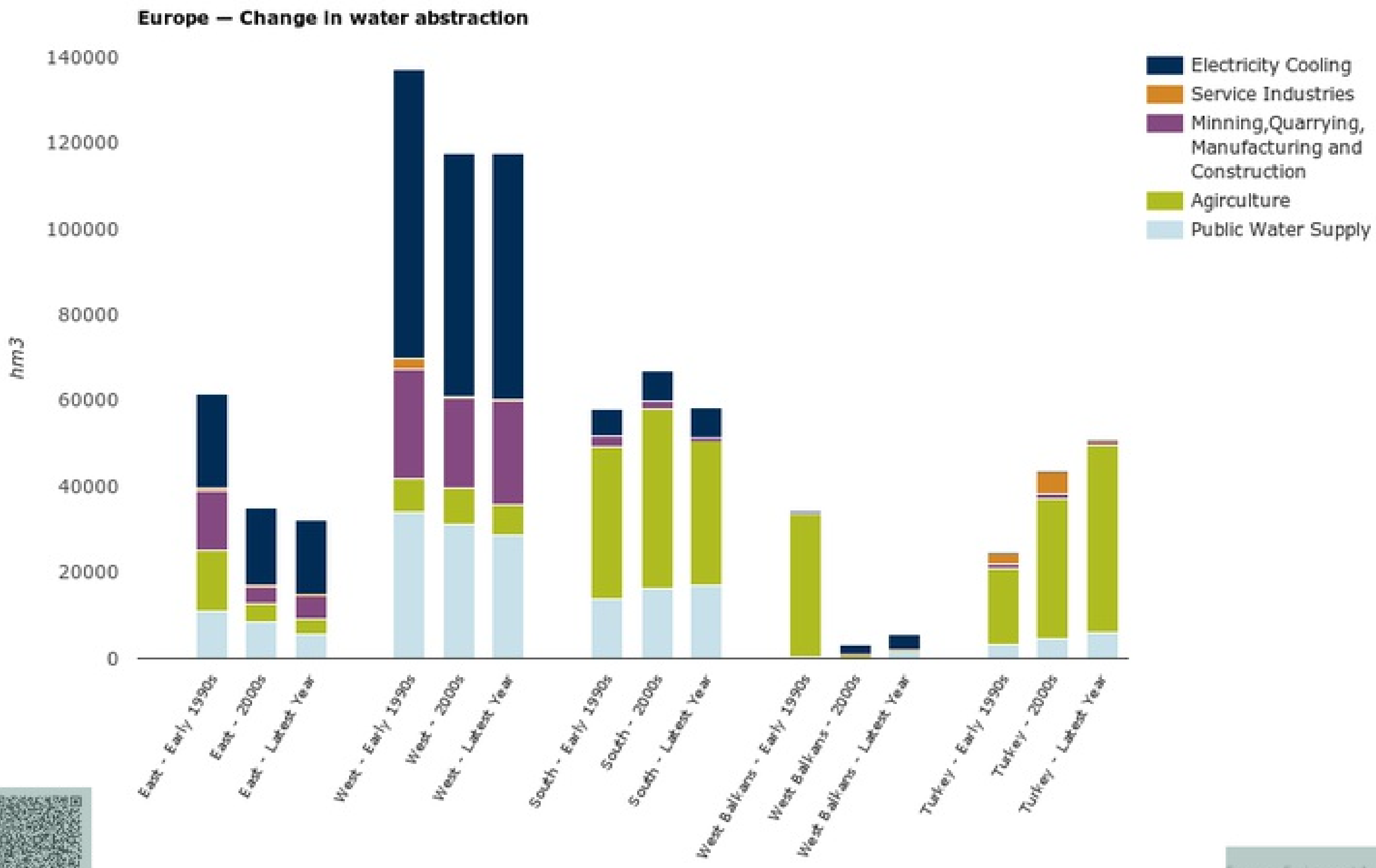
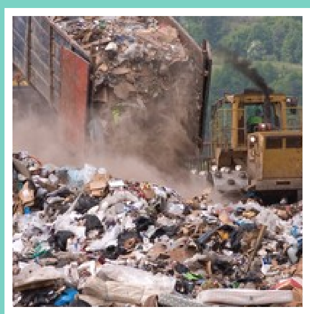
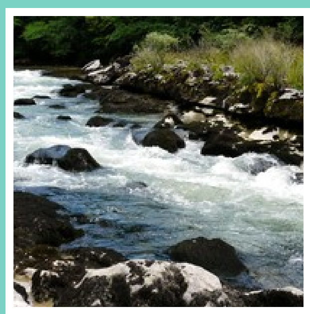
Use of freshwater resources







European Environment Agency

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Contents

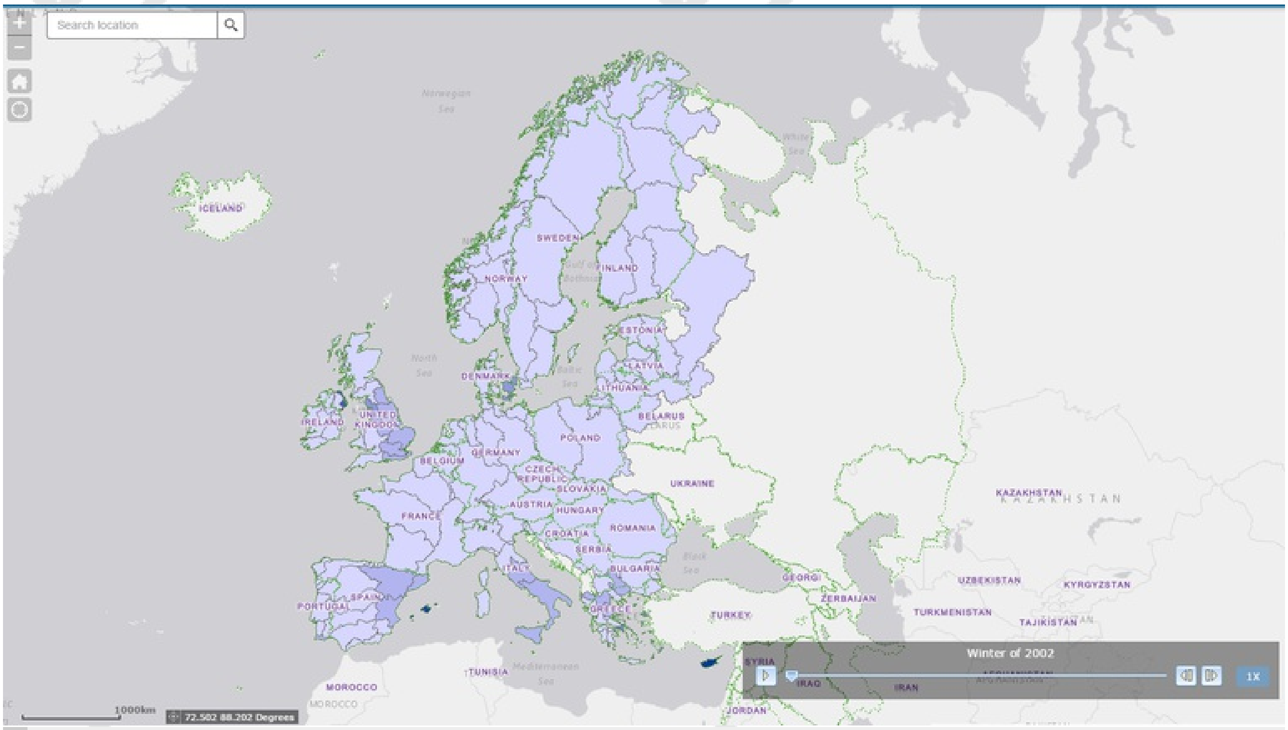
Use of freshwater resources

Key messages

- While water is generally abundant in Europe, water scarcity and droughts continue to affect some water basins in particular seasons. The Mediterranean region and most of the densely populated river basins in different parts of Europe are hot spots for water stress conditions.
- During winter, some 30 million inhabitants live under water stress conditions, while the figure for summer is 70 million. This corresponds to 6 % and 14 % of the total population of Europe respectively.
- Around 20 % of total the population of the Mediterranean region live under permanent water stress conditions. More than half (53 %) of the Mediterranean population is effected by water stress during the summer.
- At 46 % and 35 % respectively, rivers and groundwater resources provide more than 80 % of the total water demand in Europe.
- Agriculture accounts for 36 % of total water use on an annual scale. In summer, this increases to about 60 %. Agriculture in the Mediterranean region alone accounts for almost 75 % of total water use for agriculture in Europe.
- Public water supply is second to agriculture, accounting for 32 % of total water use. This puts pressure on renewable water resources, particularly in high population density areas with no water coming from upstream.
- Service sector has become one of the main pressures on renewable water resources, accounting for 11 % of total annual water use. Small Mediterranean islands in particular are under severe water stress conditions due to receiving 10-15 times more tourists than they have local inhabitants.

Is water scarcity decreasing in Europe?

Fig. 1: Water exploitation index for river basin districts

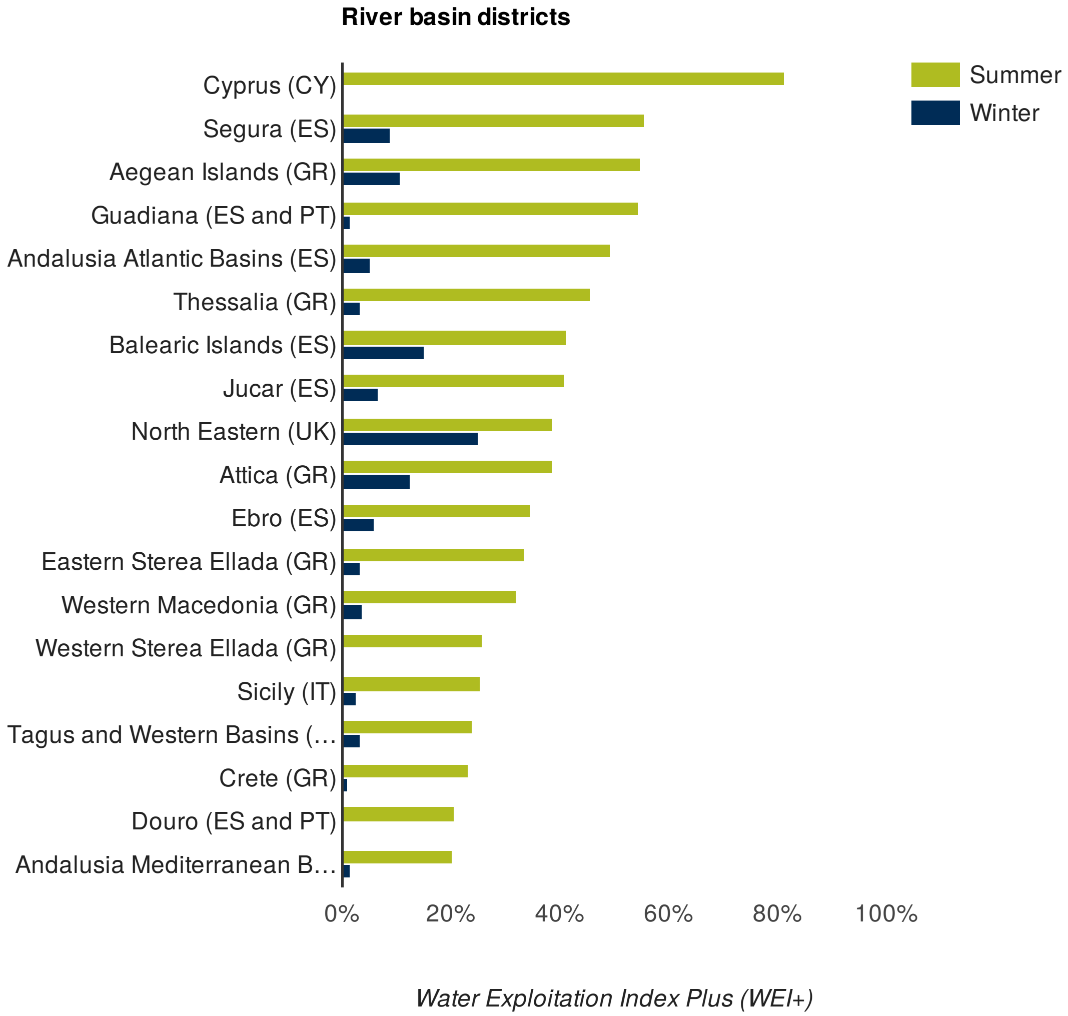


Note: This interactive map allows users to explore changes over time in water abstraction by source and water use by sector at sub-basin or river basin scale. The water exploitation index has been calculated as the quarterly average per river basin district, for the years 2002-2012, as defined in the European catchments and rivers network system (ECRINS). The ECRINS delineation of river basin districts differs from that defined by Member States under the Water Framework Directive, particularly for transboundary river basin districts.

Data sources:

- Waterbase - Water Quantity provided by **European Environment Agency (EEA)**
- European catchments and Rivers network system (Ecrins) provided by **European Environment Agency (EEA)**
- Waterbase - UWWTD: Urban Waste Water Treatment Directive – reported data provided by **Directorate-General for Environment (DG ENV)** and **European Environment Agency (EEA)**
- The European Pollutant Release and Transfer Register (E-PRTR), Member States reporting under Article 7 of Regulation (EC) No 166/2006 provided by **European Environment Agency (EEA)**
- E-OBS gridded dataset provided by **Royal Netherlands Meteorological Institute (KNMI)**
- Water statistics (Eurostat) provided by **Statistical Office of the European Union (Eurostat)**
- LISFLOOD. Distributed Water Balance and Flood Simulation Model provided by **Joint Research Centre (JRC)**

Fig. 2: River basin districts with a water exploitation index plus of more than 20 % in summer



Note:
The data series are calculated as the 2002–2012 multiannual average for the seasonal resolution of the water exploitation index plus (WEI+) at river basin district scale. River basin districts are then filtered by using WEI+ values of 20 % for the multiannual average of the summer months. In terms of a calendar year, winter (Q1) covers January, February and March, while summer (Q3) covers July, August and September.

Explore chart interactively

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Data sources:

- E-OBS gridded dataset provided by **Royal Netherlands Meteorological Institute (KNMI)**
- European catchments and Rivers network system (Ecrins) provided by **European Environment Agency (EEA)**
- Waterbase - Water Quantity provided by **European Environment Agency (EEA)**

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- LISFLOOD. Distributed Water Balance and Flood Simulation Model provided by **Joint Research Centre (JRC)**
- Water statistics provided by **Statistical Office of the European Union (Eurostat)**

The water exploitation index plus (WEI+), which looks at the percentage of total freshwater used compared to the total renewable freshwater resources available, is a relatively straightforward indicator of the pressure or stress on freshwater resources. A WEI+ above 20 % implies that a water resource is under stress, while one of over 40 % indicates severe stress and clearly unsustainable resource use (Raskin et al, 1997).

Compared with many regions of the world that face serious water shortages, water scarcity in Europe is still easier to manage. In general, water is relatively abundant, with only 5 % of renewable freshwater resources abstracted each year. However, water availability and populations are unevenly distributed. Except in some northern and sparsely-populated areas that possess abundant resources, a high WEI+ occurs in many areas of Europe, particularly in the Mediterranean and, to an extent, in densely populated river basins in the Atlantic region*. About 17 % of all renewable water resources per year are abstracted in both regions.

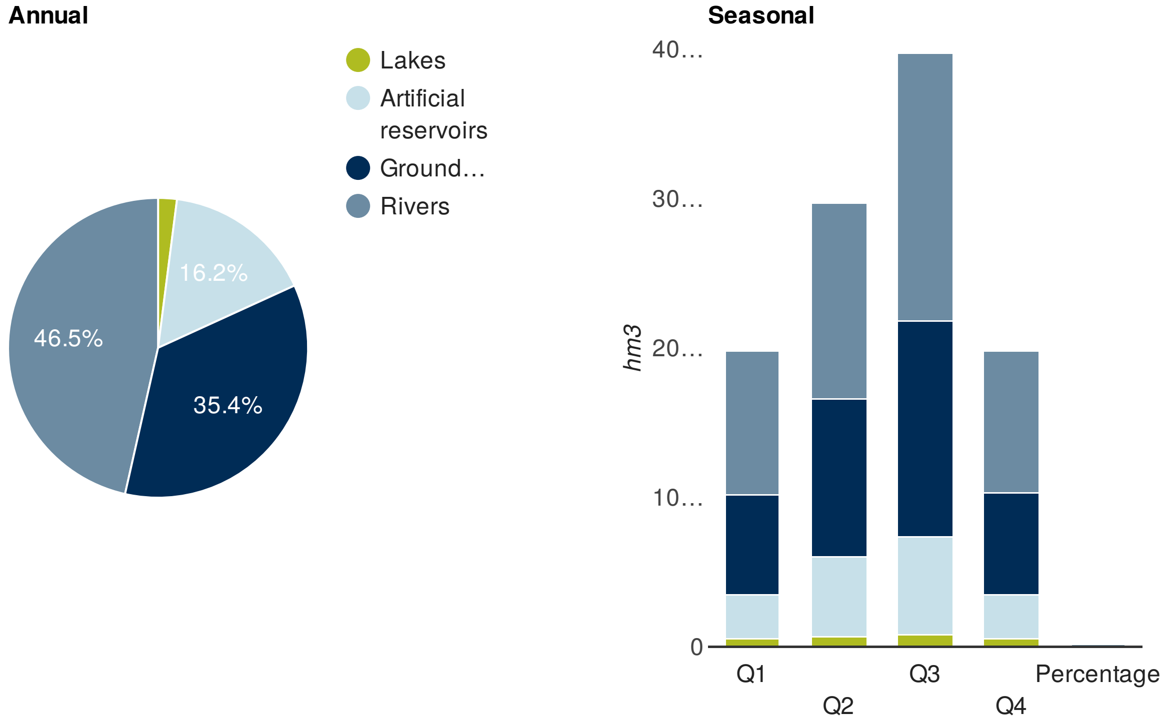
Around 20 river basin districts, primarily in the Mediterranean and Mediterranean islands including Cyprus, Malta, Crete, the Balearic Islands and Sicily, are faced with water stress (WEI > 20 %) (see Map and Figure 1). The highest multi-annual summer average water exploitation index for the period 2002-2012, is estimated for Cyprus (81 %) followed by Segura, Spain (55 %). The situation is worse in summer when average precipitation is very low and water demand for agriculture and tourism is high. This makes water resource management in these river basins particularly challenging.

There are large seasonal differences in water stress conditions across Europe. During winter, only 5 % of the total area of Europe experiences water stress (WEI+ greater than 20 %). In summer, due to lower levels of renewable water resources, accompanied with high water demand, more than 12 % of the total area of Europe experiences high levels of water stress.

* Biogeographical regions are used for the major grouping in this assessment. The delineation of biogeographical regions is made in accordance with the Habitat Directive.

Water abstraction by source

Fig. 3: Water abstraction by source



Note:
For the pie chart, the data series are calculated as the 2002–2012 multiannual average for water abstraction by source at the sub-basin scale. The mulltiannual average of quarterly values has been used to develop seasonal water abstraction by source.
Q1 = January, February, March
Q2 = April, May, June
Q3 = July, August, September
Q4 = October, November, December.

Explore chart interactively

Data sources:

- E-OBS gridded dataset provided by **European Environment Agency (EEA)**
- European catchments and Rivers network system (Ecrins) provided by **European Environment Agency (EEA)**
- Waterbase - Water Quantity provided by **European Environment Agency (EEA)**
- LISFLOOD. Distributed Water Balance and Flood Simulation Model provided by **Joint Research Centre (JRC)**
- Water statistics (Eurostat) provided by **Statistical Office of the European Union (Eurostat)**

- Waterbase - UWWTD: Urban Waste Water Treatment Directive – reported data provided by **European Environment Agency (EEA)**
- The European Pollutant Release and Transfer Register (E-PRTR), Member States reporting under Article 7 of Regulation (EC) No 166/2006 provided by **European Environment Agency (EEA)**
- Biogeographical regions provided by **European Environment Agency (EEA)**

Across Europe, water abstraction from surface resources accounts for 65 % of total water resources, while for ground water the figure is 35 %. Rivers and groundwater aquifers supply more than 80 % of the total annual water used in Europe. During summer, water abstraction from rivers, groundwater and lakes increases almost twofold compared to winter, resulting in lower availability of renewable water resources.

The overexploitation of groundwater aquifers leads to severe ecological impacts such as the lowering of groundwater tables, drying out of springs and the occurrence of salt-water intrusions, which have already been observed, particularly in Mediterranean areas (EEA 2012b). In riverine ecosystems, overexploitation alters the natural hydrological regime and degrades ecosystem integrity (EEA 2012a).

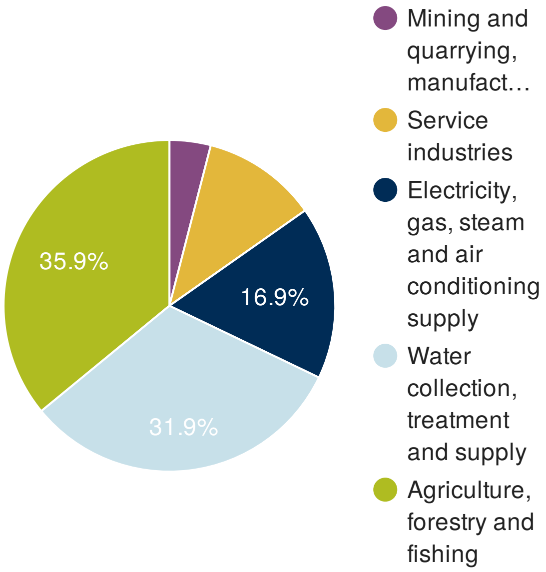
Due to the insufficient spatial and statistical data coverage of reservoirs, an assessment of water storage in reservoirs and associated possible environmental impacts is incomplete (See the methodology section and ETC ICM Report 2015). However, available data and information indicate that reservoirs are mainly used during the peak summer season when water demand is high. During summer, there is a threefold increase in abstracted water volumes compared to winter. In the Steppic region, almost 43 % of the total water abstraction comes from reservoirs, while in the Boreal region, the figure is 31 % and in the Atlantic region it is 23 %.

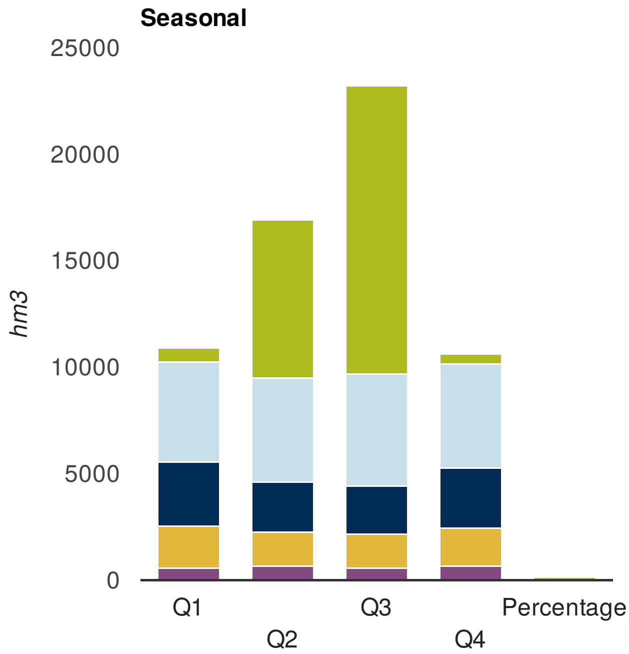
The Mediterranean region stores the largest volume of reservoir water in Europe; 38 % of the total volume of reservoir water is stored there, while the figures are 30 % for the Atlantic and 20 % for the Continental biogeographical regions of Europe.

Water use by sectors

Fig. 4: Water use by sector

Annual





2002–2012 multiannual average for water use by sector at
rly values has been used to develop seasonal water use
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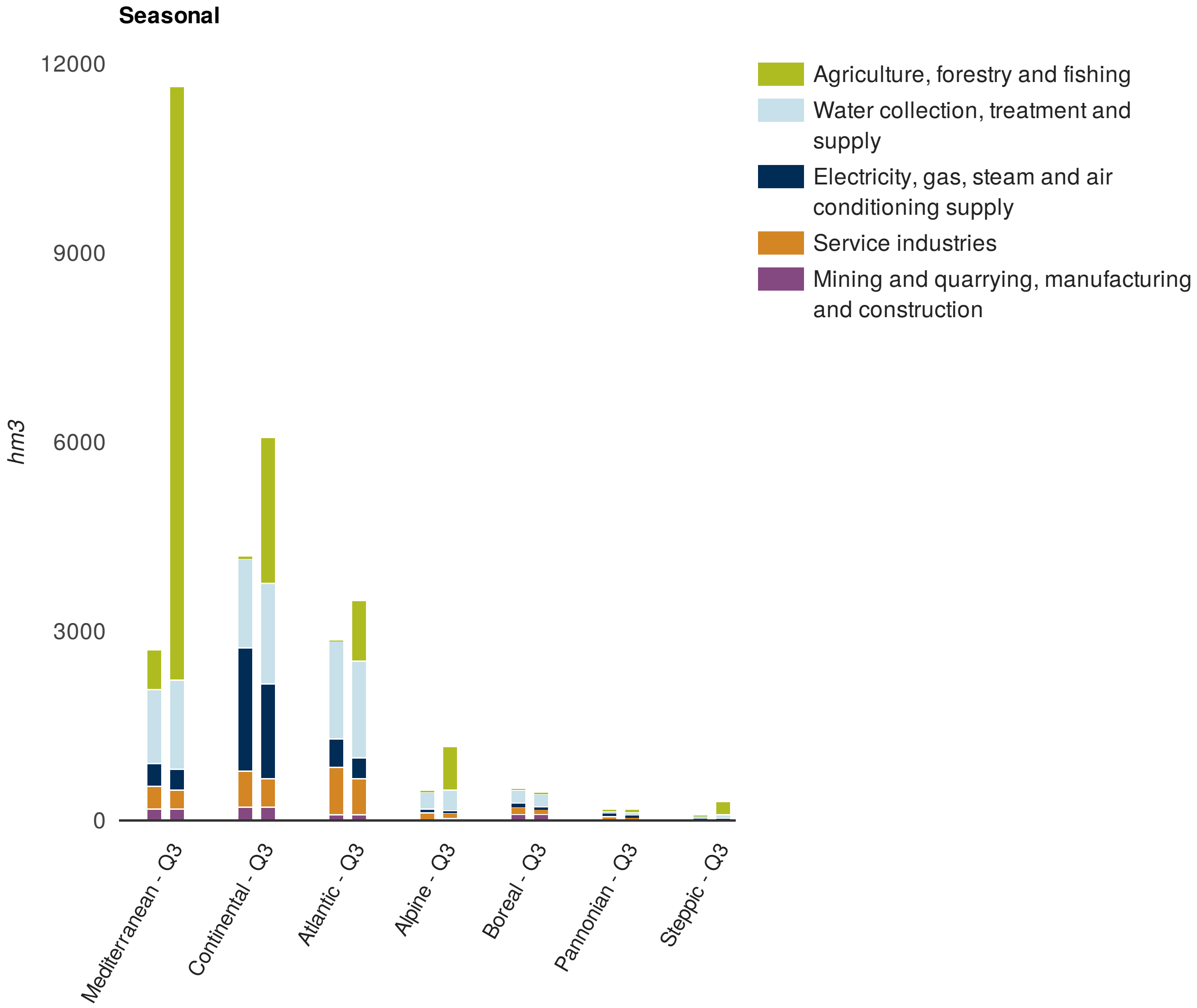
Environment Agency (EEA)
em (Ecrins) provided by **European Environment Agency**

pean Environment Agency (EEA)
od Simulation Model provided by **Joint Research Centre**

cal Office of the European Union (Eurostat)
atment Directive – reported data provided by **European Environment Agency (EEA)**

- The European Pollutant Release and Transfer Register (E-PRTR), Member States reporting under Article 7 of Regulation (EC) No 166/2006 provided by **European Environment Agency (EEA)**
- Biogeographical regions provided by **European Environment Agency (EEA)**
- Production in industry - monthly data (2010 = 100) provided by **Statistical Office of the European Union (Eurostat)**

Fig. 5: Water use by economic sector in different biogeographical regions



Note:
The data series are calculated as the 2002-2012 multi-annual average of the first and third quarters of the year for water use by sector at the sub-basin scale. This is then aggregated to the biogeographical region.

NACE classification is used in identifying the economic sectors involved.

Delineation of the biogeographical regions is taken from the official delineation of the Habitats Directive (92/43/EEC) and of the EMERALD Network, which was set up under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention).

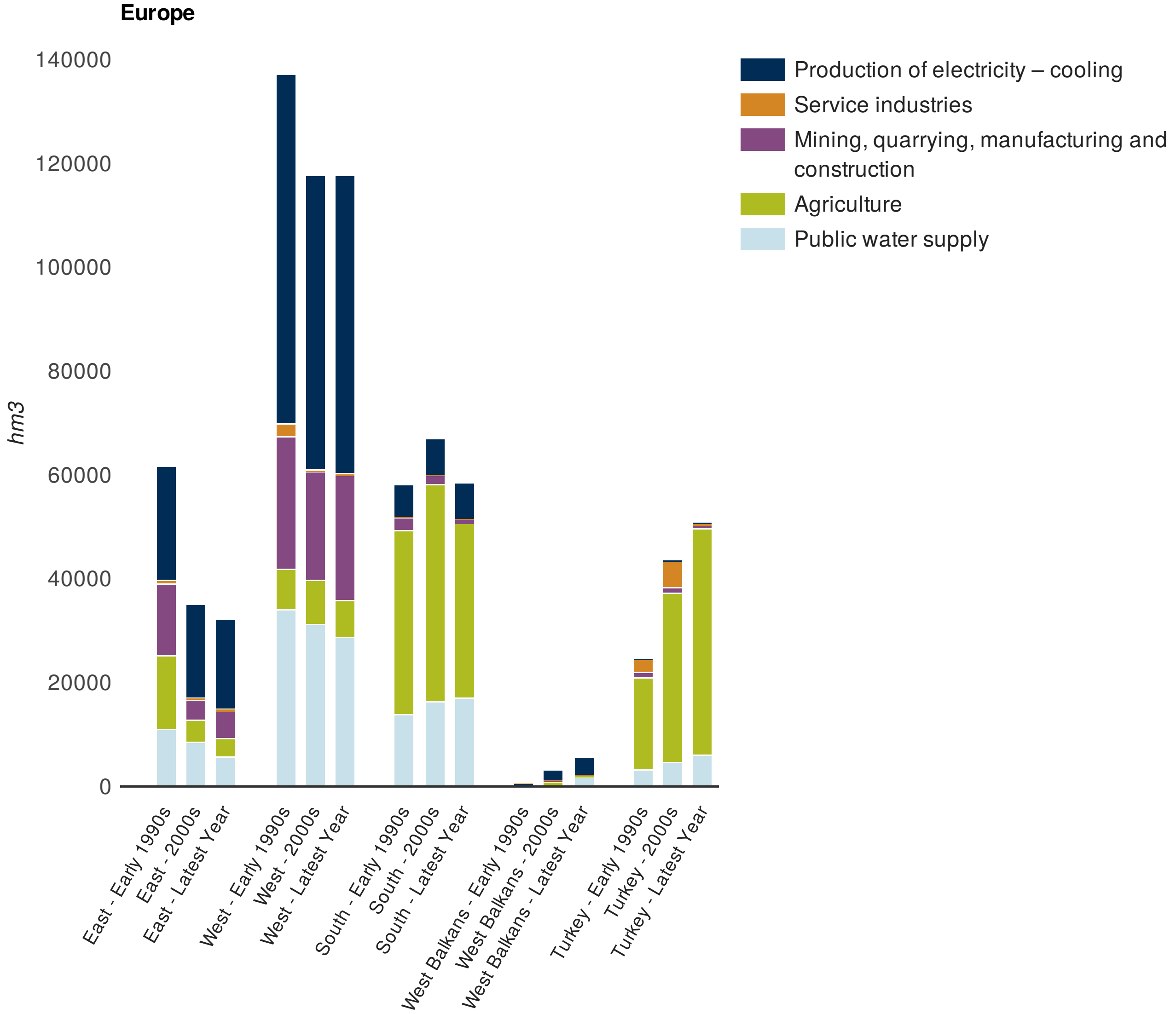
Q1= January, February, March
Q3= July, August, September

Explore chart interactively

Data sources:

- E-OBS gridded dataset provided by **European Environment Agency (EEA)**
- European catchments and Rivers network system (Ecrins) provided by **European Environment Agency (EEA)**
- Waterbase - Water Quantity provided by **European Environment Agency (EEA)**
- LISFLOOD. Distributed Water Balance and Flood Simulation Model provided by **Joint Research Centre (JRC)**
- Water statistics (Eurostat) provided by **Statistical Office of the European Union (Eurostat)**
- Waterbase - UWWTD: Urban Waste Water Treatment Directive – reported data provided by **European Environment Agency (EEA)**
- The European Pollutant Release and Transfer Register (E-PRTR), Member States reporting under Article 7 of Regulation (EC) No 166/2006 provided by **European Environment Agency (EEA)**
- Biogeographical regions provided by **European Environment Agency (EEA)**

Fig. 6: Development of water abstraction since the 1990s



Notes:
Turkey is plotted as an individual column in this graph to illustrate the large increase in its water use for agriculture.

- East: Bulgaria, Czech Republic, Estonia, Latvia, Lithuania*, Hungary, Poland, Romania, Slovenia, Slovakia
- South: Greece, Spain, Italy*, Cyprus*, Malta, Portugal*
- West: Belgium, Denmark, Germany, Ireland*, France, Luxembourg, the Netherlands, Austria, Finland, Sweden, England and Wales, Iceland, Norway, Switzerland*
- Western Balkans: Croatia, the former Yugoslav Republic of Macedonia, Albania, Serbia, Bosnia and Herzegovina, Kosovo under UNSCR 1244/99

* Water abstractions data are not available for all sectors and periods.

Temporal coverage: early 1990s, 2000s and last year up to 2013, which may differ based on data availability.

Explore chart interactively

Data sources:

- Annual freshwater abstraction by source and sector provided by **Statistical Office of the European Union (Eurostat)**

All economic sectors need water for their activities. Agriculture, industry and most forms of energy production are not serviceable if water is not available. The Water Exploitation Index Plus is driven by two important factors. Climate controls water availability and seasonality in water demand, and water demand in turn depends on population density and related economic activities. In the Mediterranean biogeographical region, these two factors coincide, leading to high indicator values. In other biogeographical regions, except for those possessing temporal dry summer conditions, water stress often occurs in areas associated with a high population density. During particular seasons of the year and in areas with high indicator values, certain economic sectors become the main drivers of water demand. For instance, agriculture leads to high indicator values in spring and summer, whereas autumn and winter are the peak seasons for the use of electricity. Industry uses less water in summer compared to other seasons.

Water use of agriculture (irrigation), forestry and fishing. Between 2002 and 2012, agriculture accounted for 36 % of total annual water use in Europe. This is the highest share of water use among all economic sectors. During winter, however, the same sector accounted for just 5 % of total water use in Europe, while in spring and summer this figure increased to 44 % and 60 %, respectively. Irrigation for crop growing is the main use of water in the Mediterranean - the region whose agriculture accounts for 75 % of all agriculture related water use - followed by the Continental (14 %) and Atlantic (5 %) biogeographical regions. This high irrigation related water demand, coupled with water resources being less renewable in spring and summer, results in water stress in the Mediterranean region.

Water collection, treatment and supply (public water supply). Public water supply is the second largest sector (32 %) after agriculture. Growing urban populations and higher living standards coupled with reduced water availability due to pollution and drought, mean that large cities or dry regions with a high population density are particularly vulnerable to water stress. In the past, Europe's larger cities have generally relied on the surrounding regions for water supply. Many large cities have already developed wide networks for transporting water, often over distances of more than 100-200 km to be able to respond to the demand for water.

In Europe, about 61 % of the total annual water supplied by the public water supply system is used in the Atlantic (31 %) and Continental (30 %) regions. These two regions are home to more than 360 million people (67 % of the total population of Europe). The Mediterranean region is the third largest consumer of water (26 %).

An average European citizen uses 36 m^3 per year of water from renewable freshwater resources. This corresponds to approximately 98 litres of water per capita per day. These figures exclude recycled, reused and desalinated water, as well as water used in other economic sectors covered by self-supply.

The highest estimated water use per capita occurs in the Mediterranean region, with 133 litres per capita per day. This is followed by the Alpine and Atlantic regions, with 123 and 120 litres per capita per day, respectively. For the Continental (estimated 72 litres per capita per day) and the Pannonian (estimated 34 liters per capita per day) regions, water use per capita is much lower.

Water use per-capita does not change much throughout the year, with only a slight increase in summer and a decrease in winter.

Water use for service industries*. This group of industries mainly covers activities such as accommodation, food, recreational activities, etc. that are core components of the tourism sector. Europe is the world's primary tourism destination, with 10 % of EU GDP (Eurostat 2013) generated from tourism. Water use for accommodation and food services has the highest impact due to an increasing demand on local water resources, not only for domestic use but also for a range of recreational activities such as irrigation of golf courses, snow making and swimming pool filling.

Every year, millions of people temporarily move from their home to other destinations in Europe. This mobility accounts for around 11 % of the total annual water use attributed to accommodation and food service activities in Europe.

Some of the most popular tourist destinations in Europe are the European capitals. With destinations such as Paris, London and Brussels, the Atlantic region has the highest proportion of total water use for accommodation and food service in Europe (38 %). It is followed by the Continental region (29 %), which has a number of historical towns and cities attracting millions of tourists every year.

Tourism, particularly in the Mediterranean islands, has a great impact on water use. The average number of tourists per year visiting the Mediterranean islands is 16 times greater than their permanent local population. Due to pressures from tourism on the use of renewable water resources, small Mediterranean islands have a water exploitation index constantly above 20 % throughout the year.

Between 2002 and 2012, the number of tourists increased by around 30 % across Europe. Water use by the service sector increased steadily by 7% between 2002 and 2008. However, during the last four years (2010-2012) a decrease of 1.5 % was observed. It is uncertain whether this occurred because of improvements in water saving or due to awareness raising at the level of the individual water user.

* Water use by the service sector is counted double due to the lack of data on the origin of tourist travel. Meanwhile, scientific literature suggests that an individual tourist generally uses 2-3 times more water per capita per day than a local inhabitant (Essex at al. 2004; Gössling at al, 2012). As such, in order to reduce the impact of this double counting, it has been assumed that one tourist uses the same amount of water as a local inhabitant.

Water abstraction for cooling in energy production

Water abstraction for energy production through hydropower is regarded as non-consumptive use, meaning that all of the water is returned to the environment. Water is also used by thermal power plants for cooling. Most of water used during cooling process returns to the environment with some lost through evaporation.

Freshwater is not only resource dependent in cooling process. For example, water from coastal areas and estuaries is also used for cooling purposes, and around 25 % of the total water abstraction for electricity production comes from brackish and salt water.

In addition to electricity production, water is also abstracted in order to supply manufacturing, steam generation and air conditioning (NACE D section). These sectors account for approximately 17 % of annual total freshwater abstraction in Europe. During winter this rate increases to 28 %.

The Continental region uses almost 65 % of total water abstraction for electricity, gas, steam and air conditioning supply, followed by the Atlantic (15 %) and the Mediterranean region (13 %).

Water use for mining, quarrying, manufacturing and construction. Total water use for mining, quarrying, manufacturing and construction accounts for 4 % of total freshwater use in Europe. The Continental region consumes 35 % of the total water used for mining and quarrying, followed by the Mediterranean (28 %), Boreal (17 %) and Atlantic (14 %) biogeographical regions. There is limited seasonal variation in water use by these sectors, with similar volumes abstracted and used in both winter and summer.

Change in water abstraction**. In general, a decrease in water abstraction in Europe has been observed for some economic sectors since the 1990s. For instance, the industrial sector has improved its water efficiency leading to a significant decrease (27 %) in water abstraction over this period. Agriculture comes next on the list.

Despite a 22 % decrease in water abstraction, agriculture is still the sector with the highest water demand. A significant increase in water abstraction for agriculture (140 %) was observed in Turkey between the 1990s and 2013.

Water abstraction for electricity has decreased by 11 % since the 1990s, indicating a more or less constant trend since 2000.

Little improvement has been achieved in water abstraction for public water supply, where there was only a 5 % decrease since the 1990s. A significant decrease in public water supply occurred in the eastern and western part of Europe, while public water supply has increased in southern Europe, the western Balkans and Turkey. This decrease might be related to improvements in the water supply network.

** Changes in water abstraction was one of the main chapters in the previous assessment. The current methodology of the Water Exploitation Index requires different data sets compared to the previous version. Thus, the relevant Eurostat data has been used for updating the respective chapter and related graph.

Indicator specification and metadata

Indicator definition

The WEI+ provides a measure of the total water use as a percentage of the renewable freshwater resources for a given territory and time scale.

The WEI+ is an advanced and geo-referenced implementation of the WEI. It quantifies how much water is monthly or seasonally abstracted and how much water is returned after use to the environment via basins. The difference between water abstraction and return is regarded as water use.

Units

WEI+ values are given as percentages, i.e. water use as a percentage of renewable water resources. Absolute water volumes are presented as millions of cubic meters (million m^3 or hm^3).

Rationale

Justification for indicator selection

Monitoring the efficiency of water use is important for the protection, conservation and enhancement of the EU's natural capital. It also contributes to improving resource efficiency, which is included as an objective of the EU's 7th EAP to 2020.

The WEI+ is a water scarcity indicator that provides information on the level of pressure that human activity exerts on the natural water resources of a territory. This helps to identify those areas prone to problems related to water stress (Faergemann, 2012). The purpose of implementing the WEI+ at spatial (e.g. sub-basin or river basin) and temporal (monthly or seasonal) scales, which are finer than annual averages at the country scale, is to better capture the balance between renewable water resources and water use (see Conceptual model of WEI+ computation).

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Policy context and targets

Context description

The objective of the EU's 7th EAP to 2020 is to ensure the protection, conservation and enhancement of the EU's natural capital and to improve resource efficiency. Monitoring the efficiency of water use in different economic sectors at national, regional and local levels is necessary to achieve this. The WEI is part of the set of water indicators published by several international organisations, such as the United Nations Environment Programme (UNEP), the Organisation for Economic Co-operation and Development (OECD), Eurostat and the Mediterranean Blue Plan. There is an international consensus about the use of this indicator for assessing the pressure of the economy on water resources, i.e. water scarcity.

The WEI+ is an advanced version of the WEI, which better addresses regional and seasonal aspects of water scarcity. In addition, it also takes water use (water abstraction minus water returned) into account. The indicator describes how total water use exerts pressure on water resources. It identifies areas (e.g. sub-basins or river basins) that have high abstraction levels on a seasonal scale in relation to the resources available and that are therefore prone to water stress. Changes in WEI+ values allow analyses of how changes in water use affect freshwater resources, i.e. by putting them under pressure or by making them more sustainable.

Targets

There are no specific targets directly related to this indicator. However, the Water Framework Directive (2000/60/EC) 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 by 2015.

The EU's Seventh Environment Action Programme (7th EAP) aims to ensure that stress on renewable water resources is prevented or significantly reduced by 2020 (EU, 2013). The EU's Roadmap to a Resource Efficient Europe (EC, 2011) also includes a milestone for 2020, namely that 'water abstraction should stay below 20 % of available renewable freshwater resources'. European-scale estimations of water scarcity are likely to shadow large local differences and would thus be misleading. Instead, estimations of the proportional area affected by water scarcity conditions (either seasonally or throughout an entire year) may better capture the actual level of water stress on the continental scale.

Regarding WEI+ thresholds, it is important that agreement is reached on how to delineate non-stressed and stressed areas. Raskin et al. (1997) 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 (Alcamo et al., 2000). Smakhtin et al. (2004) suggested that a 60 % withdrawal from the annual total runoff would cause environmental water stress. Similarly, the Food and Agriculture Organization of the United Nations (FAO) applies a value of above 25 % of water abstraction as an indication of water stress and of above 75 % as an indication of serious water scarcity (FAO, 2017). Since no formally agreed thresholds are available for assessing water stress conditions across Europe, in the current assessment, the 20 % WEI+ threshold proposed by Raskin at al. (1997) is considered to distinguish stressed from non-stressed areas, while a value of 40 % is used as the highest threshold for mapping purposes.

Related policy documents

- 7th Environment Action Programme
  DECISION No 1386/2013/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet'. In November 2013, the European Parliament and the European Council adopted the 7 th EU Environment Action Programme to 2020 'Living well, within the limits of our planet'. This programme is intended to help guide EU action on the environment and climate change up to and beyond 2020 based on the following vision: 'In 2050, we live well, within the planet's ecological limits. Our prosperity and healthy environment stem from an innovative, circular economy where nothing is wasted and where natural resources are managed sustainably, and biodiversity is protected, valued and restored in ways that enhance our society's resilience. Our low-carbon growth has long been decoupled from resource use, setting the pace for a safe and sustainable global society.'
- Addressing the challenge of water scarcity and droughts in the European Union
  EC (2007). Communication from the Commission to the Council and the European Parliament, Addressing the challenge of water scarcity and droughts in the European Union. Brussels, 18.07.07, COM(2007)414 final.
- Roadmap to a Resource Efficient Europe COM(2011) 571
  Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Roadmap to a Resource Efficient Europe. COM(2011) 571
- Water Framework Directive (WFD) 2000/60/EC
  Water Framework Directive (WFD) 2000/60/EC: 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.

Methodology

Methodology for indicator calculation

The WEI+ is an advanced version of the water exploitation index. It is geo-referenced and developed for use on a seasonal scale. It also takes into account water abstraction (gross) and return (net abstraction) to reflect water use.

In 2011, a technical working group, developed under the Water Framework Directive Common Implementation Strategy, proposed the implementation of a regionalised WEI+. This differed from the previous approach by enabling the WEI+ to depict more seasonal and regional aspects of water stress conditions across Europe (See Conceptual model of WEI+ computation). This proposal was approved by the Water Directors in 2012 as one of the awareness-raising indicators.

The regionalised 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, and as 'outflow + (abstraction - return) - ΔS' for densely populated areas.

Where:

ExIn = external inflow
P = precipitation
ETa = actual evapotranspiration

ΔS = change in storage (lakes and reservoirs)

outflow = outflow to downstream/sea.

It is assumed that there are no pristine or semi-natural river basin districts or sub-basins in Europe. Therefore, the formula 'outflow + (abstraction - return) - ΔS' is used to estimate renewable water resources.

Climatic data were obtained from the EEA Climatic Database, which was developed based on the ENSEMBLES Observation (E-OBS) Dataset (Haylock et al., 2008). The State of the Environment database was used to validate the aggregation of the E-OBS data to the catchment scale.

Streamflow data have been extracted from the EEA Waterbase — Water Quantity database. This database does not have sufficient spatial and temporal coverage yet. In order to fill the gaps, Joint Research Centre (JRC) LISFLOOD data (Burek et al., 2013) have been integrated into the streamflow data. The streamflow data cover Europe, in a homogeneous way, for the years 1990-2015 on a monthly scale.

Once the data series are complete, the flow linearisation calculation is implemented, followed by a water asset accounts calculation, which is done in order to fill the data for the parameters requested for the estimation of renewable water resources. The computations are implemented at different scales independently, from sub-basin scale to river basin district scale.

Overall, annually reported data are available for water abstraction by source (surface water and groundwater) and water abstraction by sector with temporal and spatial gaps. Gap-filling methods are applied to obtained harmonised time series.

No data are available at the European scale on 'Return'. Urban waste water treatment plant data, the European Pollutant Release and Transfer Register (E-PRTR) database, Eurostat population data, JRC data on the crop coefficient of water consumption, satellite observed phenology data have been used as proxy to quantify the water demand and water use by different economic sectors. Eurostat tourism data (Eurostat, 2013) and data on industry in production have been used to estimate the actual water abstraction and return on a monthly scale. Where available, state of the environment and Eurostat data on water availability and water use have also been used at aggregated scales for further validation purposes.

Once water asset accounts are implemented according to the United Nations System of Environmental Accounting Framework for Water (2012), the necessary parameters for calculating water use and renewable freshwater water resources are harvested.

Following this, bar and pie charts are produced, together with static and dynamic maps.

Methodology for gap filling

For each parameter of water abstraction, return and renewable freshwater resources, primarily data from the Waterbase — Water Quantity database have been used. Eurostat, OECD and Aquastat (FAO) databases have also been used to fill the gaps in the data sets. Furthermore, the statistical office websites of all European countries have each been visited not only once but several times to get the most up-to-date data from these national open sources. Despite this, some gaps still needed to be filled by applying certain statistical or geospatial methodologies (See reference data sources for gap filling and modulation coefficients).

LISFLOOD data from the JRC have been used to gap fill the streamflow data set (See reference data sources for gap filling and modulation coefficients). The spatial reference data for the WEI+ are the European Catchments and Rivers Network System (Ecrins) data (250-m vector resolution). Ecrins is a vector spatial data set, while LISFLOOD data are in 5-km raster format. In order to fill the gaps in the streamflow data, centroids of the LISFLOOD raster have been identified as fictitious (virtual) stations. The topological definition of the drainage network in Ecrins has been used to match the most relevant and nearest fictitious LISFLOOD stations with EEA-Eionet stations and the Ecrins river network. After this, the locations of stations between Eionet and LISFLOOD stations were compared and overlapping stations were selected for gap filling. For the remaining stations, the following criteria were adhered to: fictitious stations had to be located within the same catchment as the Eionet station and have the same main river segment; in addition, both stations had to show a strong correlation.

A substantial amount of gap filling has been performed in the data on water abstraction for irrigation. First, a mean factor between utilised agricultural areas and irrigated areas has been used to fill the gaps in the data on irrigated areas. Then, a multiannual mean factor of water density (m^3/ha) in irrigated areas per country has been used to fill the gaps in the data on water abstraction for irrigation.

The gaps in the data on water abstraction for manufacturing and construction have been filled by using Eurostat data on production in industry (Eurostat [sts_inpr_a]) and the E-PRTR database with the methodologies in the best available techniques reference document (BREF) to convert the production level into the volume of water.

Methodology references

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Uncertainties

Methodology uncertainty

Reported data on water abstraction and water use do not have sufficient spatial or temporal coverage. Therefore, estimates based on country coefficients are required to assess water use. First, water abstraction values are calculated and, second, these values are compared with the production level in industry and in relation to tourist movements in order to approximate actual water use for a given time resolution. This approach cannot be used to assess the variations (i.e. the resource efficiency) in water use within the time series.

Spatial data on lakes and reservoirs are incomplete. On the other hand, as reference volumes for reservoirs, lakes and groundwater aquifers are not available, the water balance can be quantified as only a relative change, and not the actual volume of water. This masks the actual volume of water stored in, and abstracted from, reservoirs. Thus, the impact of the residence time, between water storage and use, in reservoirs is unknown.

The sectoral use of water does not always reflect the relative importance of the sectors to the economy of a given country. It is, rather, an indicator that describes which sectors environmental measures should focus on in order to enhance the protection of the environment. A number of iterative computations based on identified proxies are applied to different data sets, i.e. urban waste water treatment plant data, E-PRTR data, Eurostat population data, JRC data on the crop coefficient of water consumption and satellite-observed phenology data have been used as proxies to quantify the water demand and water use by different economic sectors. This creates a high level of uncertainty in the quantification of water return from the economic sectors, thus also leads to uncertainty with regard to the 'water use' component.

In order to distribute population data across Europe, the Geostat 2011 grid data set from Eurostat was used. Then, further aggregations were performed in the spatial dimension to give the sub-basin and functional river basin district scales of Ecrins spatial reference data. The population within the time frame of one calendar year is regarded as stable. Variations are taken into account only for the annual scale. Deviations from officially reported data are expected because of the nature of the methodological steps followed.

The tourist data used were provided by Eurostat and relate to the nights spent per NUTS2 region, on the monthly scale, in accommodation establishments. Because of the aggregation/disaggregation steps followed, deviations from officially reported data are expected. The tourist population was included in the calculation as additional to the stable (local resident) population.

Where monthly data were not available, Eurostat tourist data (Eurostat, 2013), data on industry in production (Eurostat [sts_inpr_a]) and JRC satellite-observed phenology data were used to estimate the actual water abstraction and return on a monthly scale.

A validation of the results has been performed by comparing the estimates with reported data where feasible. Some contradictory results have been observed. For instance, the desalination of sea water is one of the methods used to meet the water demands of Cyprus, Malta and Spain. Based on this use of desalinated water, the actual WEI would be around 35-40 % for Malta. However, as desalinated water is not included in the computation of renewable freshwater resources, the WEI+ for Malta is around 100 %. Similarly, because of some technical issues with the reported data on streamflow, the WEI+ could not be computed for Cyprus. Therefore, the results for Cyprus were excluded from the overall assessment. The average WEI reported for Cyprus is 73.1 % for the years 2009-2013 under Water Framework Directive river basin management plan reporting.

A high degree of inconsistency between sub-basin and functional river basin district scales has been observed for the Guadiana river basin. The estimated WEI+ for Guadiana is 131 % for summer 2015, whereas the estimated WEI+ values for its sub-basins for the same period are as follows: 75 % for Upper Zancara, 41 % for Zujar and 48 % for Ardilla. This inconsistency seems to be related to the computations for the aggregation from sub-basin to functional river basin district for this basin. The value will be corrected once this technical problem has been solved.

Data sets uncertainty

Data are very sparse on some particular parameters of the WEI+. For instance, current streamflow data reported by the EEA member countries to the WISE SoE — Water Quantity database do not have sufficient temporal or spatial coverage to provide a strong enough basis for estimating renewable water resources for all of Europe. Such data are not available elsewhere at the European level either. Therefore, JRC LISFLOOD data are used intesively as surrogates (see availability on streamflow data).

Data on water abstraction by economic sectors have better spatial and temporal coverage. However, the representativeness of data for some sectors is also poor, such as the data on water abstraction for mining. In addition to the WISE SoE — Water Quantity database, intensive efforts to compile data from open data sources such as Eurostat, OECD, Aquastat (FAO) and national statistical offices have also been made (see share of surrogate data vs reported data on water abstraction).

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 have to 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. Main consequences of data set uncertainty are the followings;

The Danube river basin is accounted for as a single district in Ecrins, so it aggregates a lot of regional and national information.

The water accounts and WEI+ results have been implemented in the EEA member and Western Balkan countries. However, regional data availability was an issue for some river basins (e.g. in Cyprus, the Jarft in Poland, North West and North Eastern river basins in the United Kingdom, the Kymijoki river basin in the Gulf of Finland, Gran Canarias of Spain and some Icelandic and Turkish river basins), which had to be removed from the assessment.

Rationale uncertainty

Because of the aggregation procedure used, slight differences exist between sub-basin and river basin district scales for total renewable water resources and water use.

Data sources

- Biogeographical regions
provided by **Council of Europe (CoE)** , **Directorate-General for Environment (DG ENV)**
- The European Pollutant Release and Transfer Register (E-PRTR), Member States reporting under Article 7 of Regulation (EC) No 166/2006
provided by **European Environment Agency (EEA)**
- Waterbase - UWWTD: Urban Waste Water Treatment Directive – reported data
provided by **Directorate-General for Environment (DG ENV)** , **European Environment Agency (EEA)**
- European catchments and Rivers network system (Ecrins)
provided by **European Environment Agency (EEA)**
- Urban morphological zones 2006
provided by **European Environment Agency (EEA)**
- Waterbase - Water Quantity
provided by **European Environment Agency (EEA)**
- Water statistics (Eurostat)
provided by **Statistical Office of the European Union (Eurostat)**
- Eurostat statistics on population
provided by **Statistical Office of the European Union (Eurostat)**
- E-OBS gridded dataset
provided by **Royal Netherlands Meteorological Institute (KNMI)**
- LISFLOOD. Distributed Water Balance and Flood Simulation Model
provided by **Joint Research Centre (JRC)**
- NATIONAL STATISTICAL OFFICES (Dataset URL is not available)
provided by **Statistical Office of the European Union (Eurostat)**

Metadata

Topics:

Water and marine environment , Resource efficiency and waste

DPSIR: Pressure

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

Indicator codes

- CSI 018
- WAT 001

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EEA Contact Info

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See also

po2-04-fig2.PNG [https://www.eea.europa.eu/airs/2016/resource-efficiency-and-low-carbon-economy/freshwater-use/po2-04-fig2.png/view]

Freshwater use static [https://www.eea.europa.eu/airs/2016/resource-efficiency-and-low-carbon-economy/freshwater-use/freshwater-use-static/view]

action-download-pdf [https://www.eea.europa.eu/airs/2016/resource-efficiency-and-low-carbon-economy/freshwater-use/action-download-pdf/view]

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