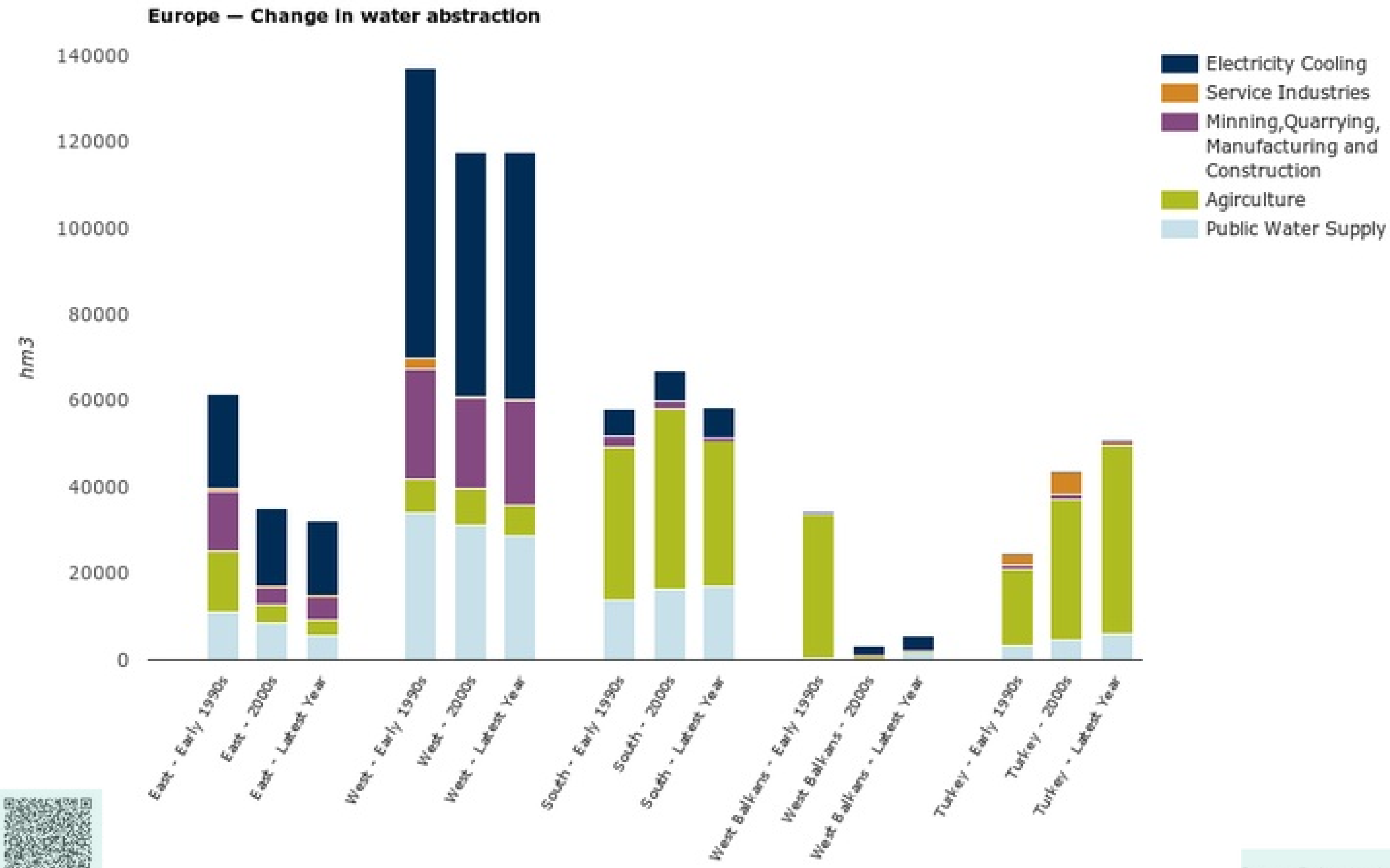
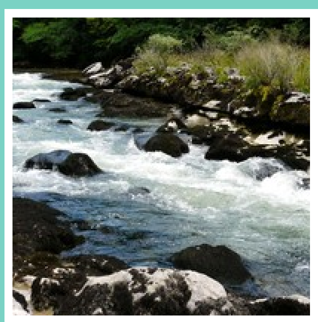
Use of freshwater resources





European Environment Agency

Cover design: EEA
Cover photo: © EEA
Layout: EEA

Electronic publication notice

This report has been generated automagically by the EEA Web content management system on 22 Mar 2016, 11:55 AM.

This report is available as a website at http://www.eea.europa.eu/data-and-maps/indicators/use-of-freshwater-resources-2/assessment-1. Go online to get more interactive facts and figures.

On the report web page you may download the electronic publication (EPUB) for easy reading on your preferred eBook reader.

Please consider the environment before printing.

European Environment Agency
Kongens Nytorv 6
1050 Copenhagen K
Denmark
Tel.: + 45 33 36 71 00
Fax: + 45 33 36 71 99
Web: eea.europa.eu
Enquiries: eea.europa.eu/enquiries

Contents

Use of freshwater resources

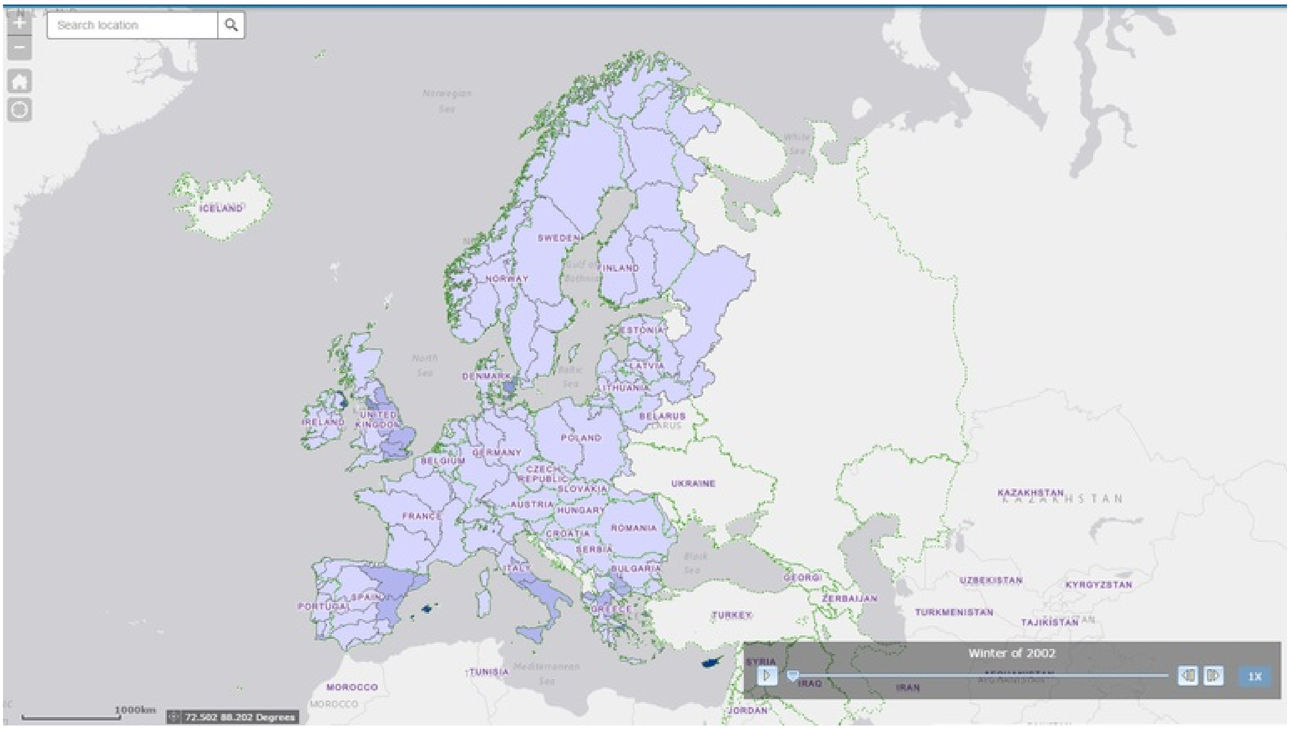
Use of freshwater resources

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 the abstraction rate of water sustainable?

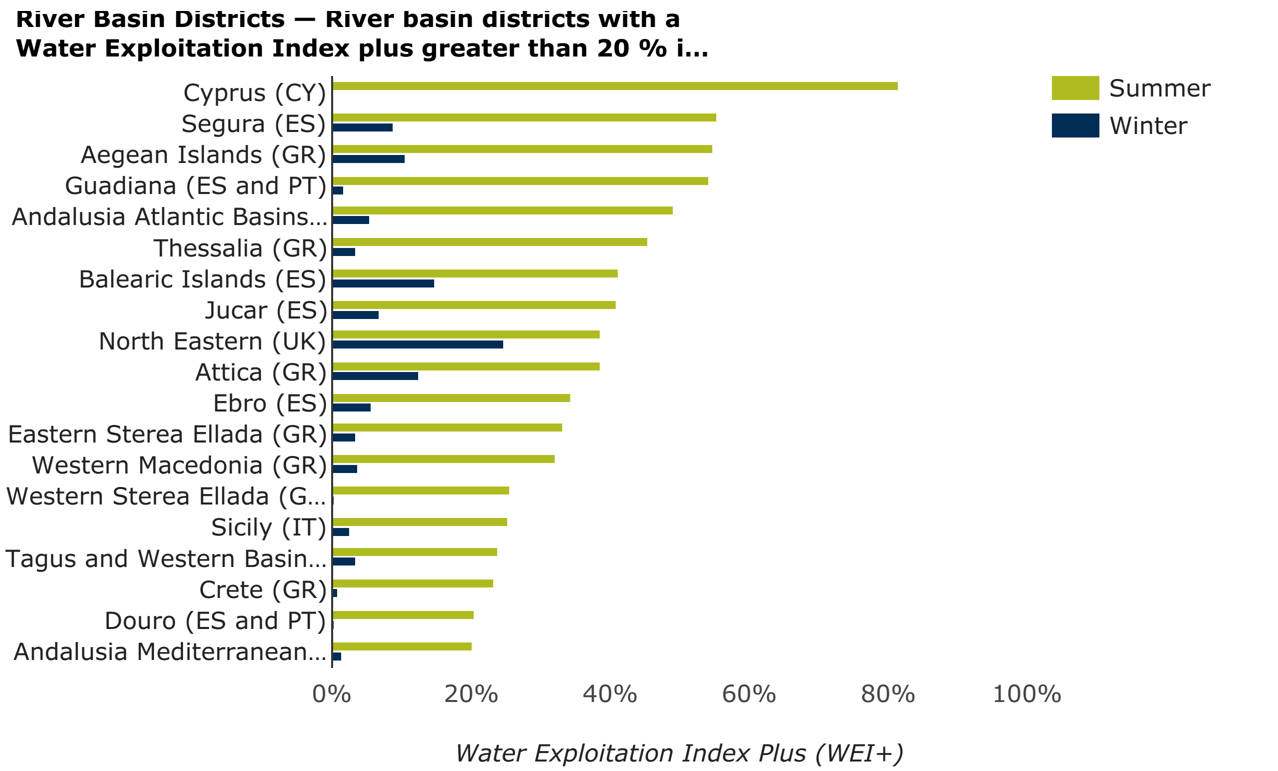
Fig. 1: Water exploitation index for river basin districts



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 greater than 20 % in summer



Note:
The data series are calculated as the 2002-2012 multi-annual average for the seasonal resolution of the Water Exploitation Index (WEI) at river basin district scale. River basin districts are then filtered by using 20 % of the WEI for the multi-annual average of summer months. According to the calendar year, winter (Q1) covers January, February and March, while summer (Q3) covers July, August and September.

Explore chart interactively

European Environment Agency

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)**
- 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)**
- 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.

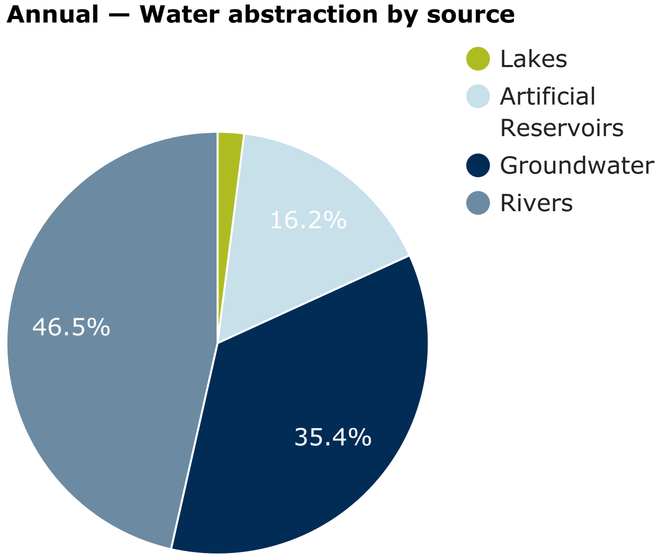
Around 20 river basin districts, primarily in the Mediterranean and Mediterranean islands including Cyprus, Malta, Crete, the Balearic Islands and Sicily, are faced with water stress (WEI > 20 %) (see Map and Figure 1). The highest multi-annual summer average water exploitation index for the period 2002-2012, 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.

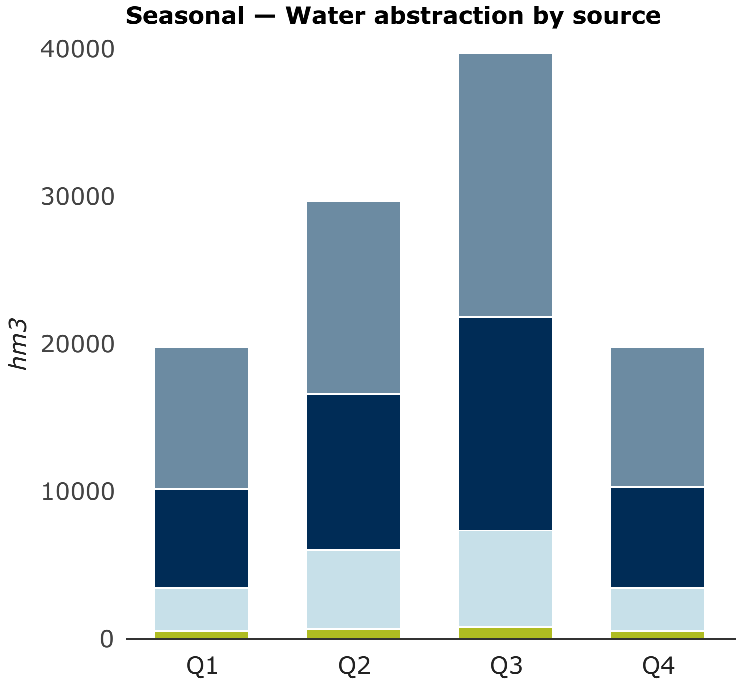
There are large seasonal differences in water stress conditions across Europe. During winter, only 5 % of the total area of Europe experiences water stress (WEI+ greater than 20 %). In summer, due to lower levels of renewable water resources, accompanied with high water demand, more than 12 % of the 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 multi-annual average for water abstraction by source at the sub-basin scale. The mullti-annual average of quarterly v
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).

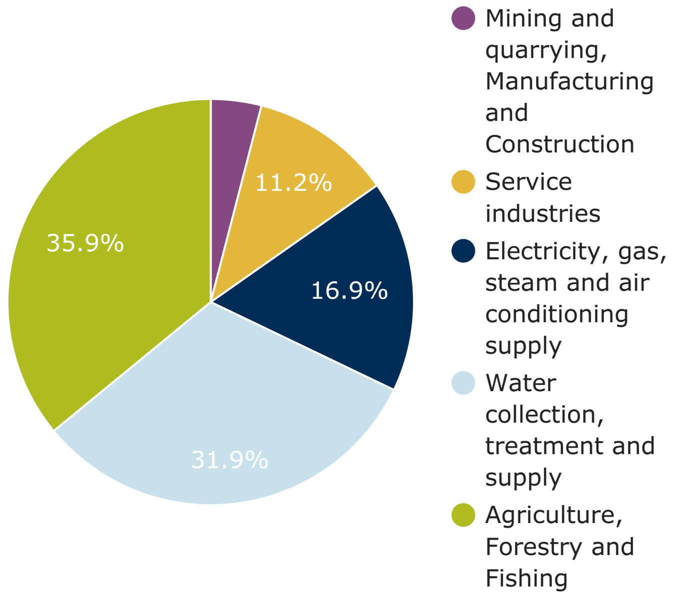
Due to the insufficient spatial and statistical data coverage of reservoirs, an assessment of water storage in reservoirs and associated possible environmental impacts is incomplete (See the methodology section and ETC ICM Report 2015). However, available data and information indicate that reservoirs 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.

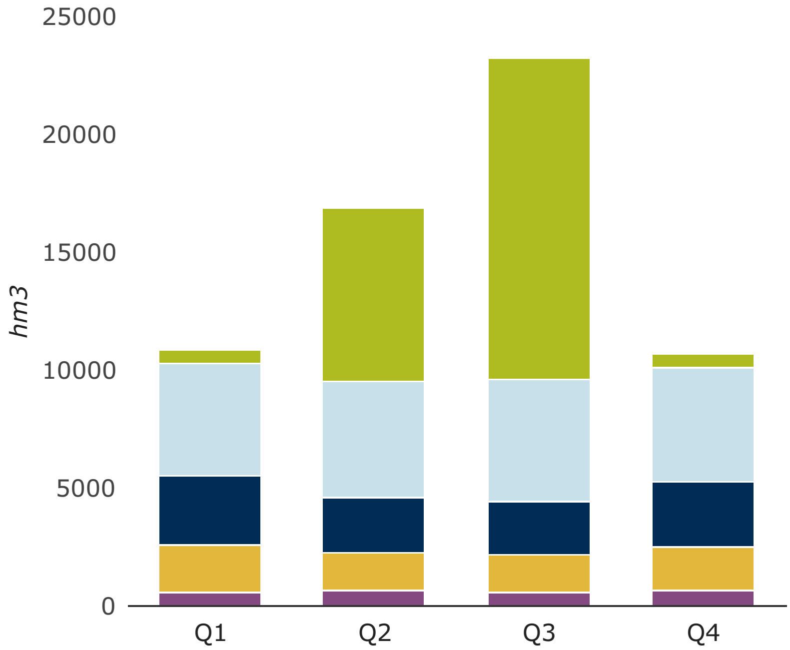
Is the use of water by sectors sustainable?

Fig. 4: Water use by sector

Annual — Water use by sector



Seasonal — Water use by sector



Note:
For the pie chart, the data series are calculated as the 2002-2012 multi-annual average for water use by sector at the sub-basin scale. The multi-annual average of quarterly values has identified according to the NACE classes.
Q1= January, February, March
Q2= April, May, June
Q3= July, August, September
Q4= October, November, December

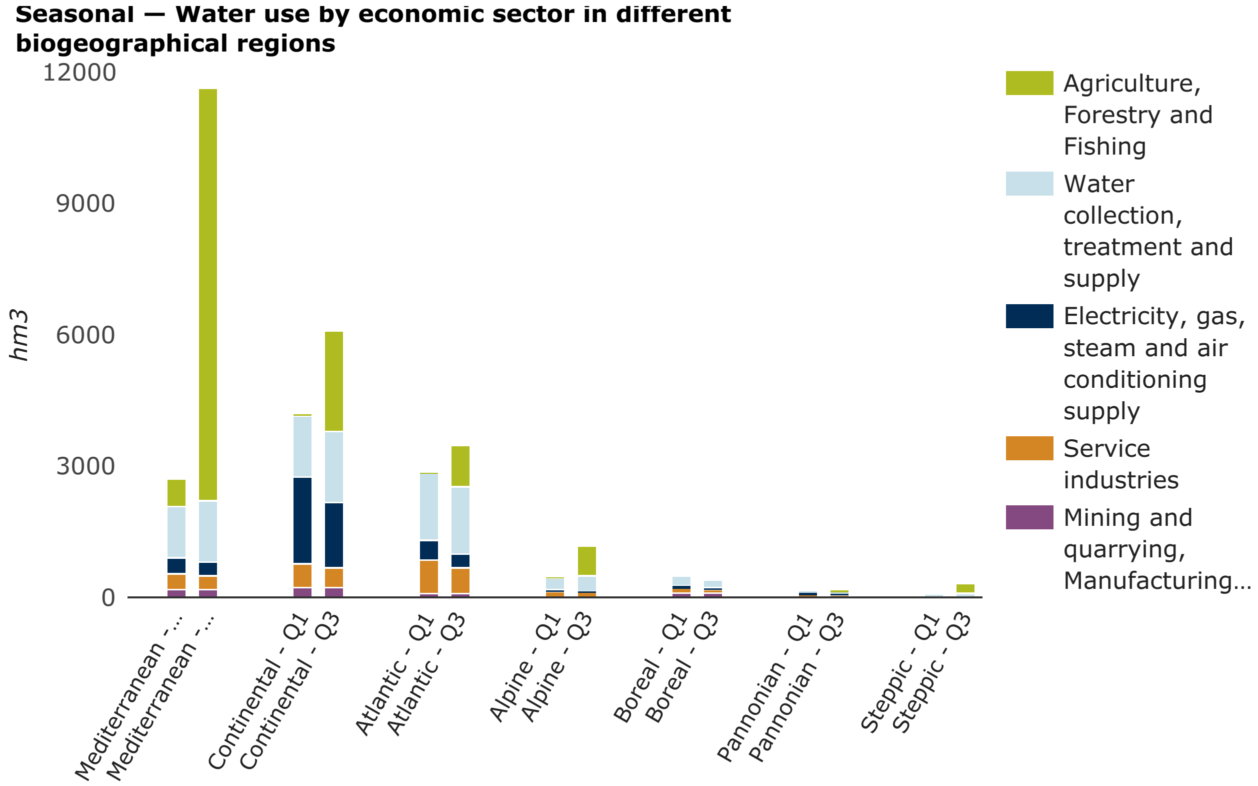
Explore chart interactively

European Environment Agency

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)**
- 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

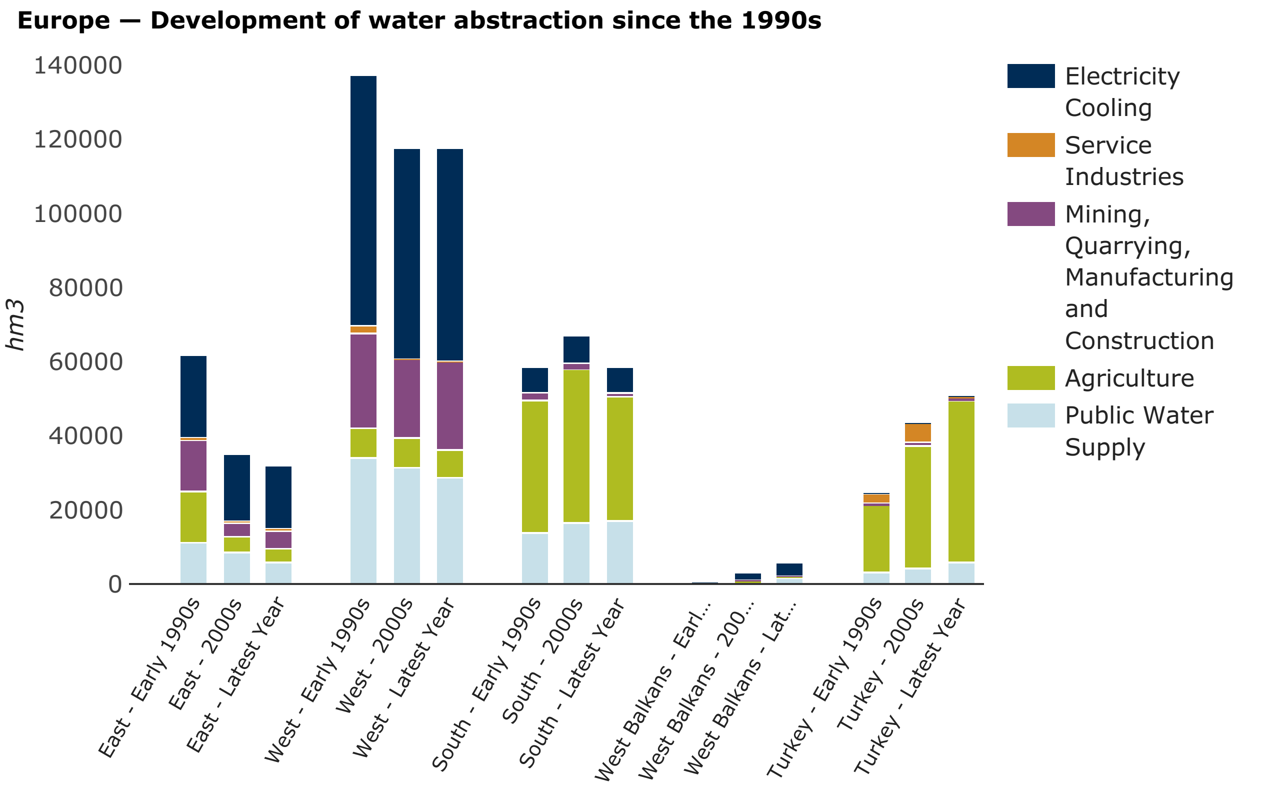
Explore chart interactively

European Environment Agency

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

European Environment Agency

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 Water Exploitation Index Plus (WEI+) is the total water use as a percentage of the renewable freshwater resources in a given territory and time scale.

Units

Percentage of water use over renewable water resources. Absolute volume of water is presented in million cubic meters (million m3)

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 helps to improve resource efficiency, which is included as an objective of the EU's Seventh Environment Action Program to 2020.

This indicator shows how total water use puts pressure on renewable water resources by identifying areas (sub-basins or river basins) with high seasonal abstraction in relation to the resources they contain, making them prone to water stress. 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 particular territory. This helps to identify those areas prone to water stress problems (Faergemann, 2012). The purpose of implementing the WEI+ at spatial (e.g. sub-basin or river basin) and temporal (monthly or seasonal) scales that are finer than the annual average at the country scale is to better capture the balance between renewable water resources and water use. This is done in order to assess the prevailing water stress conditions across Europe. In some basins, water scarcity is reflected only when calculating the indicator using the monthly WEI+, but is not necessarily captured by it.

Scientific references

- United Nations, 2012 System of environmental-economic accounting for water, United Nations, New York.
- Essex, S., Kent, M. and Newnham, R., 2004.Tourism development in Mallorca: Is water supply a constraint? Journal of Sustainable Tourism, Vol.12, No.1.
- Gössling, S., Peeters, P., Michael Hall, C.M., Ceron, J.P., Dubois, G., Lehmann, L.V., Scott, D., 2012.Tourism and water use: Supply, demand, and security. An international review. Tourism Management. Volume 33, Issue 1, February 2012, Pages 1-15.
- Faergemann, H., 2012. Update on Water Scarcity and Droughts indicator development , May 2012, presented to the WD Meeting, 4-5 June 2012, Denmark
- European Environment Agency, 2012a. European waters: current status and future challenges ; synthesis. No.8/2012, Copenhagen.
- European Environment Agency, 2012b. Water resources in Europe in the context of vulnerability: EEA 2012 state of water assessment. No.11/2012. Copenhagen
- Haylock, M. R., Hofstra, N., Klein Tank, A. M. G., Klok, E. J., Jones, P. D. and New, M., 2008.A European daily high-resolution gridded data set of surface temperature and precipitation for 1950–2006. Journal of Geophysical Research 113(D20).
- Burek, P., Kniff van der, J., Roo de, A., 2013 LISFLOOD, distributed water balance and flood simulation model revised user manual 2013. European Commission Joint Research Centre Institute for the Protection and the Security of the Citizen. Luxembourg. ISBN: 9789279331909 9279331906

- Eurostat, 2013 Tourism industries — economic analysis — Statistics Explained, Statistics in focus 32/2013.

Policy context and targets

Context description

The objective of the EU's Seventh Environment Action Programme to 2020 is to ensure the protection, conservation and enhancement of the EU’s natural capital and to improve resource efficiency. Monitoring of 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 UNEP, OECD, EUROSTAT and the Mediterranean Blue Plan. There is an international consensus about the use of this indicator.

The indicator describes how total water use puts pressure on water resources and identifies areas (e.g. sub-basins or river basins) with high abstraction on a seasonal scale in relation to the resources available, and that are therefore prone to water stress. The changes in WEI+ help to analyse how the changes in water use impact on freshwater resources by adding pressure to them or by making them more sustainable.

Targets

There are no specific quantitative targets directly related to this indicator. However, the Water Framework Directive (2000/60/EC) requires Member States to promote sustainable use of water resources based on long-term protection of available water resources and ensure a balance between abstraction and recharge of groundwater, with the aim of achieving good groundwater status by 2015.

Having agreed thresholds of water exploitation index plus (WEI+) is quite important for delineating non-stress and stress areas. Raskin et al. (1997) suggests a WEI value above 20 % indicates water scarcity whereas a value higher than 40% indicates severe water scarcity. These thresholds are commonly used in scientific studies (Alcamo et al, 2000). Besides, Smakhtin, et al., (2005) suggest that 60 % withdrawal from the annual total runoff would cause environmental water stress. Since no formally agreed thresholds are available for assessing the water stress conditions across Europe, in the current assessment 20 % threshold as proposed by Raskin at al. (1997) is applied to distinguish stress and non-stress areas while 40% is used only as the highest threshold for mapping purposes.

Related policy documents

- 7th Environmental 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’
- 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.
- 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

In 2011, a technical working group, which developed under the Water Framework Directive Common Implementation Strategy, proposed the implementation of the Regionalised Water Exploitation Index Plus (WEI+). This moved away from the previous approach, enabling the WEI to depict more seasonal and regional aspects of water stress conditions across

Europe. This proposal further 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 Water Resources

Renewable water 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 the downstream/Sea

It is assumed that there is no pristine or semi-natural river basin district or sub-basin in Europe. Therefore, the formula of (Outflow + (Abstraction - Return) - ΔS) is used in estimating the renewable water resources.

1. Climatic data was 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 has been used for validating the aggregation procedure of the E-OBS data to the catchment scale.
2. Stream flow data has 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, JRC LISFLOOD data (Burek at al, 2013) has been integrated into the stream flow data. The stream flow data covers Europe in a homogeneous way for the years 2002-2012 at monthly scale.
3. 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 to river basin district scale.
4. Urban Waste Water Treatment Plants, E-PRTR database, Eurostat population data and JRC data on the crop coefficient of water consumption has been used for quantifying the water demand and water use by different economic sectors. Eurostat tourism data and data on industry in production has 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 has also been used at aggregated scales for further validation purposes.
5. 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.
6. Afterwards, the bar and pie charts were produced, together with the static and dynamic maps.

Methodology for gap filling

LISFLOOD data of Joint Research Centre has been used in filling the gap in the stream flow data. The spatial reference data for the Water Exploitation Index Plus is Ecrins (250 m vector). Ecrins is a vector spatial data while LISFLOOD data is 5 km raster. In order to fill the gaps in the streamflow data, centroids of the LISFLOOD raster have been identified as fictitious stations. Topological definition of the drainage network in Ecrins has been used in snapping the most relevant and nearest LISFLOOD fictitious stations with EEA-EIONET stations and the Ecrins river network. Then locations of stations between EIONET and LISFLOOD have been compared and fully overlapping stations have firstly been selected for the gap filling. For the remaining stations the following principles have been implemented; fictitious stations have to be located within the same catchment with the EIONET station and share the same main river segment. In addition, both stations should provide strong correlation.

Methodology references

- Alcamo et al. 2000 Alcamo, J., Henrich, T., Rosch, T., 2000. World Water in 2025 - Global modelling and scenario analysis for the World Commission on Water for the 21st Century. Report A0002, Centre for Environmental System Research, University of Kassel, Germany
- EC 2012a Preparatory Action, Development of Prevention Activities to halt desertification in Europe, Service Contract to contribute to the building of Water and Ecosystem accounts at EU level. Part 1.
- EC 2012b Preparatory Action, Development of Prevention Activities to halt desertification in Europe, Service Contract to contribute to the building of Water and Ecosystem accounts at EU level. Part 2.
- Kurnik, B., Louwagie, G., Erhard, M., Ceglar, A. and Bogataj Kajfež, L., 2014. Analysing Seasonal Differences between a Soil Water Balance Model and In-Situ Soil Moisture Measurements at Nine Locations Across Europe. Environmental Modeling & Assessment 19(1), pp. 19–34.
- Raskin, P., Gleick, P.H., Kirshen, P., Pontius, R. G. Jr and Strzepek, K. ,1997. Comprehensive assessment of the freshwater resources of the world. Stockholm Environmental Institute, Sweden. Document prepared for UN Commission for Sustainable Development 5th Session 1997 - Water stress categories are described on page 27-29.
- Smakhtin, V., Revanga, C. and Doll, P. 2005. Taking into account environmental water requirement in global scale water resources assessment. IWMI the Global Podium.
- ETC ICM, 2015. CSI 018 Use of freshwater resources in Europe (WAT01). Supplementary document to the draft indicator sheet.

Uncertainties

Methodology uncertainty

Reported data on water abstraction and use does not have sufficient spatial and temporal coverage. Therefore, modelling with proxies needs to be implemented in order to assess net water use. First, water demand is calculated and afterwards this is compared to the production level in industry and tourism movements in order to approximate actual water use on a given time resolution. This approach does not have the ability to assess the justification of variations (i.e. resource efficiency) in water use over the time series.
Due to the reference volume of reservoirs and lakes not being available, the water balance for reservoirs can only be quantified as a relative change, and not as the actual volume of water. This masks the understanding of actual water storage in, and abstraction from the reservoirs. Thus, the impact of residence time between water storage and water use from reservoirs is unknown.
The sectorial use of water does not always reflect the relative importance of the sectors in the economy of a given country. It is, rather, an indicator describing which sectors environmental measures need to focus on in order to enhance the protection of the environment.

Data sets uncertainty

Quantifying water exchange between the environment and the economy is, conceptually, a very complex issue. A complete quantification of the water flows from environment to economy and, at a later stage, back to the environment, requires detailed data collection and processing which is not available at European level. Thus, reported data has to be combined with some modelling to construct the data for quantifying such water exchange, with the purpose of developing a good approximation to “ground truth”. But the most challenging issue is related to water abstraction and water use data as the water flow within the economy are quite complex to monitor and assess under current data availability. Therefore, several interpolation, aggregation or disaggregation procedures have to be implemented at finer scales, with both reported and modelled data.

-Due to errors in coordinates of the stream flow stations that reported, the estimated Water Exploitation Index Plus values have uncertainties, as does water use by sector for Cyprus.

- Andalusia Mediterranean Basin; eventually a substantial difference between local estimate (WAMCD Project-07.0329/2013/671291/SUB/ENV.C1) and the EEA estimate is subject due to the data precision and methodologies implemented. EEA results for the Andalusia Mediterranean Basin looks underestimated compared to the local estimation.

Because of errors in flow linearization computation, the WEI+ results are not available for the following sub-basins:

- Drau and Sava of the Danube River Basin;

- Rhine coastal sub-basin of the Rhein River Basin;

- Elbe coastal catchment; and

- Weser coastal catchment.

Rationale uncertainty

Due to 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)**
- Population data (Eurostat)
  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)**

Generic metadata

Topics:

 Water (Primary topic)

Indicator codes

- CSI 018
- WAT 001

Tags:

'wei' (water exploitation index) | water abstraction

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

Contacts and ownership

EEA Contact Info

Nihat Zal

EEA Management Plan

2015 1.5.4 (note: EEA internal system)

Ownership

- European Environment Agency (EEA)

Dates

First draft created:
27 Oct 2015, 12:38 PM
Publish date:
21 Mar 2016, 06:52 PM
Last modified:
21 Mar 2016, 06:53 PM

Frequency of updates

Updates are scheduled every 2 years

Permalinks

Permalink to this version

f3a53d9b16b348fc8c31b109c01c2adc

Permalink to latest version

9EKW4KDTGF

Related content

News and articles

Is Europe's freshwater use sustainable? [http://www.eea.europa.eu/highlights/world-water-day-is-europe]